

A SURVEY OF THE MARINE PROTOZOA OF AMOY*

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INTRODUCTION

In connection with the Summer Survey of the Marine Biological Association of China for 1932, the writers were called to make a preliminary study of the Protozoan fauna of Amoy. The work was carried on at the Marine Biological Station at the University of Amoy from July 15th to August 24th. Within the limit of such a short period, a great number of the local species might have escaped from observation, since the appearance and disappearance of certain particular forms of Protozoa in the same locality are usually correlated with the seasonal changes of the environment. It seems necessary that studies on the seasonal distributions of the species, or daily observations of the animals throughout the year should be thoroughly made before a more comprehensive report could be formulated.

In the present investigation, observations were chiefly confined to the planktonic species from the Bay of Amoy. Bottom dwellers like Foraminifera and pelagic forms like Radiolaria had not been particularly studied. Daily collections were made from various Stations and water samples were towed at the surface by means of a conical silk plankton net. In addition to hauling, littoral collections were also made from time to time. Having brought the samples to the laboratory, they were transferred into the large petri dishes or finger bottles, and, in certain cases, seaweeds were added to the samples so as to make constant standing cultures. When the species had been determined under the com-

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The writers avail themselves of this opportunity to express their thanks to Dr. T. Y. Chen for allowing them to utilize all the possible facilities from the Department of Zoology at the University of Amoy during the progress of their work.

pound microscope, careful drawings were made for each species. An ocular micrometer was used for making measurements.

There were eighty four species of Protozoa recorded in this investigation, and twelve of them were described as new. A great number of the species of Dinoflagellates and Tintinninea were frequently observed from the freshly collected samples while most of the hypotrichous Infusoria were largely found in the standing cultures of about one week old. In the following presentation, special notes on some important characters were given in certain cases for the Orders, Families, and Genera, in addition to the descriptions of species. For the benefit of the readers in touch with the contents, a list was made of all described species, indicated with the number of pages containing their respective descriptions.

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MASTIGOPHORA

Order Dinoflagellata

Suborder Diniferina

Family Peridinidae

Peridinidae is the largest Family of Dinoflagellates. It is characterized by the nature of the shell which is always made up of distinct plates. The number and arrangement of these plates furnish the basis for specific as well as generic identifications. The transverse furrow, covered by an annular girdle plate or cingulum, divides the shell body into two portions. The anterior portion, called the epitheca, consists of apical and precingular plates, and the posterior portion, called the hypotheca, consists of postcingular and antapical plates. The plates are usually separated one from another by the presence of intercalary bands. The region where the flagella are originated, is covered by one or more thin and delicate plates forming the ventral area as designated by Kofoid. Of the two flagella, as in most members of Dinoflagellates, one runs longitudinally backwards as a trailing flagellum along the longitudinal groove, and the other runs transversely round the body in the transverse groove.

Genus Peridinium

In dorso-ventral view, the general outline of the body of the species of Peridinium is either round, oval, or pentagonal. It

Sticholonche zanclea?

(Fig. 28)

Body oval or globular, rather transparent. Spicules numerous, needle-shaped or elongate blade-like, grouped together at their bases in five bundles on the surface of the body, radiating

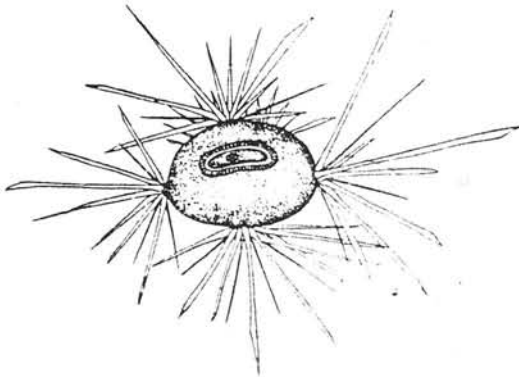


Fig. 28. *Sticholonche zanclea?* $\times 350$.

out in all directions. Central capsule rather thick, elliptical or sausage shaped, usually curved at the middle, containing a single nucleus.

Size: $50\mu \times 60\mu$

The structure of this peculiar animal deviates so much from the ordinary types of Radiolarians and the genus *Sticholonche* is generally considered as an aberrant group. Individuals are usually found in the surface collections of sea water.

INFUSORIA

Order Holotricha

Family Encheiminidae

Trachelocerca phoenicopterus Cohn 1866

(Fig. 29)

Body flattened, ribbon or worm like, from thirty to forty times as long as broad, highly elastic and retractile, prolonged

anteriorly into an attenuate, transparent neck, and posteriorly into a long pointed, tail-like portion. Cytostome terminal, circular, with a rigid annular border, followed by a funnel-like pharyngeal cleft. Cuticular surface finely ciliated, feebly striated longitudinally. Macronuclei two in number. Contractile vacuoles multiple, lineally disposed at the posterior portion of the body.

Length: 1050 μ

Width: 26 μ

Trachelocerca phoenicopterus is characterized not only by the exceedingly elongate body, but also by the presence of a rigid annular border surrounding the apical extremity together with the funnel-shaped pharyngeal cleft. The body is flattened and transparent and most of the internal structures had been made out from a single individual found in August 1, 1932. The two spherical macronuclei are located somewhat at the middle portion of the body and one separates from another for a quite distance.

The peculiar arrangement of the contractile vacuoles is also revealed in this single specimen. There are five larger vacuoles, closely grouped in a lineal series at the posterior portion of the body. Quite a distance behind the last one of these, there is an isolated vacuole. Two more minute vacuoles may be seen close to the pointed posterior extremity. It should be stated, however, that the number of the contractile vacuoles in *T. phoenicopterus* is not definitely eight, since specimens with only one or two contractile vacuoles have been recorded in Cohn's original description as cited by Kent ('82).



Fig. 29. *Trachelocerca phoenicopterus*
Cohn. $\times 150$.

The animal swims through the water very slowly with its tail-like posterior extremity turning to left or right at will. On account of its peculiar behavior of the locomotion in addition to the greatly elongated body, the animal may be easily mistaken as a flat worm at first glance.

Lacrymaria sp?

(Fig. 30)

Body clavate or flask-shaped, more than four times as long as broad, attenuate anteriorly to form a slender neck. An annular plug-like projection very prominent on the termination of the neck, and with a terminal mouth. Posterior end more or less tapering. Cuticular surface obliquely striate, finely and entirely ciliated; a single circlet of longer cilia surrounding the base of the annular plug-like projection. Macronucleus oval or ellipsoidal, centrally or subcentrally in position. Contractile vacuole single, postero-terminal.

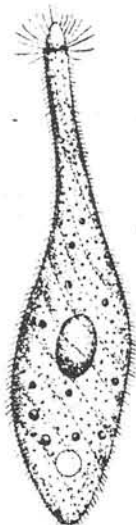


Fig. 30. *Lacrymaria* sp?.
× 500.

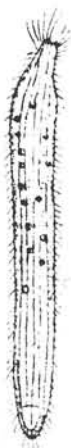


Fig. 31. *Choenia limicola*
Levander-Lauterborn × 500.

Length: 120 μ -170 μ

Width: 38 μ -42 μ

The individuals of this species are frequently found from the Bay of Amoy. Like other species of the genus, it swims through the water very swiftly with its anterior end turning in all directions. Although the neck is quite contractile, it never extends anteriorly to a great distance like *Lacrymaria olor* Müller. The animal, represented in figure 30, shows that the neck is in fully extended condition. The animal appears almost identical to *Lacrymaria versatilis* (O. F. Müller).

Choenia limicola Levander-Lauterborn 1901

(Fig. 31)

Body slightly elastic, elongate-lanceolate, about four to as much or more than ten times as long as broad, obtusely rounded at the posterior end, slightly tapering posteriorly. Cytostome at the anterior extremity, widely dilated during the passage of food substances, otherwise inconspicuous. Cuticular surface finely ciliated, faintly striated longitudinally; apical or oral cilia long and large, forming a forwardly directed brush-like tuft. Contractile vacuole single, postero-terminal in position.

Length: 85 μ -120 μ

Width: 20 μ -30 μ

Choenia limicola may be found in great abundance from the standing cultures of sea water. It swims through the water slowly or rapidly with its anterior end turning in all directions like the gesture usually performed by the worms.

The body of *C. limicola* is shorter than *C. teres* Dujardin, since the length of the latter usually exceeds twenty times its breadth. The anterior extremity of *C. teres* is conically pointed while, in the present species, it is bluntly tapered.

The endoplasm is always crowded with food vacuoles or particles and the macro- and micronucleus have not been made out during observation.

Mesodinium pulex (Cl. & L.) Stein 1862

(Fig. 32)

Halteria pulex Calp. et Lachm. 1858-9

Body turbinate, globose posteriorly, conical and tapering as it approaches the anterior end to form a projecting snout, with deep annular constriction or girdle a little above the half way of the longitudinal axis. Cytostome at the apical end of the projecting snout, armed from the inside out with four small oral tentacles. Cilia long and large, cirrose-like, forming two wreaths, developed on the annular constriction. Macronucleus single, spherical or ovoid. Contractile vacuole one.

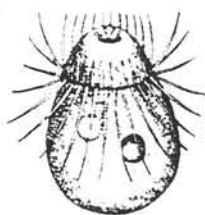
Length: 16 μ Width: 12 μ 

Fig. 32. *Mesodinium pulex* (Cl. and L.).
× 1500.

This is a very minute species, and only few specimens have been observed from Amoy.

When the animal moves, the cirrose-like cilia of the anterior wreath direct forward while those of the posterior wreath trail behind as shown in the figure.

The oral tentacles may extend forward for a considerable distance and their enlarged free terminal ends are suckorial in order to capture the prey which consists of other minute ciliates.

Family Chlamydodontidae***Thoracophrya luciae*** (Kahl 1926) var. *livida* var. nov.

(Fig. 33)

Body ellipsoidal, less than two times as long as broad. Cytostome terminal, leading into a delicate straight, tubular cytopharynx which ends abruptly into the endoplasm, associated externally with a pseudomembrane extending from the anterior extremity towards the lateral side to a distance about one third

of the entire length of the body. Cuticular surface brightly coloured, spirally furrowed, with minute trichocysts imbedded inside of these furrows appearing as shining bead-like spots. Cilia of the body surface generally uniform in size, shorter than those consisting the pseudomembrane. Macronucleus single, ovoidal or ellipsoidal, centrally or subcentrally located; micronucleus spherical, in close contact with the macronucleus. Contractile vacuole single, posteriorly located.

Length: 70 μ

Width: 40 μ

The brilliant bluish colour of the cytoplasm and the presence of shining and reflective spots, namely the trichocysts, inside of the spiral furrow give the animal a very striking appearance to distinguish itself from the other species of the ciliates. According to Kahl's (28) description for *T. luciae* var. *macilis*, the number of the spiral furrows is definitely eight, while the individuals of the present variety usually exhibit thirteen or fourteen furrows, like in the case of *T. sulcata* Mansf. *T. sulcata*, however, does not possess a pseudomembrane which is a very peculiar structure consisting of longer cilia and is characteristic to all the varieties of *T. luciae*.



Fig. 33. *Thaumocophrya luciae* var. *livida* var. nov. $\times 675$.



Fig. 34. *Dysteria tauricella* Kahl. $\times 650$.

The cytostome is not laterally located at the end of the pseudomembrane, but terminal in position. The tubular cyto-

pharynx is rather thin and delicate, and seems not composed of separate pharyngeal rods.

The animal is a voracious feeder, and usually contains many food vacuoles of large size.

The occurrence of this animal in Amoy is not abundant.

Family Dysteriidae

Dysteria navicula Kahl 1928

(Fig. 34)

Body boat-shaped, convex dorsally, flattened ventrally, truncate and more or less curved towards the left at the anterior end, with a movable spine-like caudal appendage attached to the posterior extremity which is tapering and bluntly pointed. Cytostome antero-ventral, supplemented by a simple horny tubular cytopharynx, associated with a very small pre-oral undulating membrane. Cilia in longitudinal rows, confined to the subcentral very narrow band-like area of the ventral surface, with the rows of the one side curved above the cytostome to meet those of the other side. Nucleus single, ellipsoidal, divided equatorially in two visible parts. Contractile vacuoles many, usually four in number, two anteriorly and two posteriorly located.

Length: 68 μ

Width: 16 μ

This species is frequently found among the decaying algae from the cultures of sea water.

Family Trachelinidae

Lionotus fasciola (Ehrenberg) Wrzesniowsky 1870

(Fig. 35)

Auriphileptus fasciola Ehrenberg 1838

Body more or less elastic, elongate oval or lanceolate, from four to six times as long as broad, widest at the central region, rounded posteriorly, gradually tapering toward the anterior ex-

tremity to form a narrow, hyaline, flexible neck-like proboscis which is often abruptly curved at its distal end and scarcely exceeds one half of the length of the entire body. Dorsal surface convex, naked; ventral surface flattened and ciliated throughout. Cytostome in the form of an indistinct slit-like aperture, situated at the ventral side of the neck-like proboscis, close to the left-hand

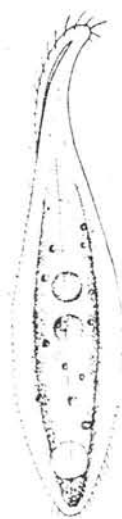


Fig. 35. *Lionotus fasciola* (Ehrenberg). $\times 650$.

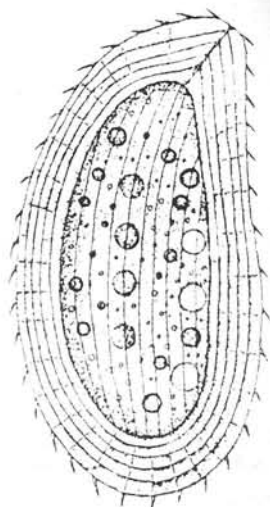


Fig. 37. *Loxophyllum setigerum* Quennerstedt. $\times 580$.

border. Macronuclei two in number, spherical, centrally placed, very close one to another. Contractile vacuole single, near the posterior extremity.

