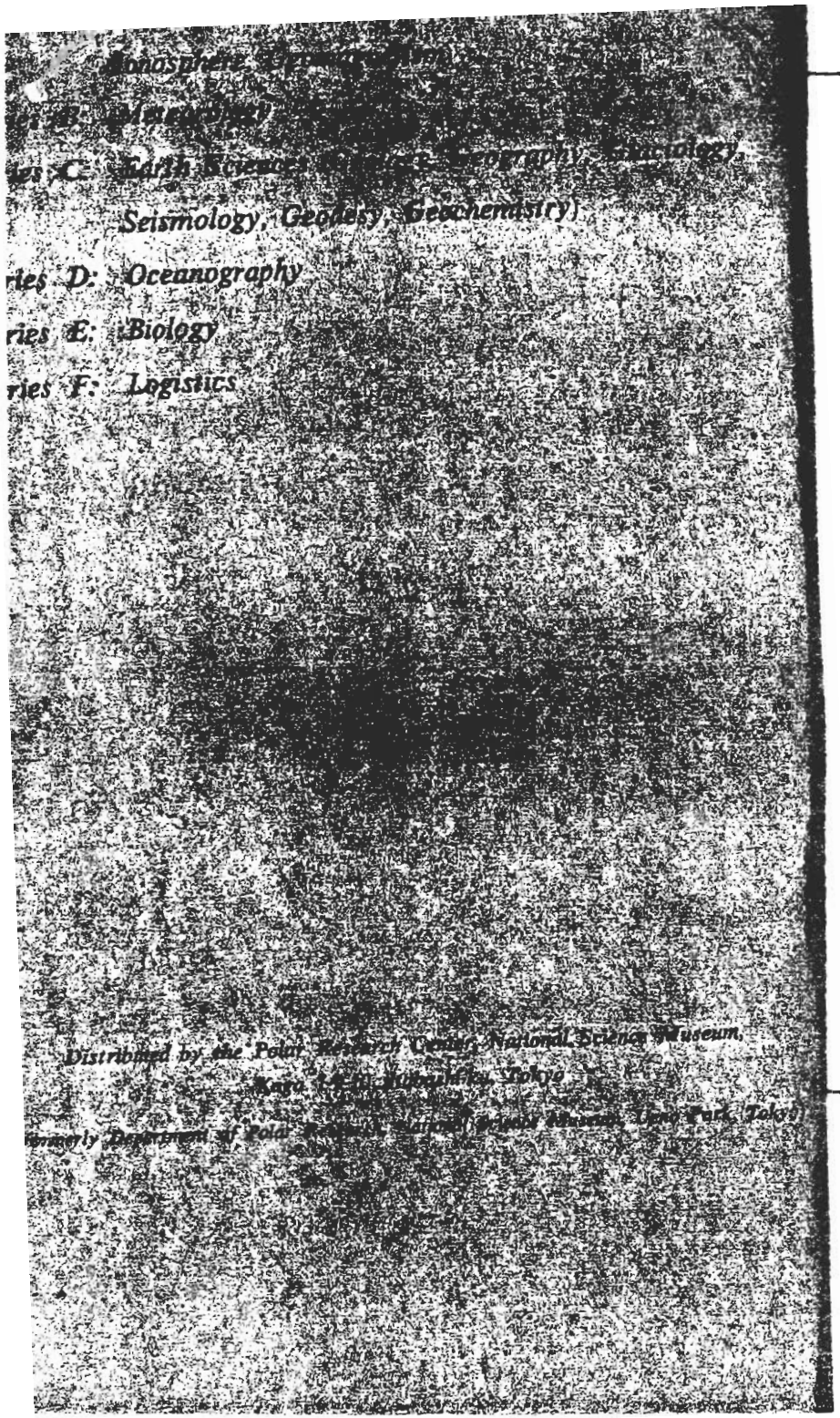

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The Protozoan Plankton of the Antarctic and Subantarctic Seas

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CONTENT

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line 5: *for* hem *read* them.

Fig. 1: *for* Locolity *read* Locality.

Abstract

The study of the protozoan plankton is based on the materials of surface water collected from the seas between Antarctica and Africa during the third and fifth voyages of the Soya (1957–1958; 1959–1960). From these plankton samples of the antarctic and the subantarctic seas have been secured 31 forms of the flagellates, a single of the pelagic foraminifera and 44 of the ciliates. Of the total 76, 18 are new species or new varieties, including one new genus. From the study it is clear that the species of the following three orders occur frequently in surface water of the southern antarctic area of the Indian Ocean: the Dinoflagellida including the unarmored genera, *Amphidinium*, *Gymnodinium* and *Gyrodinium* and the armored genus, *Peridinium*, the Oligotrichida having the marine common genus, *Strobilidium*, and the Tintinnida comprising the characteristic genera peculiar to antarctic waters, *Laackmanniella*, *Protocymatocylis* and *Cymatocylis*. Furthermore, the highest frequency of occurrences of the protozoan plankton has been observed in the materials obtained from surface water of 0–5°C in the antarctic seas.