Length: $85\mu-120\mu$

Lionotus fasciola, a very common fresh water species, is also found in great abundance from the cultures of sea water in Amoy. After a careful observation, it is confirmed that this particular marine variety is identical to the fresh water forms practically in every detail.

The animal is highly elastic, and its body may be contracted or extended in a great extent during locomotion. The endoplasm is very clear and transparent, especially in the flattened proboscis.

The two macronuclei could be easily observed without the aid of staining.

Amphileptus gutta Cohn 1866

(Fig. 36)

Body elongate-pyriform, about four and one half times as long as broad, widest at the middle portion, rounded posteriorly. Anterior extremity tapering and more or less pointed, uncinata, curved towards the dorsal aspect. Dorsal margin convex; ventral flat or slightly concave. Cytostome elongate-slit-like, situated on the ventral surface at a distance of about one third of the length of the body from the anterior extremity. Cuticular surface striate longitudinally, densely clothed with short, fine, even cilia. Cilia bordering the cytostome slightly longer than the rest. Endoplasm with numerous large, spherical water vacuoles and refringent corpuscles scattered throughout the cortical layer. Macronuclei two in number, spherical, centrally located. Contractile vacuole single, postero-terminal.

Length: 215 μ

Width: 52 μ

At a glance, this animal may be easily mistaken as a species of *Lionotus* on account of its proboscis-like anterior end and the presence of two spherical macronuclei at the middle portion of the body. *Amphileptus gutta* is, however, flask-shaped, and never extends greatly to form a very elongate and slender neck like what might be frequently observed in the case

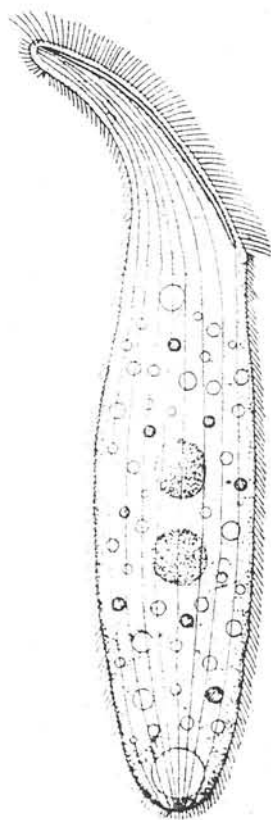


Fig. 36. *Amphileptus gutta*
Cohn. $\times 440$.

of the species of *Lionotus*. The slit-like cytostome is very prominent and much longer than that in the species of *Lionotus* occupying about the anterior third of the entire body.

The occurrence of this species in Amoy is rather rare.

***Loxophyllum setigerum* Quennerstedt 1867-68**

(Fig. 37)

Body dorso-ventrally flattened, with a broad hyaline border, ovoid or sometimes irregularly rhomboidal, about two times as long as broad, widest centrally, attenuate anteriorly, rounded posteriorly. Ventral border nearly straight, neither undulate nor bearing trichocyst; dorsal border strongly or gibbously arcuate. Cytostome slit-like, situated on the ventral side close to the anterior extremity. Cuticular surface longitudinally striated; with cross markings or linings perpendicular to the longitudinal striae on the lateral sides of the hyaline border. Ciliation restricted to the ventral side of the body only; cilia bordering the lateral periphery often transformed into seta-like projections. Macronuclei spherical, four in number, disposed in a linear series in the mid-dorsal region. Contractile vacuoles more than one, forming a continuous row down the dorsal margin when they are numerous.

Length: 105 μ

Width: 60 μ

Loxophyllum setigerum is characterized by the presence of the seta-like cilia bordering the lateral periphery of the body. In the dorso-ventral view, the animal seems to be composed of two parts, a humped granular central mass and a hyaline, broad, peripheral border surrounding the central mass. The nuclei, contractile vacuoles, and endoplasmic granules are all included in the central mass and, thus, the latter gives a dark or opaque appearance in contrast with the peripheral hyaline layer.

According to Kahl ('28), there is probably a row of trichocysts along the left side of the pharyngeal slit as indicated by the presence of the shining reflective dots. Such a row of

shining dots has not been observed in the two individuals found in Amoy.

Family Chiliferidae

Uronema marina Dujardin 1841

(Fig. 38)

Body persistent in shape, elongate ovate, from two to three times as long as broad, narrower and slightly truncate at the anterior end, thicker and rounded posteriorly, with the marginal surface usually crenulated or rugose in appearance. Peristome-field located at the ventral surface, in the form of a deep furrow, extending from the anterior extremity backward to a distance a little anterior to the center of the body. Oral aperture situated at the posterior end of the peristome which is supplemented externally with an extensile trap-like adoral membrane. Cilia of the general surface vibratile, of even length throughout, dispersed in parallel rows, four or five of which are exposed to the view by the body as seen in profile. A long seta-like tactile filament produced from the posterior extremity, almost equalling the body in length. Macronucleus single, spherical or oval, subcentral in position. Contractile vacuole one, posteriorly located.

Length: 35 μ

Width: 14 μ -17 μ

Only several individuals of *Uronema marina* were found from the Bay of Amoy during the latter part of July. Although the species was recorded by Dujardin as most abundantly developed in salt-water, a form, identical in all essential details to the present species, has been found from fresh water by Kent and other authors.

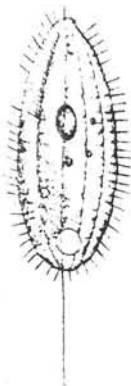


Fig. 38. *Uronema marina* Dujardin. \times 335.

Glaucoma hyalina sp. nov.

(Fig. 39)

Body persistent in shape, somewhat elongate-ovate, more than two times the breadth in length, rounded at both extremities. Anterior third narrower and hyaline, slightly expanded toward the posterior extremity. Cytostome situated laterally close to the anterior extremity, associated with a projecting vibratile undulating membrane. Cuticular surface longitudinally ciliated. Trichocysts numerous and fine, uniformly disposed.

Length: 70 μ Width: 30 μ

The new species is characterized by the permanent presence at the anterior half of the body a hyaline area which is more or less bluish in colour and gives a reflective or shining appearance when the animal performs a constant locomotion. As a rule, the posterior half of the body is crowded with food vacuoles and oil-like corpuscles and it appears very dark and opaque in contrast with the above hyaline area.

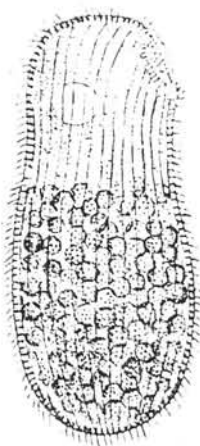


Fig. 39. *Glaucoma hyalina* sp. nov.
×835.

The cytostome has the same structure as in the other species of the genus, and the vibratile undulating membrane is composed of two alike pieces. The trichocysts are very fine and numerous and could be seen under a very careful observation. It is also a peculiar fact that, in this species, the contractile vacuole is located near the anterior end of the hyaline area but not close to the posterior extremity.

Individuals of this species may be found in great abundance from the standing cultures of the sea water.

Anophrys sarcophaga Cohn 1866

(Fig. 40)

Body elongate ovate, two to three times as long as broad, rounded posteriorly, more or less pointed and curved anteriorly. Cytostome situated on the ventral surface at a distance of one third of the length of the entire body from the anterior extremity, bearing a fascicle of about eight or nine large and long adoral cilia. Cuticular surface furrowed longitudinally and finely ciliated. Macronucleus large, spherical, centrally located. Contractile vacuole single, postero-terminal.

Length: 45 μ Width: 20 μ

The presence of eight or more long cilia at the oral region is the distinct character served to separate *Anophrys sarcophaga* from the species of the closely related genera. According to Cohn's original description as cited by Kent ('81-'82), there should be a number of transverse furrows in addition to the longitudinal ones present at the posterior half of the body. Such transverse furrows are not observed in the individuals found in Amoy. The occurrence of this species is rather rare.

Family Pleuronemidae

Cyclidium glaucoma O. F. Müller 1786

(Fig. 41)

Body somewhat compressed, ovate or lemon shaped, flattened ventrally in the neighbourhood of the subcentral cytostome, tapering abruptly at the anterior extremity, about twice as long as broad. Peristome-field extending from the anterior end backward to a distinct depression a little below the middle of the ventral surface where the cytostome is located. Preoral membrane rather broad and prominent, extensile and hood-shaped. Cuticular surface faintly striated longitudinally. Cilia fine and evenly distributed, not equalling the breadth of the body in length. A single long caudal bristle developed at the posterior extremity.

Macronucleus single, spherical, located at the anterior half of the body. Contractile vacuole single, posteriorly located.

Length: 20 μ

Width: 11 μ

This marine variety of *Cyclidium glaucoma* occurs very abundantly in Amoy, especially in the standing cultures of sea water. In *C. citrullus* Cohn, a typical marine species, both the anterior and posterior ends are remarkably tapered, while the

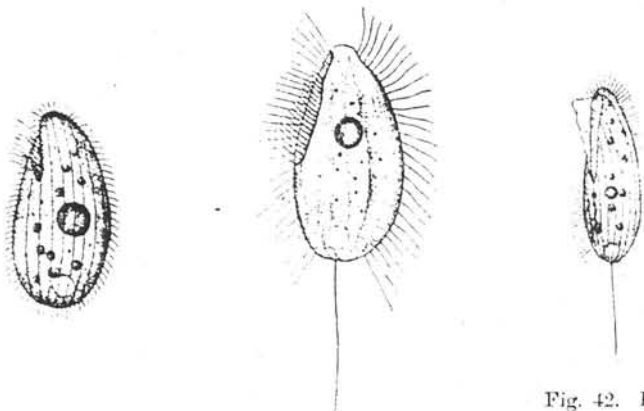


Fig. 40. *Anophrys sarcophaga* Cohn.
×500.

Fig. 41. *Cyclidium glaucoma* O. F. Müller.
×1200.

Fig. 42. *Lembus pusillus*
Quennerstedt.
×1000.

posterior region of the present animal appears more rounded and expanded. The organization of the body of this animal agrees almost in every detail with the fresh water individual of the species, except that the macronucleus and micronucleus are more anteriorly located.

Lembus pusillus Quennerstedt 1869

(Fig. 42)

Lembus moebii Kahl 1926

Body elongate ovate to subcylindrical, about three times as long as broad, rounded at both extremities, the anterior one

usually narrower and sometimes tapering. Peristome-field almost extending to the middle of body, with two subtriangular or band-like undulating membrane of unequal size on its right hand border. Cuticular surface striated longitudinally, evenly and finely ciliated throughout. A single, long and stiff cilium developed posteriorly to form the caudal filament. Macronucleus one, spherical, central or subcentral in position. Contractile vacuole, one, posteriorly located.

Length: 25 μ

Width: 8 μ

The smaller size of the body, the longitudinal striations on the cuticular surface, and the exceedingly long caudal filament serve to distinguish this species from *Lembus velifer* Cohn. The animal may be found in great abundance from the standing cultures of the sea water in association with *Lembus velifer*.

Lembus velifer Cohn 1866

(Fig. 43)

Vibrio vermicus O. F. Müller 1786

Cyclidium elongatum Clap. et Laehm. 1851

Body lanceolate or elongate clavate, more tapering anteriorly than posteriorly, highly elastic, from six to ten times as long as broad. Peristome field extending from the anterior end backwards to a distance about one half the length of the body, associated with two subtriangular or band-like undulating membranes of unequal size on its right-hand border. Cilia of the cuticular surface longer towards the anterior extremity: a single and stiff cilium developed posteriorly to form the caudal filament. Cuticular surface of the posterior half of the body finely striated or annulated transversely. Macronuclei two, spherical, central or subcentral in position. Contractile vacuole usually posteriorly located.

Length: 85 μ

Width: 14 μ

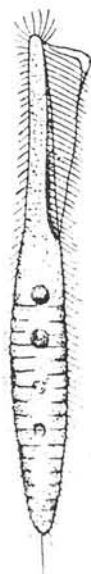


Fig. 43. *Lembus volifer*
Cohn. $\times 750$.

This species is characterized by the presence of transverse annulations on the cuticular surface of the posterior half of the body and the development of the longer cilia along the peristomial furrow. The body is the longest among the species of the genus *Lembus*. Its anterior extremity is flexible or more or less elastic and may turn in all directions like in the case of *Amphileptus* and *Lionotus*. The caudal filament in this species is much shorter than in the other species. The cytoplasm is transparent and granular. There are usually one or more small vacuoles located between the contractile vacuole and the posterior macronucleus. Their function is unknown.

The occurrence of this species in Amoy is very abundant. The animal is generally found from the cultures of sea water kept in the laboratory after one or two weeks.

Pleuronema coronata var. *marina* (Duj. - Möb.) Kahl 1928
(Fig. 44)

Pleuronema marinum Dujardin 1841

Body ovoid or more or less compressed, about twice as long as broad, almost flattened ventrally, convex at dorsal side, rounded at both extremities. Peristome-field very prominent, ventrally located, extending from the anterior end into a depressed or invaginated area near the posterior end where the cytostome is located. Pre-oral membrane broad and hyaline, extensile and hood-shaped. Cuticular surface faintly striated longitudinally, covered with long and stiff cilia, accompanied by a few additional longer seta-like ones projecting at various angles from the posterior end. Macronucleus spherical, centrally or subcentrally located. Contractile vacuole single, posteriorly located.