1. Introduction

The protozoan plankton of the antarctic seas has been attractive for the present author since the beginning of the study of the Protozoa in consequence of learning the bipolarity of the lorica-carrying ciliates, Order Tintinnida, in the excellent report of Dr. H. LAACKMANN (1909) on the species of the order collected from the antarctic sea off the Wilhelm II Land. The author obtained many samples of the plankton of the antarctic seas taken by several mother whalers with a common plankton-net during six years until 1940. However, he was unable to secure sufficient materials for studying the protozoan plankton of the antarctic seas. The major reason is that the protozoan plankton comprises a great number of minute forms belonging to nannoplankton, wich is difficult to collect with a common plankton-net made in Japan. Therefore, most of the samples of plankton examined in the study were gathered by means of fixing sea water. The method of collecting plankton is effective to get minute species of the pelagic Protozoa.

Regarding the protozoan plankton of the antarctic and subantarctic seas the following reports have been published by H. LAACKMANN (1909) on the Order Tintinnida taken off the Wilhelm II Land, by W. BUSCH (1930) on the oligotrichoid Ciliatea, Genus *Strobilidium*, obtained from the Antarctic East Australian Current, by E. BALECH (1944) on the Orders Dinoflagellida and Tintinnida obtained from the sea neighboring Cape Horn, (1947) from the Bellingshausen Sea in the antarctic area of the Pacific Ocean, (1958) from the western region of the Weddell Sea and the sea off the Adélie Coast south of Australia, (1959) on the Order Dinoflagellida collected from the South Atlantic Ocean and (1962) from the southwestern sea of the same ocean, and on the protozoan nannoplankton of the Weddell Sea, and furthermore, by the author (1961) on some pelagic Ciliatea in the samples same to the present.

In the study as well as in the previous investigations, it has become clear that the two groups of the Protozoa, one belonging to the Mastigophora and the other to the Ciliatea, are dominant protozoans of the antarctic and subantarctic seas. The author has identified a single silicoflagellate, 31 dinoflagellates, one pelagic foraminifera, and 44 forms of the Class Ciliatea of which 29 are included in the Order Tintinnida. In all of these forms, 15 species and two varieties are probably new to science.

The author is indebted to Dr. H. FUKUSHIMA, Professor of Yokohama Municipal University, for furnishing him with the important materials for study.

2. Method of Collection

The examined materials of the protozoan plankton, wihch was taken on board the research boat in the voyage, were obtained by fixing surface water with 1% formaline. In the protozoan plankton the naked forms without shells or skeletons are well reserved by means of this method, for instance (HADA, 1969), the pelagic amoeba in the open sea were fixed as pseudopodiae were stretching just as in living. About 600 cc of sea water was taken and fixed at every station. This volume of water is sufficient for the systematic study of the protozoan plankton.

3. Stations of Collection

The samples of the study were collected during the third (1957–1958) and the fifth (1959–1960) voyages of the Soya for the Japanese Syowa Station in Lützow-Holm Bay. The stations of collection are distributed in the seas between Antarctica and Africa.

Observations of the plankton were carried out on samples of fixed surface water, typically below 10°C at the time of collection. Table 1 shows location and water temperatures of the third voyage. The stations of the fifth are scattered in the antarctic and subantarctic area of the Indian Ocean.

Table 1. Stations of the third voyage of the Soya.

Station	Date 1957–58	Every day at noon			
		Position		Air temp. °C	Water temp. °C
		Latitude	Longitude		
1	Dec. 24	34°04′S	18°15′E	19.5	11.2
2	25	37 15	20 56	22.0	
3	26	40 48	23 55	13.4	
4	27	44 12	27 07	11.4	
5	28	47 48	30 38	4.8	7.0
6	29	50 57	34 23	3.5	3.7
7	30	54 26	37 56	0.5	2.5
8	31	58 06	41 46	0.8	1.9
9	Jan. 1	61 55	45 48	0.7	1.9
10	2	65 24	50 56	−1.4	0.2
11	3	65 42	47 20	−0.8	−1.4
12	4	66 14	41 14	0.0	−0.5
13	5	66 07	41 16	−1.1	−1.2
14	6	66 55	42 44	−0.5	−1.6
15	7	66 33	43 59	−0.5	−0.6

Station	Date 1957–58	Every day at noon			
		Position		Air temp. °C	Water temp. °C
		Latitude	Longitude		
16	Jan. 8	66° 47′S	41° 51′E	−1.4	−0.9
17	9	67 18	40 15	−0.5	−1.3
18	10	67 21	40 03	0.0	−0.9
19	11	67 21	39 54	−1.6	−1.7
20	12	67 28	40 08	−1.0	−1.7
21	15	67 34	40 26	−1.3	−1.8
22	16	67 44	40 14	−1.4	−1.7
23	18	67 43	39 56	−0.6	−1.7
24	21	67 44	39 39	−0.7	−1.7
25	22	67 49	39 07	−0.5	−0.6
26	26	67 56	37 29	0.6	
27	27	67 54	37 26	−1.3	−1.7
28	29	67 55	37 20	−1.1	−1.7
29	30	67 54	37 12	−5.1	−1.7
30	31	67 51	37 10	−3.2	−1.8
31	Feb. 1	67 49	37 18	−3.1	−1.7
32	2	67 50	37 22	−3.3	−1.8
33	3	67 19	40 33	−2.2	−0.7
34	4	66 53	40 06	−2.2	−1.0
35	5	67 09	40 11	−4.0	−1.0
36	6	67 04	40 51	−3.6	−0.7
37	7	66 36	40 43	−3.6	−1.2
38	8	66 01	50 02	−3.0	−1.7
39	9	66 39	44 03	−3.5	−0.9
40	10	67 18	35 32	−2.2	−1.4
41	11	67 36	31 05	−4.8	−1.1
42	12	67 08	32 38	−3.1	2.0
43	13	64 09	30 10	−1.7	1.8
44	14	60 15	28 43	1.0	1.7
45	15	57 01	27 49	2.1	1.9
46	16	54 03	26 33	2.0	1.5
47	17	50 25	24 34	4.3	3.0
48	18	46 29	22 19	7.5	6.6
49	19	42 55	20 52	8.9	9.8
50	20	40 57	18 03	13.7	15.2

Table 2. List of the pelagic Protozoa in the antarctic and subantarctic seas.

Subphylum Sarcomastigophora
Superclass Chromonadea
Class Chrysomonadea
Order Chrysomonadida
Suborder Silicoflagellina
Family Silicoflagellinidae
1. *Distephanus speculus* (Ehrenberg)
Order Dinoflagellida
Suborder Adinidina
Family Protocentridae
2. *Exuviaella marina* (Cienko)
3. *Exuviaella antaretica* n. sp.
Suborder Diniferina
Family Dinophysidae
4. *Dinophysis antarcticum* Balech
5. *Oxytoxum punctulatum* Rampi
Family Gymnodinidae
6. *Amphidinium acutissimum* Schiller
7. *Cymnodinium cinctum* Kofoid & Swezy
8. *Gymnodinium flavum* Kofoid & Swezy
9. *Gymnodinium baccatum* Balech
10. *Gymnodinium soyai* n. sp.
11. *Gymnodinium frigidum* Balech
12. *Gymnodinium minor* Lebour
13. *Gyrodinium lachrymum* (Meunier)
14. *Gyrodinium glacialis* n. sp.
15. *Gyrodinium glacialis* var. *microgranum* n. var.
Family Noctilucidae
16. *Noctiluca scintillans* (Macartney)
Family Nematodinidae
17. *Warnowia rubescens* (Kofoid & Swezy)
Family Peridinidae
18. *Diplopeltopsis minor* (Paulsen)
19. *Goniodoma sphaerica* Murray & Whitting
20. *Gonyaulax spinifera* (Claparède & Lachmann)
21. *Gonyaulax turbynei* Murray & Whitting
22. *Peridinium curtum* Balech
23. *Peridinium nanum* Balech
24. *Peridinium parvicollum* Balech
25. *Peridinium mediocre* Balech
26. *Peridinium incertum* Balech
27. *Peridinium applonatum* Manoin
28. *Ceratium fusum* (Ehrenberg)
29. *Ceratium furcum* (Ehrenberg)
30. *Ceratium lineatum* (Ehrenberg)
31. *Ceratium kofoidi* Jörgensen