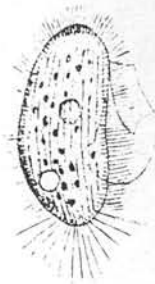


Fig. 44. *Pleuronema coronata* var. *marina* (Duj-Möb.)
 $\times 550$.

Length: 63 μ

Width: 33 μ

This animal was first described by Dujardin ('41) from the sea water and, later, re-described by Möbius ('88) under the same specific name, *Pleuronema marinum*. As all the important characteristics of the animal are practically identical to a fresh water species, *Pleuronema coronata* Kent, it is finally amended by Kahl as a marine variety of Kent's species.

The variety differs from the type species in its more rounded and wider posterior portion of the body. The peristome field is more prominent and the macronucleus is much larger in the marine variety than in the fresh water individuals. Few specimens were observed during the first part of August.

Order Heterotricha

Suborder Polytrichida

Family Stentoridae

Folliculina ampulla O. F. Müller 1786

(Fig. 45)

Sheath or lorica horny in structure, transparent when young, glaucous or sea green in adult, more or less ovate or flask-shaped at base which is attached on the algae or other foreign bodies by its lateral side, with a tubular neck bending upward; neck short in young individuals, becoming much prolonged with age and ornamented with regular, horizontal ascending annulations. Aperture of lorica, circular, evenly margined. Animal body similar in colour to the lorica, elongate, highly elastic at its tapering posterior extremity. Peristome-field large, embracing the entire frontal border, produced into two more or less symmetrical, elongate, flattened, lappet-like lobes or arms. Peristomial lobes or arms from three to six times as long as broad, with their extremities more usually bluntly, but sometimes sharply pointed. Cytostome situated at a deep cleft between the two lobes or arms. Cilia on the general cuticular surface very fine, disposed in evenly

longitudinal rows, those on the frontal border exceedingly long. Macronucleus single, ovoid or ellipsoidal.

Length of base of lorica 135 μ

Length of the neck of lorica 155 μ

The genus *Folliculina* has been long considered as being derived from *Stentor* on the basis of the structural features. It deviates from the latter type chiefly by the huge development of the peristome border into two very expanded, bilobate wings or arms, and by the permanent occupation of the animal in a rigid sheath or lorica.

As stated in the above description, the lorica is divided into two parts, the base and the neck. The base is flask shaped and adheres very firmly to the substratum by its flattened ventral side. The neck turns straightly upward from the base, forming

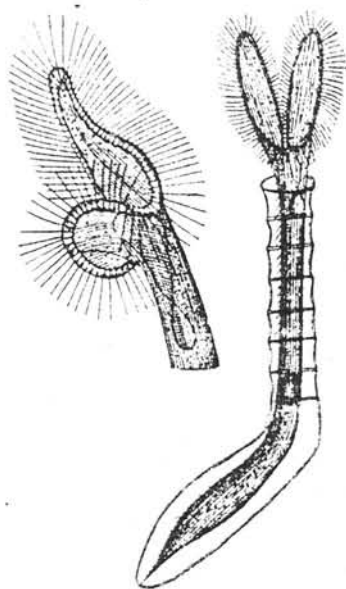


Fig. 45. *Folliculina ampulla* O. F. Müller. $\times 210$.

an angle about 120° between them. In all the four observed individuals, there are seven annulli marked on the neck, although the number of annulations tends to vary among different indivi-

duals. The wall of the lorica has been generally described as chitinous in structure. Penard ('19), however, considered it as composed of hardened mucilage on account of its great adhesive strength.

The animal differs very greatly in appearance between the specimens in the expanded condition and in the retracted state. When it expands, the posterior portion of the body becomes fusiform while anteriorly it stretches in a very extensible prolongation, and finally the two prominent lobes becomes widely spread.

Sometimes the two lobes are not of equal size, and the large one usually terminates in a sharp point while the smaller is rounded at the summit. The membranelles consist of groups of long vibratile cilia which are compressed into a prominent lamina. The bases of the lamina are marked by rod-like transverse lines giving a special scalariform appearance to the peristome border. The groups of cilia of the membranelles possess at times an independent activity, since they may vibrate in one region of the peristome alone but not in the others. The peristomial furrow runs along the whole border of the lateral lobes, descends into a funnel and finally plunges into the vestibulum. At the bottom of the vestibulum, the mouth is located. The membranelles become thinner and thinner as the furrow descends, and there are nothing but ordinary cilia until the vestibulum is reached.

The sea-green or dark bluish colour of *Folliculina ampulla* is inseparably interblended with the substances of the cytoplasm as to communicate its characteristic tint to the externally secreted lorica. According to Penard ('19), the colour of the animal is due to the presence of very small grains or concretions in the cytoplasm. These concretions are, at first, transformed from the clear bluish fluid contained in the vacuoles and, later, they disseminate in the adjoining plasma after breaking down the wall of the vacuoles. When in great abundance, the coloured matter may be expelled to the outside through a simple small opening in the posterior extremity of the body and lumps of green matter are usually observed lying in the space between the lorica and the body.

Four specimens of this species were collected from Nantaiwu and found to be attached on *Cladophora*.

Family Bursaridae

Condylostoma patens Dujardin 1841

(Fig. 46)

Trichoda patens O. F. Müller 1786

Uroleptus patens Ehrenberg 1833

Body highly elastic, elongate elliptical or almost cylindrical in form, slightly flattened and obliquely truncate anteriorly, rounded posteriorly, somewhat contracted behind the region of the peristome, its length being about five times its great breadth. Peristome field large, prominent, unciliated and transparent, consisting of an irregular triangular excavation occupying a median position at the anterior extremity of the ventral surface, extending from the anterior end to a distance about one third of the longitudinal axis of the entire body, with its right-hand border bearing a conspicuous undulating membrane which is as long as and about one half the width of the peristome-field. Cytopharynx narrow and short, tubular in form, extending from the posterior extremity of the peristome to the middle portion of the body. Striation and ciliation longitudinal, closely approximated. Macronucleus elongate moniliform, located near the right side of the animal.

Length: 340 μ

Width: 68 μ

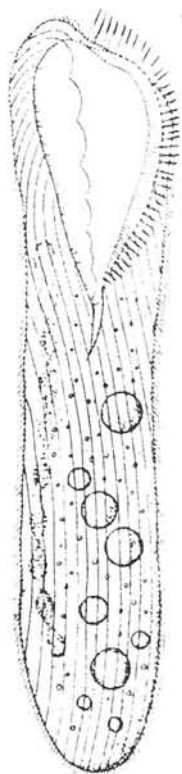


Fig. 46. *Condylostoma patens* Dujardin. $\times 290$

The above description is based upon a single specimen observed from the standing culture of sea water kept with marine algae at the Zoological Laboratory of the Univer-

sity of Amoy on August 14, 1932. In this single specimen, the length of the body is shorter and the peristome is larger in comparison with the typical individuals of the species as reported by Dujardin ('41), Bütschli ('82), and other authors. A canal shaped contractile vacuole together with its secondary vesicular spaces so peculiar to the species is not found in this particular individual. All these differences are considered by the writers as due to individual variations.

The endoplasm is colourless and transparent, and appears granular in structure. Food vacuoles of different size are mostly found in the posterior portion of the body. The moniliform macronucleus of this individual consists of ten ovoid segments or beads, extending for a quite long distance along the right side border of the animal.

Family Plagiotomidae

Blepharisma minima Lepsi (1927)

(Fig. 47)

Body of small size, persistent in form, more or less ovate, less than two times as long as broad; posterior end rounded, anterior end pointed, sickle shaped, and curved towards the left. Peristome field in the form of a long, deep, fissure-like cleft situated on the left hand border of the body, extending to the middle of the body, associated with membranelles consisting of more than ten strong cilia. Undulating membrane probably wanting. Cuticular surface faintly longitudinally striated and finely ciliated. Macronucleus single, ellipsoidal, centrally located. Contractile vacuoles two, one anteriorly and the other posteriorly located.

Length: 32 μ

Width: 20 μ

This is a small species of *Blepharisma* and, unlike other species of the genus, its body is not coloured with any kind of tint. The endoplasm appears very transparent and contains scattered granular bodies of various size. The presence of one

contractile vacuole at the anterior end and another at the posterior end is peculiar to the individuals found at Amoy, since,

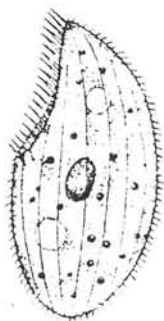


Fig. 47. *Blepharisma minima*
Lepsi. $\times 1250$.

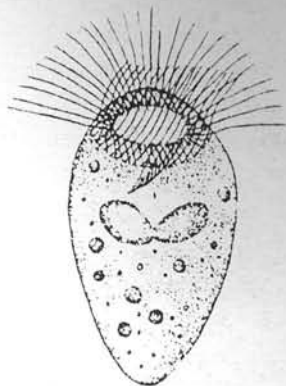


Fig. 48. *Strobilidium typicum*
(Lankester). $\times 1140$.

according to Lepsi's original figure, no contractile vacuole is present in the type of this species. Only few specimens were observed from Amoy.

Suborder Oligotrichida

Family Halteriidae

Strobilidium typicum (Lankester) Fauré-Fremiet 1924

(Fig. 48)

Torquatella typica Lankester 1874

Body ovoid, more or less elongate, rounded at both extremities; posterior portion narrower than the anterior. Peristome-field in the form of a concaved depression, limited by a high, large, and circular lip-like process at the anterior end. Cytostome opened at the lateral side of the bottom of the peristome-field. Adoral fringe closed, consisting of numerous short cilia, turning from right to left on the peristomial lip. Cilia on the external of the lip-like process long and numerous, coalesced together to form large, powerful membranelles. Cuticular surface smooth, not ciliated. Macronucleus consisting of two elliptical masses, subcentrally located.

Length: 35 μ

Width: 20 μ

The present animal is identical to *Torquatella typica* described by Lankester and *Strobilidium typicum* described by Fauré-Fremiet. The average size of the individuals is, however, very small as compared with the measurements of the specimens given by the above authors. The animal occurs very abundantly in Amoy, especially in the cultures of sea water. It may be considered as a small variety of *S. typicum*.

Suborder Tintinnoinea

The Suborder Tintinnoinea has been recently established by Kofoid and Campbell ('29) to include a large group of heterotrichous Infusoria with a conical or trumpet-shaped body attached inside of a lorica. The inclosed animal possesses a laetotropic adoral zone of 16 to 22 membranelles and a number of longitudinal lines of somatic cilia. The lorica is secreted by the animal, incorporated with coccoliths or other faecal residues and usually attached with agglomerating particles of foreign substances.

Thirteen species of Tintinnoinea belonging to four different families have been recorded in Amoy during the summer, 1932. In most of these species, observations were made only on empty loricae as the living animals were rare.

Family Tintinnididae

This Family includes the Tintinnoinea with the lorica usually tubular or diversely saccular in form. It differs from other Families of the Suborder in having only the finely primary structure in the wall and in the absence of the well developed and separated lamellæ in the lorica.

Leprotintinnus nordqvisti (Brandt 1906)

(Fig. 49)

Lorica elongate, tube like or cylindrical, with an expanded, conical base at the posterior extremity; about six times the oral

diameter in length; opened at both ends; wall soft and coarsely alveolar, viscous on the surface, freely agglomerated with foreign bodies.

Length of lorica: 200 μ

Leprotintinnus differs from *Tintinnidium*, another genus of the Family Tintinnididae, by the widely opened aboral end, and *nordqvisti* is distinguished from the other species of the genus by its expanded base or aboral region of the lorica. Although *Leprotintinnus nordqvisti* occurs very abundantly in Amoy, living specimens have been, thus far, not observed.

Family Codonellidae

In this Family, the wall of the lorica bears coarse secondary structures in addition to the minute primary alveoli. A collar may be present in some species, but not in others. The bowl varies greatly in shape, from globose to conical or cylindrical. The aboral end is rounded or pointed, and with or without an aboral horn. The Family was first named by Kent ('82).



Fig. 49. *Leprotintinnus nordqvisti* (Brandt).
×260.



Fig. 50. *Tintinnopsis gracilis* Kof. & Campb.
×400.



Fig. 51. *Tintinnopsis tocanensis* Kof. and
Campb. ×400.

greater in diameter in proportion to the cylindrical oral part as compared with that of the type specimen described by Kofoid and Campbell. The length of the lorica in the Amoy variety is also greater than that of the type. The occurrence of this species is rather rare.

Tintinnopsis minima sp. nov.

(Fig. 52)

Lorica very short campanulate, about 1.5 times the oral diameter in diameter, thin at the out margin, greatly thickened toward the base whose inside border represents the oral rim of the lorica; nuchal constriction very slight or almost imperceptible; bowl more or less subglobular, narrowing down gradually and very slightly from the nuchal region to the aboral portion; aboral extremity inverted convex conical, evenly and bluntly ended; wall very coarse, irregular alveolar blocks.

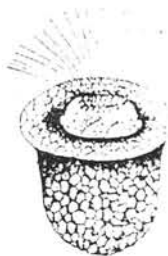


Fig. 52. *Tintinnopsis minima* sp. nov. $\times 500$.

Length: 36 μ

This is a small new species discovered from the Bay of Amoy during the middle part of August, 1932. In the general outline of the body, it differs very greatly from *Tps. nana* Lohmann, *Tps. minuta* Wailes, and *Tps. parva* Merkle, the other known minute species of the genus, since all the latter species do not possess a collar at their oral ends. Regardless to the size of the lorica, the present species seems to be more closely related with *Tps. schotti* Brandt. In the case of *Tps. schotti*, the bowl is more globular than that of *Tps. minima*, and there is a distinct nuchal constriction between the bowl and the collar while, in *Tps. minima*, the demarcation of such a constriction is very feeble or almost imperceptible. The aboral end of the lorica in the latter species is almost rounded instead of bluntly pointed as in the case of the former.

The anterior portion of the animal body resembles, in a great extent, that of *Tps. cylindrica* Daday. The peristomial lip is

vated with its superior border inflected abruptly to form an annulation that contracts the opening of the peristome field. The oral membranelles are exceedingly long and greatly expanded.

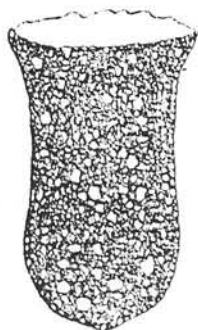


Fig. 53. *Tintinnopsis loricata* (Brandt). $\times 270$.



Fig. 54. *Tintinnopsis rotundata* (Jørgensen). $\times 350$.

Due to the opaqueness of the lorica, the posterior portion of the animal has not been successfully detected.

The occurrence of this species in Amoy is not very abundant.

Tintinnopsis loricata (Brandt 1906)

(Fig. 53)

Lorica tall campanulate, from 1.5 to 1.8 times the oral diameter in length; suboral region forming a flaring collar, inflected conical; cylindrical below; convex conical just above oral region; aboral end bluntly pointed; wall laid up of coarse segments, with coarse primary alveoli.

Length: 140 μ

Tintinnopsis loricata differs from other species of the genus, reported presently, in its well developed flaring collar. The length of the lorica shorter than that of the type specimen originally found off the West coast of Borneo. The occurrence of this species in Amoy is rather abundant.

Tintinnopsis rotundata (Jørgensen) Kofoid and Campbell 1929

(Fig. 54)

Tintinnopsis beroidea Daday 1887*Tintinnopsis beroidea* var. *rotundata* Jørgensen 1899

Lorica in the form of a short, stout, round-ended vial, from 1.9 to 2.4 times the oral diameter in length, coarsely agglomerated with foreign bodies on its wall; aboral end hemispherical; oral margin ragged.

Length: 98 μ Breadth: 40 μ -52 μ

The cylindrical lorica with its hemispherical aboral end distinguishes this species from other *Tintinnopsis* very distinctly. The occurrence of *Tps. rotundata* in Amoy is very abundant.

Tintinnopsis spiralis Kofoid and Campbell 1929

(Fig. 55)

Tintinnopsis cylindrica (Meunier 1910)

Lorica very tall, inverted campanulate, about 2.5 times oral diameter in length; oral margin with adherent spicules; suboral region flaring, inverted conical; aboral region convex conical; cylindrical between the suboral and aboral regions; aboral end blunt; wall marked with ten to twelve equal spiral turns, agglomerated with scanty foreign particles.

Length of the lorica: 55 μ 

Fig. 55. *Tintinnopsis spiralis* Kof. and Camp. $\times 730$.

The presence of ten to twelve equal spiral turns on the wall of the lorica is the distinct character of the species. The individuals found at Amoy appear much smaller in size than the type specimen discovered from Barents Sea. The occurrence of this species is rather rare.

Tintinnopsis cylidrica (Daday 1887)

(Fig. 56)

Tintinnopsis radix Jörgensen 1924*Tintinnopsis bottnica* Rossolimo 1922

Lorica elongate-cylindrical, six to seven times the oral diameter in length, with the posterior third gradually tapering into a bluntly pointed and sometimes slightly curved aboral end; oral margin not everted; bowl with no trace of spiral organization, and no change in diameter except the tapering aboral end; wall rather thinly agglomerated with foreign particles of various shape and size.

Length of lorica: 238 μ -355 μ

The species is characterized by the elongate cylindrical lorica together with its bluntly pointed and slightly curved aboral end. It is the most abundant species of *Tintinnopsis* that occurs in the Bay of Amoy during the months of July and August.

The living animals of this species were found in some specimens. The body is globular or somewhat campanulate. The peristomial lip is thick and elevated, and its superior border inflects abruptly forming a thick annulation that contracts the opening of the peristome field. The adoral membranelles are in the form of a closed zone which extends directly forward and keeps constant wave-like movements. Cilia on the general surface of the body were not observed.



Fig. 56. *Tintinnopsis cylidrica* (Daday). \times 400.

A thread like slender pedicle or stalk is prolonged from the posterior end of the body to the bottom of the aboral end of the lorica for a quite long distance. Carrying its elongate lorica, the animal may swim very freely through the water.

Family Codonellopsidae

In this Family, the lorica of the animal is divided distinctly into two parts, an anterior hyaline collar, and a posterior patterned bowl. *Codonellopsis* is the large genus of the Family. It differs from the other genera by its more prominent collar which is usually high, but narrower than the bowl, and is marked on its wall at least with one or two coiled bands. Two species of the genus have been recorded at Amoy, and one of them is new.

Codonellopsis ostenfeldi (Schmidt) Kofoid and Campbell 1929

(Fig. 57)

Codonellopsis ostenfeldi Schmidt 1901

Codonellopsis fenestrata Cleve 1901

Tintinnopsis ostenfeldi Brandt 1907

Lorica with bowl and collar distinctly separated, about three times the oral diameter in length; collar thin, hyaline, a trifle shorter than the length of the bowl, slightly greater in diameter anteriorly than posteriorly, with 5 or 6 rows of elliptical or round fenestrae at posterior four fifth and 2 or 3 coiled bands at the anterior fifth; bowl spheroidal or subglobular, as long as wide, agglomerated with irregular foreign particles of comparatively large size.

Length of the lorica: 114 μ

This species is characterized by the regular arrangement of elliptical or round fenestrae on the collar of the lorica. Its occurrence in Amoy is rather rare.

Codonellopsis rotunda sp. nov.

(Fig. 58)

Lorica with bowl and collar distinctly separated, about 2.6 times the oral diameter in length; collar thin and hyaline, shorter

than the length of the bowl, cylindrical, with 7 to 8 feeble coiled bands throughout its entire length, attached with numerous scattered foreign particles of various size and different shape; bowl spheroidal or globular, wider than long, paved more or less regularly with granule like foreign particles throughout the entire surface of its wall.

Length of the lorica: 82 μ

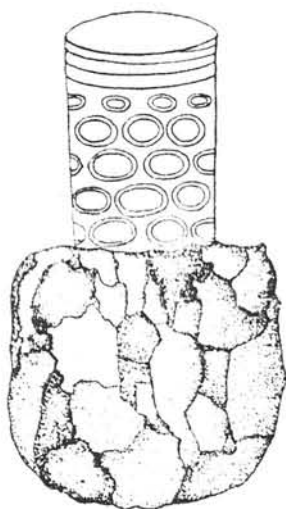


Fig. 57. *Codonellopsis ostensfeldi* (Schmidt). $\times 520$.



Fig. 58. *Codonellopsis rotunda* sp. nov. $\times 625$.

This new species differs from *C. americana* Kofoid and Campbell and *C. orientalis* Hada ('32) in its more rounded bowl and from *C. globosa* Kofoid and Campbell in its more regularly arranged particles on the wall of the bowl. The attachment of the foreign particles on the wall of the collar is also one of the specific peculiarities. The diameter of the collar in proportion to the diameter of the bowl appears greater than what has been found in the other closely related species.

Only few specimens were observed during the middle part of August.

Family Cyttarocylidae

This family was established by Kofoid and Campbell to include a group of Tintinnoinea generally with a large, campanulate, and often pedicellate lorica. It differs from codonellidae and Tintinnidae in prominent development of secondary prismatic structure between the two lamellae of the lorica and from Codonellopsidae in the absence of a hyaline and spiral collar.

Favella panamensis Kofoid and Campbell 1929

(Fig. 59)

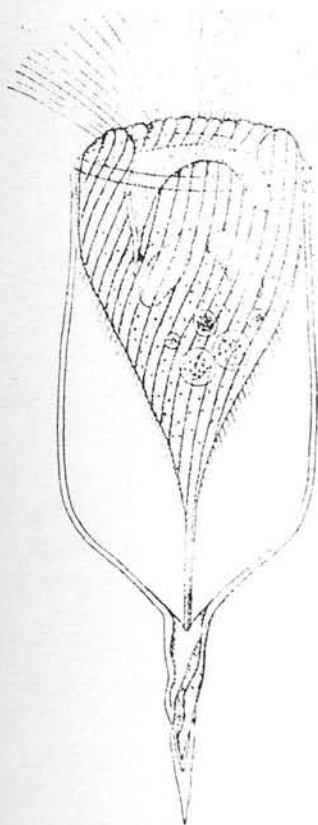
Cyttarocylis serrata var. Van Breeman 1905*Cyttarocylis chrenbergi* Brandt 1907

Fig. 59. *Favella panamensis* Kof. and Campb. $\times 432$.

Lorica stout, cylindrical, very slightly less in diameter anteriorly than posteriorly, about two times the diameter in length excluding the aboral horn; oral margin entire, with one annular ring, slightly tipped below the ring; bowl without nuchal constriction, subcylindrical; aboral region contracting abruptly; aboral horn 0.4 to 0.8 oral diameter in length, usually with oblique wings, tip pointed.

Length of the lorica: 200 μ

Favella panamensis occurs very abundantly in Amoy during the months of July and August. The living animal is campanulate and attaches to the middle of the bottom of lorica simply by its prolonged posterior end. The peristome is well developed and bordered by a thick, circular, and slightly elevated peristomial

lip. The membranelles are rather long and prominent. The general surface of the body is longitudinally ciliated and striated.

Favella amoyensis sp. nov.

(Fig. 60)

Lorica very stout, cylindrical, about one and half times the oral diameter in length excluding the aboral horn; oral margin entire, with three annular rings, slightly tipped below the rings; bowl without nuchal constriction, cylindrical; aboral region contracting abruptly; aboral horn short, about 0.27 oral diameter in length, without oblique wings, tip rounded.

Length of the lorica: 170 μ

Although *Favella amoyensis* resembles the preceding species very closely in the general form of the lorica, it may be distinguished from the latter mainly by (1) its shorter but wider pro-

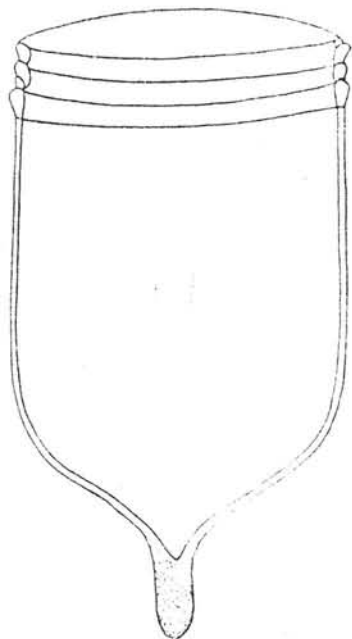


Fig. 60. *Favella amoyensis* sp. nov. $\times 432$.

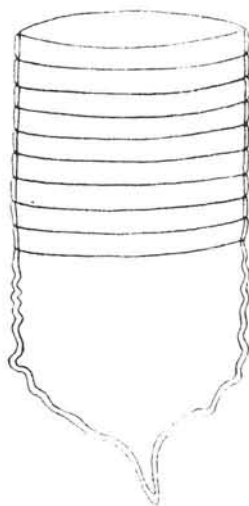


Fig. 61. *Favella undulata* sp. nov. $\times 430$.

portion of size, (2) the constant number of annular rings, and (3) the very short aboral horn with rounded tip end. The occurrence of this species in Amoy is rather few as compared with *F. panamensis*.

***Favella undulata* sp. nov.**

(Fig. 61)

Lorica rather stout, cylindrical, about 1.7 times the oral diameter in length excluding the aboral horn; oral margin entire, followed by nine successive, regular, annular rings, the last one of which is located at a level a little below the middle part of the entire lorica; bowl without nuchal constriction, with its wall undulated between the last annulose ring and the aboral region; aboral region contracting abruptly; aboral horn rather slender, short, about 0.2 oral diameter in length, smooth, oblique or slightly curved, bluntly pointed.

Length of the lorica: 166 μ

As indicated by its specific name, this new species is characterized by its undulated wall at the posterior portion of the lorica. The presence of nine regularly arranged annuli on the anterior half of the lorica is also one of the important peculiarities. The short and slender aboral horn is somewhat curved or a little obliquely directed.

Favella undulata is rather an unique or unparalleled species, since it is not closely related with any of the eighteen known species of the genus cited by Kofoid and Campbell. Only a single specimen was observed on July 23, 1932. A retracted living animal was gradually dying out during observation.

Order Hypotracha

Family Urostylidae

***Holosticha simplicis* sp. nov.**

(Fig. 62)

Body elongate ovate, somewhat flexible and retractile, about four times as long as broad, widest at the region a little posterior

to the middle of the body, gradually narrowing towards and equally rounded at both extremities. Peristome field rather narrow, extending backwards to a distance of about one third of the length of the body. Ventral cirri prominent, forming two median rows throughout the longitudinal axis of the animal; marginal cirri same in size as the ventral ones, uninterrupted, scarcely projecting beyond the periphery; anal cirri five or six, forming a single, oblique row, projecting beyond the posterior extremity of the body. Macronuclei two, elliptical or oval, widely separated. Contractile vacuole single, usually located at the posterior half close to the left-hand border.

Length: 68 μ

Width: 22 μ

This is a colorless species and is usually found in association with *Holosticha rubra* Kent. After a search in the available literature, it seems that the present animal has not been previously described. The organization of its body is, however, quite simple, and the absence of frontal cirri and presence of five or six anal cirri and two longitudinal rows of ventral cirri, which may be considered as the characteristics of the species, are also the peculiarities of the genus. The name, *Holosticha simplicis* is, therefore, proposed. A paroral undulating membrane or rather right-hand reflected border of the peristome has not been observed in this species.



Fig. 62. Ventral view of *Holosticha simplicis* sp. nov. $\times 800$.