Superclass Sarcodina
Class Rhizopodea
Subclass Granuloreticulosia
Order Foraminiferida
Family Globigeriniidae
1. *Globigerina bulloides* d'Orbigny
Subphyllum Ciliophora
Class Ciliatea
Subclass Holotricha
Order Gymnostomatida
Family Didiniidae
1. *Didinium gargantum* Meunier
2. *Didinium balbianii* var. *nanum* Kahl
Family Colepsiidae
3. *Tiarina fusca* (Claparède & Lachmann)
4. *Tiarina fusca* var. *minor* n. var.
5. *Tiarina antarctica* n. sp.
Family Amphileptidae
6. *Lionotus lamellus* Ehrenberg
Order Hymenostomatida
Family Helicostomidae
7. *Helicostoma notata* (Möbius)
Subclass Spirotrichia
Order Oligotrichida
Family Strobilididae
8. *Strobilidium sulcotum* Claparède & Lachmann
9. *Strobilidium conicum* Kahl
10. *Strobilidium striatum* (Busch)
11. *Strobilidium diversum* (Busch)
12. *Strobilidium antarcticum* (Busch)
13. *Strobilidium syowaensis* n. sp.
14. *Strobilidium elongatum* (Leegaard)
15. *Strobilidium elegans* n. sp.
Order Tintinnida
Family Tintinnopsidae
16. *Tintinnopsis glans* Meunier
17. *Tintinnopsis fimbriata* Meunier
18. *Tintinnopsis petasa* n. sp.
19. *Tintinnopsis bacillaria* n. sp.
20. *Tintinnopsis radix* (Imhof)
Family Codonellopsidae
21. *Stenosemella nivalis* (Meunier)
22. *Stenosemella perpusilla* n. sp.
23. *Stenosemella avellana* (Meunier)
24. *Codonellopsis soyai* n. sp.
25. *Codonellopsis glacilis* (Laackmann)
26. *Codonellopsis gaussi* (Laackmann)
27. *Laackmanniella naviculaefera* (Laackmann)

Family Coxliellidae
28. *Helicostomella antarctica* HADA
Family Cyttarocylidae
29. *Protocymatocylis pseudoconica* HADA
30. *Protocymatocylis subrotundata* (LAACKMANN)
31. *Cymatocylis kerguelensis* LAACKMANN
32. *Cymatocylis parva* (LAACKMANN)
33. *Cymatocylis cristallina* LAACKMANN
34. *Cymatocylis brevicaudata* LAACKMANN
35. *Cymatocylis calyciformis* (LAACKMANN)
Family Petalotrichidae
Subfamily Craterellineae
36. *Craterella perminuta* n. sp.
Subfamily Metacylineae
37. *Metacylis corbula* KOFOID & CAMPBELL
Subfamily Petalotrichineae
38. *Parapetalotricha meridiana* n. gen. & n. sp.
Family Undellidae
39. *Undella antarctico* n. sp.
Family Dictyocystidae
40. *Dictyocysta polygonata* KOFOID & CAMPBELL
Family Tintinnidae
Subfamily Amphorellineae
41. *Bursaopsis ollula* n. sp.
42. *Bursaopsis conicoides* n. sp.
43. *Dadayiella ganymedes* (ENTZ)
Subfamily Tintinninеae
44. *Daturella frigida* n. sp.

4. Systematic Description

Phylum Protozoa
Subphylum Sarcomastigophora

The subphylum comprises flagellates and rhizods.

A. Superclass Mastigophora

The superclass includes most of the flagellated organisms.

Class Chromonadea

In the class are included the flagellates originally having chromatophores. These which obtained from the antarctic and subantarctic seas as plankton, belong only to two orders.

Order Chrysomonadida

The flagellates of the order originally contain greenish or brownish yellow chromatophores.

Suborder Silicoflagellina

The flagellates of the suborder have a framework composed of silicious skeletons, and are common in neritic seas. A single species has been detected from the antarctic and subantarctic seas.

Family Silicoflagellinidae

1. ***Distephanus speculus*** (EHRENBERG) Fig. 1

Distephanus speculus: MARSHALL, 1934, p. 625, figs. 1, 2; MARGALEF & DURÁN, 1953, p. 20, figs. 2c–e; BALECH & EL-SAYED, 1965, pp. 108–112.

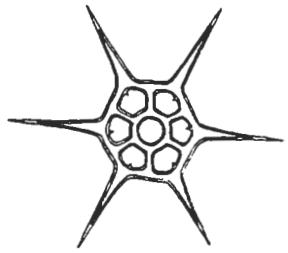


Fig. 1. Distephanus speculus (EHRENBERG), 900 ×.

The skeleton of the flagellate consists of double hexagonal frames connected to each other with supporting bars, long radial spines stretching from each angle of the outer frame, and short inward ones from the hexagonal bars of the same. Living specimens carry a single flagellum, a number of pseudopodia, and numerous yellowish brown chromatophores (MARSHALL, 1934). Diameter of the frame, 18–20μ.