Holosticha rubra (Ehrenberg) Kent 1880-1882

(Fig. 63)

Oxytricha rubra Ehrenberg 1838

Body more or less elastic and changeable in form, elongate-lanceolate, about five times as long as broad, widest at the middle portion, slightly tapering toward the rounded anterior and post-

erior extremities. Peristome field extending backwards to distance about one third of the length of the body; its right-hand

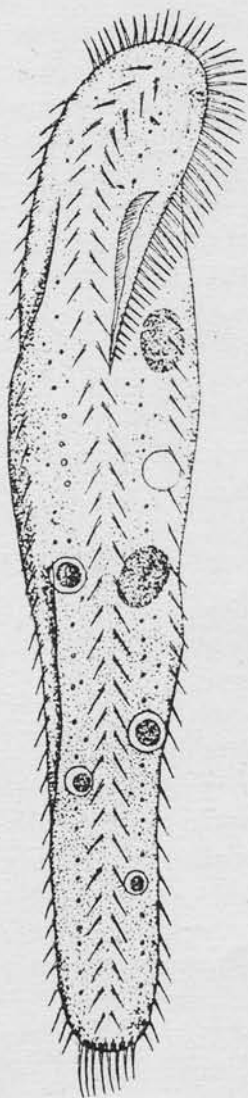


Fig. 63. Ventral view of *Holo-sticha rubra* (Ehrenberg). \times 500.

border bearing an endoral undulating membrane. Ventral setae fine, forming two uninterrupted median rows throughout the longitudinal axis of the animal; marginal setae, as fine as ventral ones, bordering the periphery of the ventral surface; anal cirri eight or nine, long and slender, forming a transverse row, projecting beyond the posterior extremity of the body. Endoplasm deep yellowish or brick-red in colour. Contractile vacuole single, located between two macronuclei. Macronuclei elliptical or ovoidal, two in number, close to the left hand border.

Length: 255 μ

Breadth: 45 μ

This is the largest species of hypotrichous Infusoria observed from Amoy. It appears usually in the old cultures of sea water, especially among the decaying zoophytes collected days or weeks ago. The great contractility and flexibility of the body often effect its cuticular surface in a corrugated appearance as indicated in the figure. In most individuals, the anterior extremity of the body turns slightly towards the left side and, thus, it makes a more rapid revolving movement from the right to left when the animal swims or swerves through the water. Creeping movement is rather rare, as the ventral cirri are very slender in this species.

As indicated by its specific name, *Holosticha rubra* is generally coloured with reddish tint. Most of the individuals observed by the writers at Amoy are, however, deep yellowish in colour instead of red. Such a variation in coloration is probably due to the difference in the nature of the ingested food material or in the chemical properties of the surrounding medium. According to the descriptions given by previous authors, there would be two central and two marginal longitudinal rows of minute bright red corpuscles in the endoplasm. The entity of these corpuscles has not been traced by the present writers.

***Strongylidium maritimum* sp. nov.**

(Fig. 64)

Body more or less flexible, elongate elliptical, a little more than four times as long as broad, evenly rounded at both extremities, but slightly narrower anteriorly. Peristome-field very narrow, confined to the left hand lateral border, extending backwards nearly to the center of the body. Adoral zone of membranelles bearing three or four long, large, and stiff cirrose-like cilia at the most anterior portion of the body. Differentiated frontal cirri absent; ventral cirri slender and minute, forming four longitudinal, oblique rows at the anterior half of the body; anal cirri wanting; caudal cirri usually three; marginal cirri minute and slender, uninterrupted. Macronuclei oval, two in number.

Length: 68 μ

Width: 15 μ

Since the establishment of *Strongylidium* as a genus of hypotrichous Infusoria by Sterki ('78), the species of the genus has probably not been thoroughly studied. A single species, *S. crassum*, was very briefly described by Sterki as to correspond with *Uroleptus pisces* O. F. Müller in general contour, but having a thicker almost cylindrical body,



Fig. 64. Ventral view of *Strongylidium maritimum* sp. nov. $\times 660$.

which is twisted upon its longitudinal axis towards the left side. This single species is certainly not identical with *Strongylidium maritimum* discovered from Amoy. A figure of an unknown species of *Strongylidium*, after Bütschli, is given by Calkins ('26) in his text book (page 392), and it appears quite different from the present species in the outline of the body, the extension of the peristome, and the number and arrangement of both ventral and caudal cirri.

The animal may be easily recognized by the presence of three or four long, large, and stiff cirrose-like cilia at the anterior portion of the adoral membranelles. The ventral cirri are very slender and minute, and their definite arrangements could be made out only through a very keen and patient observation. The caudal cirri are usually three, although variation in the number of these cirri may occur in certain cases. The cytoplasm is very clear and transparent, and scarcely enclosing with any foreign bodies. Individuals of this species are frequently found among the decaying matter from cultures of sea water.

Amphisia kessleri (Wrzesniowski 1877)

(Fig. 65)

Body highly flexible and retractile, elongate-lanceolate, almost four times as long as broad, widest centrally, narrowed gradually towards both extremities. Peristome-field extending backwards to a distance of about one third of the entire body. Frontal Cirri unciniate, three in number, closely arranged one to another; ventral setae fine, forming two closely approximate median rows throughout the longitudinal axis of the body; marginal setae as fine as ventral ones, originated from the ventral surface at a considerable distance from the periphery of the body; anal cirri five or six, disposed in an oblique or curved row projected beyond the posterior border of the body. Contractile vacuole one, located close to the left hand border at a little distance behind the middle portion of the body. Macronuclei two, oval in shape, micronuclei not determined.

Length: 150μ - 170μ

Width: about 34μ at the middle portion of the body.

The presence of the frontal cirri serves to distinguish *Amphisia kessleri* from the species of *Holosticha*. It should be mentioned, however, that, according to the descriptions and figures of this particular animal given by different previous

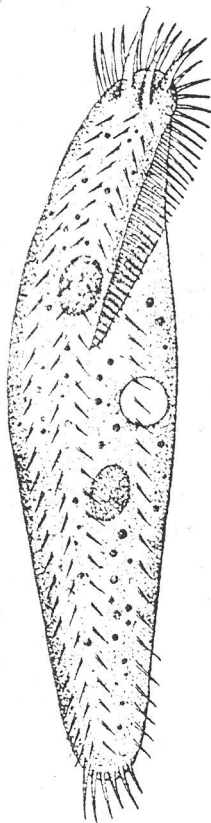


Fig. 65. Ventral view of *Amphisia kessleri* (Wrzesniowsky). $\times 580$.

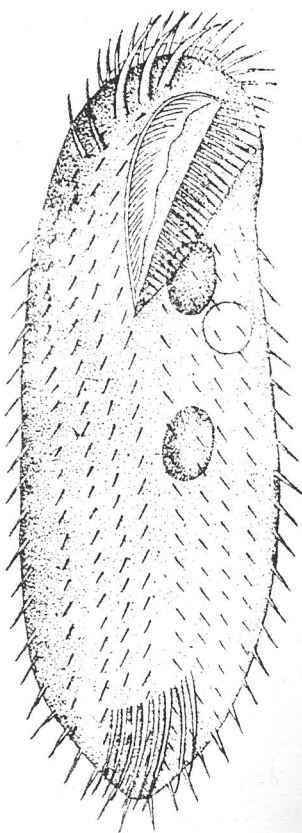


Fig. 66. Ventral view of *Urostyla limboonkengi* sp. nov. $\times 640$.

authors, the frontal cirri are four in number, while the individuals of the species observed in Amoy generally possess three frontal cirri. Such a variation in the number of the frontal

cirri is accounted here as racial deviation, but not as a specific difference.

The endoplasm of the body is coloured with yellowish tint. The nature of the coloration, whether it is derived directly from the cytoplasmic substance or resulted from the ingestion and retention of the coloured food particles in the body, has not been determined. The animals are usually found among filamentous algae cultured in the sea water.

Urostyla limboonkengi sp. nov.

(Fig. 66)

Body elongate elliptical, somewhat flexible and extensible, about three times as long as broad, widest at a position a little posterior to the middle region; rounded anteriorly, bluntly tapering posteriorly. Peristome field triangular, confined to the anterior third of the ventral surface of the animal, its right-hand reflected border or paroral undulating membrane ciliated, curved upwards at the apical extremity. Frontal cirri five, two of them comparatively small; ventral cirri fine, arranged in eight to thirteen longitudinal rows; anal cirri eight, forming a single, oblique row, not or slightly projecting beyond the posterior end of the body; marginal cirri uninterrupted, projected beyond the periphery. Macronuclei two, ovoid or elliptical. Contractile vacuole single, close to the left-hand border, just beneath the peristome field.

Length: 155 μ

Width: 55 μ

Urostyla limboonkengi differs from many fresh-water species of the genus chiefly in the number of the longitudinal rows of the ventral cirri. It is also a peculiar fact that two of the frontal cirri are shorter and more slender than the other three, but yet they are clearly differentiated from the neighbouring ventral and marginal cirri. The body appears broader in comparison with the other species and the paroral undulating membrane or the right-hand reflected border of the peristome

is also large. The species is named in honor of Doctor Lim Boon Keng, President of the University of Amoy.

Several specimens have been observed among the decaying algae of the sea-water culture.

Family Pleurotrichidae

Gonostomum pediculiforme (Cohn) Maupas 1883

(Fig. 67)

Stichochaeta pediculiformis Cohn 1866

Body elongate oval, elastic but not contractile. Posterior end rounded; anterior third or fourth produced into a narrow, neck-like process. Peristome-field very narrow, extending from the apical extremity to the base of the neck-like prolongation. Frontal cirri five or six, long and movable, radiating out from the apical extremity; ventral cirri numerous, arranged in two longitudinal rows throughout the entire length of the body; marginal cirri very fine; anal cirri long and slender, sometimes curved, disposed either in a transverse row or in two groups of three and two each, projected beyond the posterior extremity of the body; caudal cirri three, fine.

Length: 114 μ

Width: 22 μ

The presence of the neck-like process in the anterior portion of the animal makes this species very recognizable from other species of the hypotrichous Infusoria during observation. The five long, large, and stiff cilia at the anterior extremity are the well differentiated frontal cirri which may be easily mistaken as the components of adoral membranelles like in the actual case of *Strongylidium maritimum*. There are neither movable setae along the ventral surface of the neck-like process nor flexible long cilia issuing from the oral aperture as what had been originally reported by Cohn.

The endoplasm is highly granular and more opaque posteriorly than anteriorly. The presence of macro- and micronucleus

and the contractile vacuole have not been successfully observed. Individuals may be frequently found from the standing cultures of sea-water collected one or two weeks' ago.

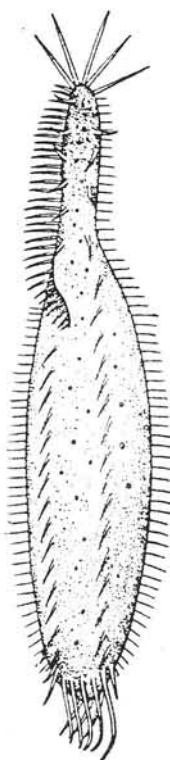


Fig. 67. *Gonostomum pediculiforme* (Cohn). $\times 700$.



Fig. 68. Ventral view of *Oxytricha ferruginea* Stein. $\times 570$.

Oxytricha ferruginea Stein 1859

(Fig. 68)

Body linear oblong, about five times as long as broad, widest at the middle or at a position a little above to the posterior extremity, bluntly pointed anteriorly, rounded posteriorly. Peristome-field rather wide, extending backwards to a distance of about one third of the length of the entire body, its right hand

reflected border or paroral undulating membrane ciliated, curved to the left at the apical extremity. Frontal cirri eight, the foremost three very prominent, arranged in an oblique row paralleling to the frontal border of the animal, the lowest two placed posterior to the peristome field, more close to the group of ventral cirri than to that of the frontal; ventral cirri five, three arranged in an oblique row at the middle of the body, two more posteriorly located; anal cirri large, five, forming an obliquely curved row, not or slightly projecting beyond the posterior border of the body; marginal cirri uninterrupted, projecting posteriorly only. Endoplasm deep yellowish. Macronuclei two, ovate, one anteriorly and the other centrally or subcentrally located. Contractile vacuole one, situated close the left-hand border of the body, usually between two macronuclei.

Length: 150 μ

Width: 35 μ

This species may be recognized as a marine variety of *Oxytricha ferruginea*. It differs from Stein's fresh-water type chiefly in the coloration of the body substances in cytoplasm. The deeply yellowish tint appears very homogeneous throughout the cytoplasm and it certainly does not, as in most ciliates, result from the inception and temporary retention of the coloured food-particles.

The body of the present variety is more flexible than that of the fresh-water type and its posterior end is not always the widest portion. The animal is a voracious feeder, and large numbers of Diatoms and other marine algae are usually found to be enclosed in the endoplasm. The two afferent canals of the contractile vacuole, described by Penard ('22) in the fresh water forms of the species, are not present in the marine individuals. The occurrence of this animal in Amoy is rather abundant.

Family Psilotrichidae

Balladina Parvula Kowalewsky 1882

(Fig. 69)

Body elliptical or ovate, twice as long as broad, rounded at

both extremities. Peristome-field rather narrow, extending backwards to a distance a little above of the middle of the body, its right-hand border bearing an endoral undulating membrane. Ventral cirri prominent but rather few in number, forming a single longitudinal or slightly oblique row; marginal cirri heavy, bristle like, projecting beyond the periphery of the body. Macronuclei two, oval. Contractile vacuole single, located at the middle of the body, close to the left-hand border.

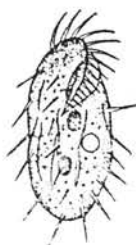


Fig. 69. Ventral view of *Balladina parvula* Kowalewsky. $\times 630$.

Length: 37μ

Width: 18μ

The presence of the heavy bristle-like marginal cirri and a simple row of ventral cirri is characteristic not only to the species but also to the genus *Balladina*. The organization of *B. parvula* appears very simple on account of the great reduction of the ventral cilia and the absence of frontal, anal, and caudal cirri. The occurrence of this animal in Amoy is rather rare.

Family Euplotidae

Uronychia transfuga (O. F. Müller) Stein 1859

(Fig. 70)

Trichoda transfuga O. F. Müller 1786

Plasconia scutum Dujardin 1841

Campylopus paradoxus C. et L. 1858

Body oval, encuirassed, turgid, evenly rounded at both sides, obliquely truncated at the anterior end, with a prominent membranous dorsal lip, rounded at the posterior extremity, with two well developed converging bow-shaped clefts on the ventral surface. Peristome field large, in the form of a pocket-shaped excavation, extending from the anterior end to the center of the body, with its right-hand border bearing a prominent band shaped endoral undulating membrane. Dorsal surface of the body

sometimes smooth, sometimes longitudinally ribbed. Cilia on the dorsal lip of the anterior end forming a row of membranelles. Ventral cirri usually four, grouped in two pairs close to the right-hand border. Posterior cirri large and strong, usually recurved, five to seven inserted in the right hand posterior cleft and two in the opposite cleft. Each fascicle of cirri occasionally supplemented by one or two fine simple setae.

Length: 55 μ

Width: 37 μ

There are two distinct varieties of this species frequently found at Amoy. In one variety, as shown in figure 70, the body is oval and the posterior cirri are long and more slender, while in the other, the body is much shortened and the posterior cirri appear like heavy and huge hooks as those reported by Calkins ('02 and '11). A wide range of the individual variations also occurs in the first variety, which was more commonly observed in the present investigation, with respect to the number and



Fig. 70. Ventral view of *Uronychia transfuga* (O. F. Müller). $\times 800$.



Fig. 71. Ventral view of *Diophrys appendiculatus* (Ehrenberg). $\times 800$.

character of the posterior cirri. In some instance the cirri are straight, or but slightly bent, in others strongly curved and

hooked, while in a third series, they are branched or fimbriated. The number of these cirri varies from five to seven in the right posterior cleft, but in the left, ~~the number never exceeds two.~~ The presence of the fine setae supplementary to the posterior cirri is also not a constant character of the species.

The endoplasm is granular and usually contains a great number of food vacuoles. ~~The macronucleus is composed of about ten spherical segments~~ which have not been properly made out in the present study.

The animal occurs very abundantly in the standing cultures of sea water collected several days or weeks ago. It swims very freely in the water and revolves from the right to the left on its longitudinal axis to produce a spiral path. Unlike other hypotrichous Infusoria, creeping movement is not common in this species. By the action of the posterior cirri, the animal may, however, jump forward for a certain distance, accompanying with the swimming locomotion.

Diophrys appendiculatus (Ehrenberg) 1833

(Fig. 71)

Stylonychia appendiculata Ehrenberg 1833

Diophrys marina Dujardin 1841

Schizopus norwegicus C. et L. 1858

Styloplotes appendiculatus (Stein) Fresenius 1865

Styloplotes norwegicus Quennerstedt 1869

Body encuirassed, turgid, elliptical, thickened and rounded at the lateral margins, with a median channel-like excavation extending from anterior end to the posterior extremity of the ventral surface. Anterior end with a projecting dorsal lip which is ovoid or somewhat pointed; posterior extremity obliquely truncate, curved to the right. Peristome field rather broad, extending backwards to a distance about half-way the length of the body, its right hand border bearing a prominent endoral undulating membrane. Frontal cirri five, more or less scattered; ventral cirri four, two located at the center of the median channel.

and two at the posterior half of the left-hand lateral thickening; anal cirri five, long and stout, closely approximated, variously curved, forming a single transverse row, projected considerably beyond the margin of posterior extremity; caudal cirri three, recurved uncinata, originated from the posterior border, near the lateral thickening of the right side. Macronuclei sausage-shaped, two in number, one close to the anterior end and another posteriorly located.

Length: 62 μ

Width: 27 μ

Due to the presence of a longitudinal broad excavation at the ventral surface of the body, the animal assumes a choncoid shape in dorso-ventral view. It is frequently found in great abundance associated with *Uronychia transfuga* O. F. Müller. The animal swims through the water very freely in a like manner as in the case of the preceding species. Creeping movement is seen to be performed by the action of frontal and ventral cirri, while jumping is less common than in *U. transfuga*.

The anal and caudal cirri vary in form and thickness among different individuals of the species. The endoplasm is granular and transparent, and sometimes appears yellowish as resulted from the inception and temporary retention of the coloured food particles.

Euplotes charon Ehrenberg 1833

(Fig. 72)

? *Trichoda cimex* O. F. Müller 1786

Plaesconia charon Dujardin 1841

Carapace short oval or suborbicular, with several (usually five) longitudinal ridges on its dorsal surface. Anterior and posterior extremities more or less truncate. Left-hand border more convex than right hand border. Frontal cirri six, arranged more or less in two transverse rows; ventral cirri four, scattered, two disposed close to the right hand border while another pair originating at a distance a little front to the middle portion of

the ventral surface; anal cirri five, long and stout, forming a single, oblique row, projecting beyond the posterior extremity of the body; caudal cirri four, short and slender, one pair almost close to the left-hand border, projected beyond the truncated margin of the posterior extremity. Peristome field extending backwards to a distance of about three fourth of the length of the body. Contractile vacuole single, in the posterior half of the body, near the right hand border. Macronucleus long, band or ribbon shaped.

Length: 90μ - 120μ

Width: 54μ - 74μ

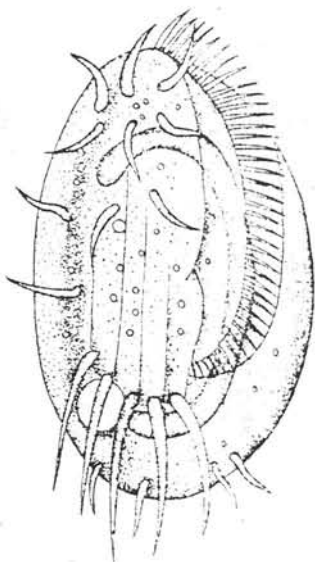


Fig. 72. Ventral view of *Euplotes charon* Ehrenberg. $\times 500$.

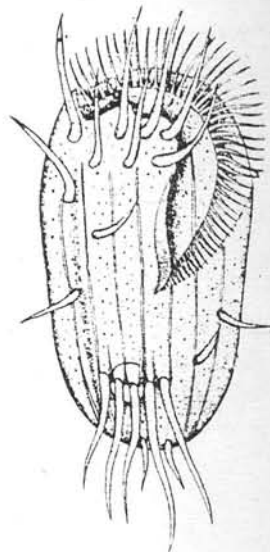


Fig. 73. Ventral view of *Euplotes harpa* Stein. $\times 500$.

Euplotes charon is most likely to be confused with *E. patella* Ehrenberg. The latter, however, shows a more elliptical contour of the carapace and two of its caudal cirri are usually branched or fimbriated. In the present species, the peristome is more posteriorly extended than in the case of *E. patella*. The number of the ventral cirri is also different between the two species.

This is the most abundant Protozoa found in Amoy. It occurs usually in the standing cultures of sea-water collected several days or weeks ago. The reproductive rate of this animal must be very rapid and individuals undergoing processes of binary division have very frequently been observed.

***Euplotes harpa* Stein 1859**

(Fig. 73)

Carapace elongate oval, about twice as long as broad, with eight or nine longitudinal ridges traversing its dorsal surface. Anterior end widest, rounded, with a sharply pointed tooth-like process at the right-hand corner and two blunt denticulations near the anterior margin of the ventral surface. Posterior extremity rounded, much narrower as compared with the anterior. Frontal cirri seven, arranged in two transverse rows, four above and three below; ventral cirri five, scattered, two close to the frontal cirri, one along the middle of the right-hand border, two near the left hand border posterior to the middle portion of the ventral surface; anal cirri five, long, forming a single, straight or oblique row, projected beyond the posterior extremity of the body; caudal cirri two, short and slender. Peristome field narrow, extending backward to a distance about half-way the length of the animal. Contractile vacuole single, in the posterior portion of the body, near the right-hand border.

Length: 100 μ -110 μ

Width: 36 μ -40 μ

This species may be readily distinguished from the preceding one by its more elongated body, the ciliated reflected border of the peristome, and the tooth-like process at the right-hand corner of the anterior end of the carapace. The presence of eight longitudinal ridges traversing the dorsal surface of the carapace is also one of the specific peculiarities.

The band or ribbon shaped macronucleus has not been made out in the present study. Two of the ventral cirri located near the left-hand border, a little posterior to the middle portion of

the body, are, in reality, a pair of the caudal cirri which had been shifted anteriorly in such a position that they would be no longer considered as caudal cirri.

The occurrence of this animal in Amoy is very rare. It is found to be associated with *E. charon* and other hypotrichous Infusoria.

Family Aspidiscidae

Aspidisca lynceus (O. F. Müller) Ehrenberg 1838

(Fig. 74)

Trichoda lynceus O. F. Müller 1773

? *Cocculina crassa* Dujardin 1841

Carapace ovate, widest and somewhat truncate posteriorly; left side almost straight, right side somewhat convex; dorsal surface convex, smooth or sometimes marked with three feeble longitudinal furrows; ventral surface plane. Peristome field narrow, extending from the anterior end to the posterior third



Fig. 74. Ventral view of *Aspidisca lynceus* (O. F. Müller). $\times 750$.

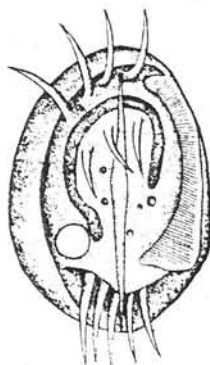


Fig. 75. Ventral view of *Aspidisca turrita* (Ehrenberg). $\times 850$.

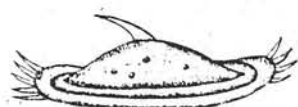


Fig. 76. Lateral view of *Aspidisca turrita* (Ehrenberg). $\times 850$.

of the body, associated with a simple arcuate fringe of adoral cirri which do not project beyond the anterior and left lateral margins. Frontal cirri four, forming a single, oblique row,

usually projecting beyond the anterior extremity of the body; ventral cirri three, disposed at a distance little below the frontal cirri; anal cirri five, long and slender, forming a single oblique row, projecting beyond the posterior half of the body, near the right hand-border. Macronucleus long, band or ribbon shaped.

Length: 40 μ

Width: 34 μ

This species is generally considered as the type of the genus *Aspidisca*. It differs from *A. costata* (Dujardin), a common fresh-water species, in that the ventral plate does not project beyond the left border of the carapace.

The animal is frequently found both in the standing cultures and in the freshly collected samples of sea-water.

Aspidisca turrita (Ehrenberg) C. et L. 1857

(Fig. 75 & 76)

Euplotes turritus Ehrenberg 1838

Carapace suborbicular, widest and somewhat truncate toward the posterior extremity; left side nearly straight; right side evenly rounded. Ventral surface plane; dorsal surface convex, with a thorn-like recurved spine developed from its center. Peristome field narrow, extending from the anterior end to the posterior third of the body, associated with a simple arcuate fringe of adoral cilia which do not project beyond the anterior and left lateral margins. Frontal cirri four, forming a single oblique row, usually projecting beyond the anterior extremity of the body; ventral cirri three, disposed at a distance little below the frontal cirri; anal cirri five, long and slender, forming a single straight or oblique row, projecting beyond the posterior margin of the body. Contractile vacuole single, in the posterior half, near the right-hand of the body. Macronucleus long, band or ribbon shaped.

Length: 35 μ

Width: 30 μ

Aspidisca turrita may be distinguished from the preceding species by its more orbicular body and the thorn-like recurved spine developed from the center of the dorsal surface.

The occurrence of this animal in Amoy is rather rare and it is found to be associated with *A. Lynceus* (O. F. Müller).

***Onychaspis polystyla* (Stein) Diesing 1865**

(Fig. 77)

Aspidisca polystyla (Subgenus *Onychaspis*) Stein 1859

Aspidisca plana Perejaslawzewa 1886

Carapace oval, nearly rounded at both extremities; left side almost straight, right side evenly rounded; dorsal surface slightly convex, usually marked with three longitudinal furrows. Peristome-field short but rather broad, beginning at the middle of the left margin of the body. Fronto-ventral cirri brush-like and huge in size, eight in number, seven disposed in two oblique rows, one isolated below the middle portion of the body close to the right hand border; anal cirri long and slender, variable from 10 to 13 in number, arranged in a single oblique row, projected beyond the posterior margin of the body. Contractile vacuole single, posteriorly located.

Length: 34 μ

Width: 30 μ

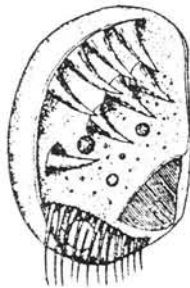


Fig. 77. Ventral view of *Onychaspis polystyla* (Stein). $\times 800$.



Fig. 78. Ventral view of *Onychaspis hexeris* (Quennerstedt). $\times 650$.

The genus *Onychaspis* was originally established by Stein ('59) and Diesing ('65) to separate a group of ciliates formerly included in *Aspidisca*. The former differs from the latter not only in its huge, brush-like fronto-ventral cirri, but also in the position of the peristome. In the species of *Aspidisca*, the peristome extends from the left side of the anterior end to the posterior portion of the animal while in *Onychaspis*, it begins at the center of the left edge. In his review on "The genus *Aspidisca* Ehrenberg", Plough ('16) still placed the species of *Onychaspis* in the genus *Aspidisca*.

Onychaspis polystyla is characterized by the presence of a greater number of the anal cirri which are very slender as compared with the fronto-ventral cirri. The animal is frequently found among the algae cultured in sea water aquarium.

Onychaspis hexeris (Quennerstedt 1867)

(Fig. 78)

Aspidisca andrewii Mereschkowsky 1879

Carapace elliptical, equally rounded at both anterior and posterior extremities; right side evenly rounded; left side nearly straight; armed closely behind its center with a single backwardly directed spur-like projection; dorsal surface convex usually marked with three feeble longitudinal furrows. Peristome-field short, rather broad, beginning at the middle of the left margin of the body. Fronto-ventral cirri brush-like and huge in size, eight in number, disposed in two or three oblique rows; anal cirri long and much slender as compared with the fronto-ventral ones, six in number, forming a single oblique row, projecting beyond the posterior margin of the body. Contractile vacuole single, in the posterior half of the body, near the right-hand border.

Length: 52 μ

Width: 34 μ

Onychaspis hexeris differs from the preceding species in the number of the anal cirri and in the presence of a spur-like process projected backwardly from the left margin of the body.

The genus *Onychaspis* was originally established by Stein ('59) and Diesing ('65) to separate a group of ciliates formerly included in *Aspidisca*. The former differs from the latter not only in its huge, brush-like fronto-ventral cirri, but also in the position of the peristome. In the species of *Aspidisca*, the peristome extends from the left side of the anterior end to the posterior portion of the animal while in *Onychaspis*, it begins at the center of the left edge. In his review on "The genus *Aspidisca* Ehrenberg", Plough ('16) still placed the species of *Onychaspis* in the genus *Aspidisca*.

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Length: 52 μ

Width: 34 μ

Onychaspis hexeris differs from the preceding species in the number of the anal cirri and in the presence of a spur-like process projected backwardly from the left margin of the body.

The fronto-ventral cirri appear larger, but shorter than those of *O. polystyla*. It occurs in association with the preceding species.

Order Peritricha

Family Vorticellidae

Vorticella patellina O. F. Müller 1773

(Fig. 79)

Body conical campanulate when fully extended, widest at the anterior border and tapering thence almost in a straight line to its point of junction with the pedicle. Diameter of the expanded frontal border equalling or exceeding the length of the body. Peristome border exceedingly thin, usually expanding in a flattened or rotate form around the frontal margin. Ciliated disc but slightly elevated. Cuticular surface finely striated.

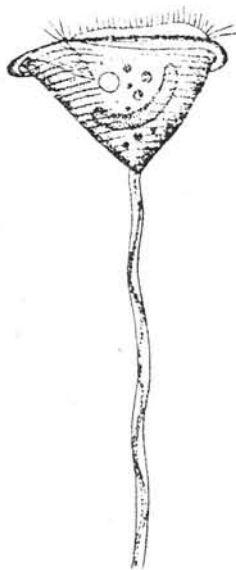


Fig. 79. *Vorticella patellina*
O. F. Müller. $\times 360$

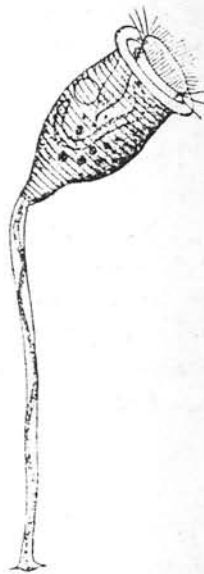


Fig. 80. *Vorticella marina*
Greef. $\times 450$

Pedicle rather slender, three or four times the length of the body, contracting spirally. Macronucleus band shaped. Contractile vacuole single, very close to the vestibule.

Length of the body: 42 μ

Width: 68 μ

Length of the stalk: 150 μ

The angular or conical aspect of the body, as presented during its expanded condition, distinguishes this species conspicuously from other representatives of the genus. It should be mentioned, however, that the cuticular surface of the animal is described by previous authors as very smooth while the individuals discovered from Amoy are all faintly striated. Such a difference is, here, considered as a local variation, since other important characters are practically identical with O. F. Müller's original type.

This is a social species and the individuals are found to be attached on algae and zoophytes especially from cultures of sea-water.

Vorticella marina Greef 1870

(Fig. 80)

Body campanulate or elongate conical, tapering posteriorly, slightly constricted just beneath the peristomial border, about one and half times as long as broad. Peristome border rather thick, dilated and usually revolved. Ciliary disc moderately elevated. Cuticular surface distinctly and coarsely striated transversely. Pedicle somewhat thick, from two to five times the length of the body, contracting spirally. Macronucleus ribbon or horse-shoe shaped. Contractile vacuole single, very close to the vestibule.

Length of the body: 45 μ

Width: 20 μ

Length of the stalk: 100 μ in average.

Vorticella marina occurs more abundantly in Amoy than does the preceding species. Scattered individuals or individuals in small social groups are frequently found attached on the algae and zoophytes among the sea-water aquarium.

Zoothamnium niveum Ehrenberg 1838

(Fig. 81)

Zoothamnium plumosum Wright 1860 (in Pritchard's
"Infusoria")*Zoothamnium spirale* Gosse 1856

Main stem of the zoodendrium or pedicle prolonged, sinuous or spiral, giving off short alternate verticillate branches. Myone-

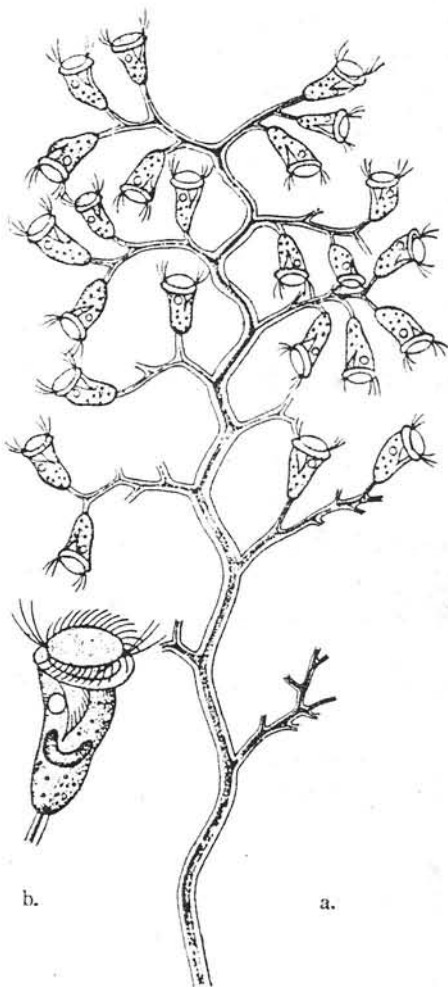


Fig. 81. *Zoothamnium niveum* Ehrenberg. a. Colony, \times 120. b. Enlarged individual, \times 600.

mes of the pedicle continuous throughout, highly contractile. Individual animal elongate campanulate. Peristome border rather thick. Ciliary disc moderately elevated. Cuticular surface smooth. Macronucleus sausage-shaped, usually curved, centrally located. Contractile vacuole single, close to the vestibule.

Length of the individual animal: 38 μ

Length of the colony: 935 μ

The zoodendrium of this species is often greatly lengthened and, as mentioned by Kent ('80-'82) the zooids on lower branches may die off as the colony becomes distally extended. Under the weight of the living animals on the upper branches, the zoodendrium usually bends and assumes a sinuos or spiral aspect.

The observed animals are attached to the algae and Sertularians.

Zoothamnium alternans C. et L. 1858

(Fig. 82)

Individual body more or less campanulate, subpyriform or globular when contracted. Peristome border rather thick, wide-

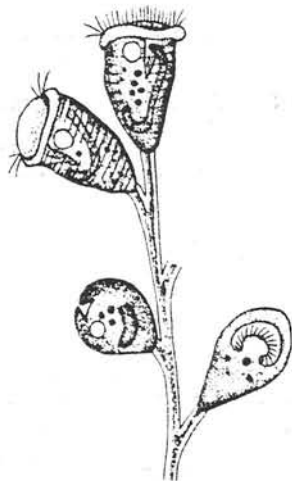


Fig. 82. *Zoothamnium alternans* C. & L. $\times 560$.

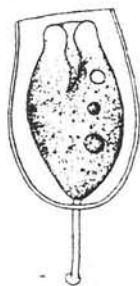


Fig. 83. *Cothurnia maritima* Ehrenberg. $\times 880$.

ly everted, its frontal border puckered or plicate in contracted examples. Ciliated disc rarely elevated. Cuticular surface finely striate transversely. Macronucleus ribbon like or sausage shaped. Contractile vacuole single, close to the vestibule. Zoodendrium or pedicle consisting of an erect and basally very thick rachis, from which are given off mostly alternate intervals.

Length of the individual: $26\ \mu - 34\ \mu$

Width of the individual: $20\ \mu$

The zoodendrium of this species is much shorter but more expanded than that of *Z. niveum*. The individual zooids may be distinguished from those of the preceding species by its less elongated body and the presence of transverse striations on the cuticular surface.

Colonies are usually found to be attached on the sea-weeds and littoral hydrozoans.

Cothurnia maritima Ehrenberg 1838

(Fig. 83)

Lorica transparent, somewhat ovate, one and half times as long as broad, slightly dilated posteriorly. Pedicle much shorter than the lorica. Animal body hyaline and whitish ovoid, wide at the middle portion, narrowed at both extremities, scarcely protruding beyond the mouth of the lorica, fixed to the bottom of the lorica by a very short intermediate stalk.

Length of the lorica: $45\ \mu$

Width of the lorica: $30\ \mu$

Length of the stalk: $20\ \mu$

Excepting for its small size, *Cothurnia maritima* closely resembles *C. imberbis* Ehrenberg, a fresh water species. Specimens are found to be attached on decomposing algae in the old cultures of sea-water. In all the observed specimens, the living animals are practically in retracted state and their detail structures have not been successfully made out.

Cothurnia acuta sp. nov.

(Fig. 84)

Lorica transparent, erect, a little more than three times the widest diameter in length, more or less cylindrical at the anterior three fourth, gradually tapering at the posterior one fourth to form a bluntly pointed basal end which adheres to the sea-weeds or Bryozoa directly without an additional supporting pedicle. Animal body colourless, subcylindrical or elongate vase shaped, protruding beyond the oral margin of the lorica when extended, attaching to the bottom of the lorica by its posterior tapering end. Peristome border rather thick, usually dilated. Ciliary disc moderately elevated. Macronucleus long, filamentous. Contractile vacuoles two in number, centrally located.

Length of lorica: 155 μ

Width of lorica: 50 μ

Cothurnia acuta may be distinguished from other known species of the genus by its tapering, conical and bluntly pointed posterior extremity of the lorica. Above the posterior fourth, the lorica is cylindrical in form without any change in diameter toward its mouth. It seems more closely related with a fresh-water species, *Cothurnia crystallina*, in comparison with the figure of the latter given by de Fromentel ('74) under the name *Planicola crystallina*.

Each lorica usually contains two living animals but for the sake of clearness only one individual is represented in the figure. The animal directly attaches to the bottom of the lorica and there is a visible constriction usually found a little above to the posterior extremity.

The endoplasm is hyaline and granular, and the slender and elongate macronucleus could be detected without the aid of staining.



Fig. 81. *Cothurnia acuta* sp. nov. $\times 446$.

Specimens are usually found to be attached on the marine algae.

Class Suctoria

Family Acinetidae

Acineta tuberosa Ehrenberg 1833

(Fig. 85)

Acineta cucullus C. et L. 1858-1860

Acineta poculum Hertwig 1876

Acineta foetida Maupas 1881

Acineta corrugata Stokes 1894

Lorica compressed, subtriangular in expanded form, widest at its distal margin and thence tapering or rather narrowing gradually towards its point of junction with the pedicle; lateral walls usually smooth, sometimes corrugated, continuous over the frontal border, with two ovate apertures at the anterior angles for the extrusion of the tentacles. Pedicle slender and straight.

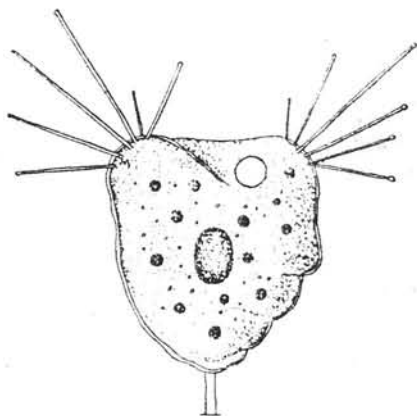


Fig. 85. *Acineta tuberosa* Ehrenberg. $\times 780$.

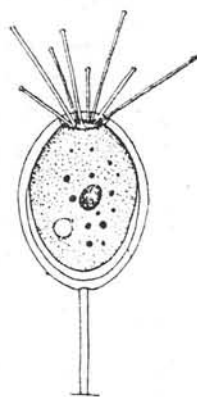


Fig. 86. *Acineta lividiana* Moreschkowsky. $\times 730$.

exceedingly variable in length, from one fifth the length of the body to three or four times as long as the body. Protoplasmic

body not completely filling the cavity of the lorica. Tentacles forming two antero-lateral fascicles, protruding when extended through the corresponding ovate apertures in the lorica. Macronucleus usually ovate. Contractile vacuole single, antero-laterally situated.

Length of the body: 36 μ

Greatest width: 28 μ

Length of stalk from 8 μ to 120 μ

Acineta tuberosa appears to be subjected to a wide range of individual variation with respect to the length of the lorica and pedicle. The animal presented in the figure is a short individual with the surface of its lorica more or less corrugated. The presence of this animal in Amoy is very abundant.

Acineta livadiana Mereschkowsky 1881

(Fig. 86)

Cothurnia havniensis Ehrenberg 1838

Acineta neapolitana Daday 1886

Lorica transparent, symmetrically ovate, with its anterior extremity truncate, a little less than twice as long as broad. Pedicle straight, rather slender, as long as or shorter than the length of the lorica. Protoplasmic body ovoid or spheroid, not completely filling the inside of the lorica. Tentacles distinctly capitate, forming a single fascicle developed from the anterior end of the body, as long as the body when fully expanded. Macronucleus oval, central or subcentral in position, contractile vacuole single, latero-posteriorly located.

Length: 30 μ

Width: 20 μ

Length of the stalk: 18 μ

The symmetrically ovate contour of the lorica distinguishes this species from others of the genus very distinctly. According to Collin's ('11 & '12) classification, this species should be includ-

ed in the genus *Paractineta*. In the description of the species given by Kent ('81), it is stated that the animal rarely occupies more than the anterior moiety of the lorica, while in the individuals observed from Amoy, the protoplasmic body is only a little smaller than the capacity of the lorica. The animal is frequently found to be attached on the Polyzoa, Sertularian Hydrozoa and sea weeds.

Acineta infundibuliformis sp. nov.

(Fig. 87)

Lorica elongate infundibulate, widest toward the anterior margin, tapering posteriorly, seated on a long rectilinear stem

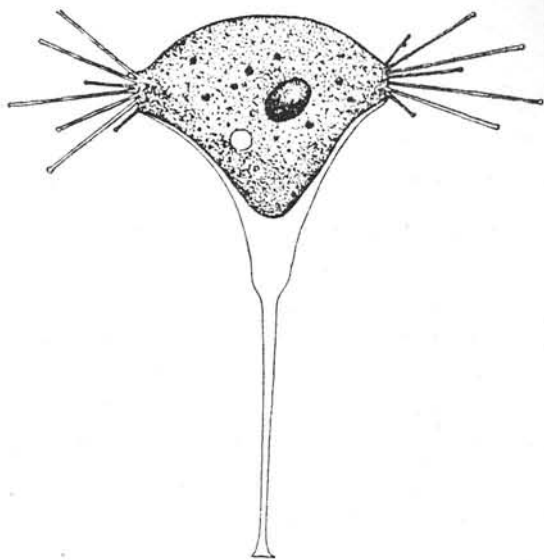


Fig. 87. *Acineta infundibuliformis* sp. nov. $\times 600$.

which is almost as long as the lorica and separated from the latter only by a very slight constriction. Protoplasmic body wedge-shaped, not completely filling the inside of the lorica. Tentacles distinctly capitate, forming two fascicles developed from the antero-lateral sides of the body. Macronucleus single, ovoid, centrally or subcentrally placed. Contractile vacuole one, usually in the posterior half, laterally placed.

Length of lorica including the stem: 110μ

Length of stem: 52μ

Greatest width: 50μ

long as the lorica and separated from the latter only by a very slight constriction. Protoplasmic body wedge-shaped, not completely filling the inside of the lorica. Tentacles distinctly capitate, forming two fascicles developed from the antero-lateral sides of the body. Macronucleus single, ovoid, centrally or subcentrally

Acineta infundibuliformis seems to be closely related with *A. patula* C. et L. in the general outline of the lorica. In the former, the funnel shaped body is, however, more elongated than that of the latter. The constriction at the point of junction between the lorica and the stem is also different in these two species. The capitate tentacles of *A. patula* are protruded from every portion of the periphery of the animal body while those in the present species are developed in two fascicles from the antero-lateral sides of the body. The animal is usually found to be attached on the algae.

***Acineta annulata* sp. nov.**

(Fig. 88)

Lorica elongate campanulate, widest anteriorly, gradually narrowing toward the posterior extremity, annulate transversely throughout the entire length of the body; each annulation probably representing a new cycle of growth. Pedicle rather short. Protoplasmic body filling the entire cavity of the lorica and adherent to it, projecting in a semicircular hyaline mass beyond the anterior margin of the lorica, bearing two antero-lateral fascicles of capitate tentacles. Macronucleus single, spherical or ellipsoidal, usually antero-laterally located. Contractile vacuole single, posterior to the middle portion of the body.

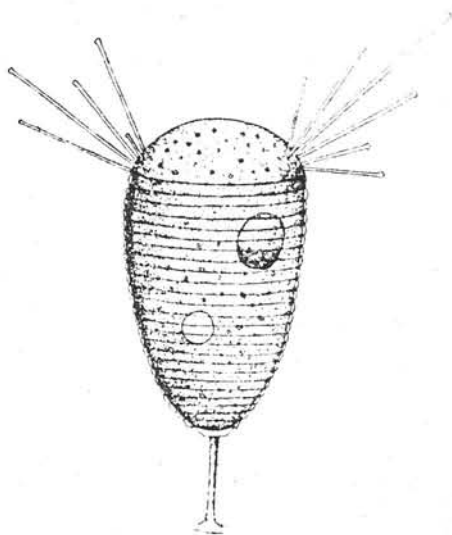


Fig. 88. *Acineta annulata* sp. nov. $\times 750$.

Length: 62 μ
 Width: 35 μ
 Stalk: 12 μ in length

This species is characterized by the presence of regular annulations throughout the entire length of the surface of the lorica. The number of the annulations vary greatly from the young specimens to the adult forms, since, as described above, each annulation probably represents a new cycle of growth. The pedicle is rather short and slender in proportion to the size of the lorica and its posterior extremity is usually expanded to form a circular base for adhering to the sea weeds and Sertularian Hydrozoa.

The granular endoplasm is transparent and reflective. The number of tentacles in each antero-lateral fascicles is less than ten. The length of the tentacles scarcely exceeds the length of the body. The occurrence of this animal in Amoy is rather abundant.

Family Dendrosomidae

Trichophrya sp?

(Fig. 89)

Body ill-loricated, elongate, flattened, temporarily affixed in a sessile manner to various objects without the intermedian of a supporting pedicle, bearing two fascicles of capitate suckers at the two extremities of the longitudinal axis. Contractile vacuoles two in number, macronucleus single, elongate elliptical, centrally located.

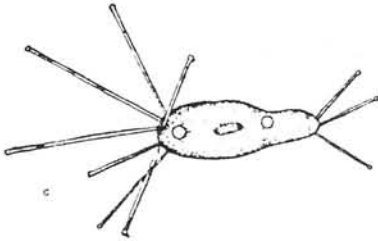


Fig. 89. *Trichophrya* sp?. $\times 950$.

Size: $20\mu \times 10\mu$

Literature cited

- Pergh, R. S. 1882. Der Organismus des Ciliaflagellaten. Eine phylogenetische Studie. *Morphologisches Jahrbuch.*, Bd. 7.
- Plüschli, O. 1882. Protozoa in Bronn's Klassen und Ordnungen des Thierreichs. Leipzig und Heidelberg.
- Salisbury, G. N. 1902. Marine Protozoa of Woods Hole. Bull. U. S. Fish Commission. Washington.
- Salisbury, G. N. 1911. Regeneration and cell division in Uronychia. *Jour. Exp. Zool.*, vol. 10.
- Salisbury, G. N. 1926. The Biology of Protozoa. Philadelphia & New York.
- Saparede, E. et Lachmann, J. 1854. Études sur les Infusoires et les Rhizopodes. *Mémoires de l'Institut Genevois*, T. 5 et 6.
- Schäfer, F. 1866. Neue Infusorien im Seeaquarium. *Zeitsch. f. wiss. Zool.*, Bd. 16.
- Stollin, B. 1911. Étude monographique sur les Acinétiens. I. Recherches expérimentales sur l'étendue des variations et les facteurs tératogènes. *Arch. Zool. Exp.*, T. VIII.
- Stollin, B. 1912. Étude monographique sur les Acinétiens. II Morphologie, Physiologie, Systématique. *Arch. Zool. Exp. et Gén.*, T. 51.
- Strassburger, W. 1926. Recherches sur les Flagellates de nos eaux saumâtres. I Partie: Dinoflagellates. *Arch. für Protistenk.* Bd. 55.
- Strauss, K. M. 1865-6. Revision der Prohelminthen. -Sitz. d. K. Akad. d. wiss. Wein. Bd. LII et LIII.
- Thuret, F. 1841. Histoire naturelle des Zoophytes. Infusoires, comprenant la physiologie et la classification de ces Animaux, et la manière de les étudier à l'aide du microscope. Paris.
- Thuret-Fremiet, E. 1908. Étude descriptive des Périidiens et des Infusoires ciliés du plankton de la Baie de la Hougue. *Ann. Sc. Nat. Zoo.*, 9 Series, T. VII, 14.
- Thuret-Fremiet, E. 1924. Contribution à la connaissance des Infusoires planctoniques. *Bull. Biol. de France et de Belgique*, Suppl. 4.
- Fromentel, E. 1874. Études sur les Microzoaires ou Infusoires proprement dits. Paris.
- Thomson, P. H. 1856. Tenby: A Seaside Holiday. Article *Zoothamnium*. London.
- Thomson, R. 1870. Untersuchungen über den Bau und die Naturgeschichte der Vorticellen. *Wiegmann's Archiv*. Bd. 36 und 37.
- Yada, Y. 1932. Report of the Biological Survey of Mutsu Bay. 26. The pelagic Ciliata, Suborder Tintinnoinea. *Sci. Rep. Tôhoku Imp. Univ.*, 4th Ser., Biol. vol. 7, no. 4.

- Haeckel, E. 1887. Report on the Radiolaria collected by H. M. S. Challenger. in: Chall. Rep. Zool., vols. 17 and 18.
- Jørgensen, E. 1911. Die Ceratien. Eine kurze Monographie der Gattung Ceratium Schrank. Leipzig.
- Kahl, A. 1926. Neue und wenig bekannte Formen der holotrichen und heterotrichen Ciliaten. Arch. für Protistenk., Bd. 55.
- Kahl, A. 1928. Die Infusorien (Ciliata) der Oldesloer Salzwasserstellen. Arch. f. Hydrobiol., Bd. 19.
- Kent, S. 1880-2. A manual of the Infusoria. London.
- Kofoed, C. A. 1907. Dinoflagellates of the San Diego Region. III. Descriptions of new species. Univ. Calif. Pub. in Zoology., vol. 3, no. 13.
- Kofoed, C. A. 1908. Notes on some obscure species of Ceratium. Ibid., vol. 4, no. 7.
- Kofoed, C. A. 1920. A new morphological interpretation of the structure of Noctiluca and its bearing on the status of the Cystoflagellata (Haeckel). Ibid., vol. 19.
- Kofoed, C. A., and Campbell, A. S. 1929. A conspectus of the marine and fresh-water ciliates belonging to the Suborder Tintinnoinea, with descriptions of new species principally from the Agassiz Expedition to the Eastern tropical Pacific 1904-1905. Ibid., vol. 34.
- Kofoed, C. A., and Swezy, O. 1921. The free-living unarmored Dinoflagellata. Mem. Univ. Calif. Pub., vol. 5.
- Lankester, R. 1874. Torquatella typica. Quart. Jour. Microsc. Sc. (n.s.) vol. 14.
- Lauterborn, R. 1908. Protozoen-Studien v. Teil. Zur Kenntnis einiger Rhizopoden und Infusorien aus dem Gebiete des Oberrheins. Zeitsch. f. wiss. Zool., Bd., XC.
- Lepsi, J. 1927. Die Infusorien des Süßwassers und Meeres. Berlin.
- Maupas, E. 1881. Contribution a l'étude des Acinétiens. Arch. Zool. exp., T. 5.
- Maupas, E. 1883. Contribution a l'étude morphologique et anatomique des Infusoires Ciliés. Arch. Zool. Exp. et Gén., 2 Serie T. 1.
- Mereschkowsky, C. 1879. Studien über Protozoen des nördlichen Russland. Arch. für microsk. Anat., Bd. XVI.
- Mereschkowsky, C. 1881. On some new or little known Infusoria. Ann. & Mag. Nat. Hist. ser. 5, vol. 7.
- Möbius, K. 1888. Bruchstücke einer Infusorien fauna der Kieler Bucht. Arch. f. Naturgesch., I.
- Okamura, K., and Nishikawa, T. 1904. A list of the species of Ceratium in Japan. Annot. Zool. Japon., vol. V, 3.

- Penard, E. 1919. On *Folliculina boltoni* (S. Kent). Jour. Roy. Micr. Soc., pp. 305-19.
- Penard, E. 1922. Études sur les Infusoires de l'eau douce. Genève.
- Plough, H. H. 1916. The genus *Aspidisca* Ehrenberg. Trans. Amer. Micr. Soc., vol. 35, no. 4.
- Pritchard, A. 1861. A History of Infusoria, including the Desmidiaceae and Diatomaceae. Ed. 4. London.
- Quennerstedt, A. 1865-9. Bidrag till Sveriges Infusorie-fauna. Acta Universitatis Lundensis, t. 1-3.
- Stein, F. 1859-78. Der Organismus der Infusionsthier. I. Hypotricha. II. Heterotricha. Leipzig.
- Stein, F. 1883. Der Organismus der Infusionsthier. III. Abt. Der Organismus der Flagellaten. 1 u. 2. Hälfte. Leipzig.
- Sterki, V. 1878. Beiträge zur Morphologie der Oxytrichinae. Zeitsch. f. wiss. Zool., Bd. 31.
- Stokes, A. C. 1894. Notices of presumably undescribed Infusoria. Proc. Am. Phil. Soc., vol. 33.
- Wrzesniowsky, A. 1870. Ueber Infusorien aus der Umgebung von Warschau. Zeitsch. f. wiss. Zool., Bd. 20.
- Wrzesniowsky, A. 1877. Beiträge zur Naturgeschichte der Infusorien. Ibid., Bd. 29.