The species is one of the common planktonic flagellates in the antarctic and subantarctic seas, being found in many samples of the present work and examined frequently by BALECH & EL-SAYED (1965) in the materials from the Weddell Sea, but it has not been found from surface water below 0°C in the study.

Order Dinoflagellida

The order includes the forms with two flagella different in structure and movement, and is the most important group of the antarctic and subantarctic protozoan plankton in qualitative and quantitative studies.

Suborder Adinidina

In the forms of the suborder two flagella originate from the same point.

Family Protocentridae

2. ***Exuviaella marina*** CIENKO Fig. 2

Exuviaella marina: HADA, 1967, p. 8. figs. 10a, b.

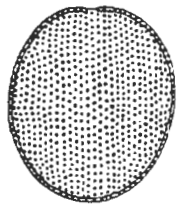


Fig. 2. Exuviaella marina CIENKO, 1,000 ×.

The cosmoplitan neritic species with an oval theca was rarely observed in plankton materials taken from the region of Syowa Station. Temperature of surface water varied from −1.6 to −1.4°C, when collection was made (1960). Length, 27–37μ; breadth, 27–32μ.

Antarctic specimens are generally smaller than those of the Inland Sea of Japan.

3. ***Exuviaella antarctica*** n. sp. Fig. 3

Exuviaella sp. BALECH & EL-SAYED, 1965, p. 112, pl, 3, fig. 55.

The new form bears a small ovate theca compressed fairly. The surface of the theca is smooth, and minute perforation is hardly observable. Length, 15–17μ; breadth, 12–15μ; thickness, 9–10μ. It was rarely found in sample of surface water −1.4 to −0.2°C in temperature, taken from the sea near Syowa Station.

The new species is distinguishable from the known forms of the genus in

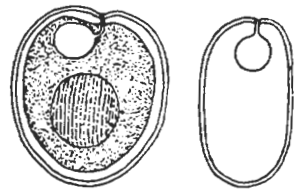


Fig. 3. Exuviaella antarctica n. sp., 1,600 ×.

having a smooth theca. *Exuviaella* sp. reported by BALECH & EL-SAYED (1965) from the Weddell Sea is slightly different from this species in presence of few minute pores on the theca, but these forms of antarctic waters may be included in the same species owing to the similar shape.

Suborder Diniferina

Of two flagella, one grows from a flagellar pore in the sulcus, while the other from a pore in the girdle.

Family Dinophysidae

4. ***Dinophysis antarcticum*** BALECH

Dinophysis antarcticum BALECH, 1958a, p. 82, pl. 2, figs. 14–25; 1958b, p. 384.

The antarctic ovate species was detected in the samples obtained from surface water of temperatures of 0.2–1.4°C on January 4, 1960. Length, 25μ; breadth 23μ.

The specimens from the antarctic sea off Syowa Station are smaller than those reported by BALECH (1958) from the seas in the regions of the Graham Land and off the Adélie Land.

5. ***Oxytoxum punctulatum*** RAMPI Fig. 4

Oxytoxum punctulatum: SILVA, 1956b, p. 70, pl. 11, figs. 15, 16.

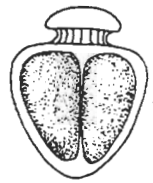


Fig. 4. Oxytoxum punctulatum RAMPI, 1,500 ×.

The ovoidal form consists of a small low epicone, a wide girdle, and a large high hypocone containing double chromatophores. Length, 18μ; breadth, 15μ.

Being a warm water dinoflagellate, it was collected from the station near South Africa. The temperature of surface water was 9.4°C, when sea water was scooped up.

Family Gymnodinidae

Naked dinoflagellates are comprised in the family, and ten forms have been

secured in the study.

6. ***Amphidinium acutissimum*** SCHILLER Fig. 5

Amphidinium acutissimum: AKATSUKA, 1952, p. 25, pl. 14, fig. 9.

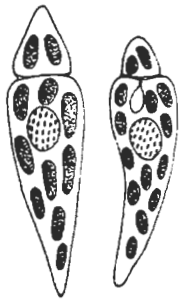


Fig. 5. Amphidium acutissimum SCHILLER, 1,000 ×.

The naked fusiform dinoflagellate is made of a small conical epicone and an elongate hypocone. In the flexible body are seen several oblong chromatophores, a large round nucleus and a single pulsing vacuole. Length, 26–49μ; breadth, 7–13μ.

It is one of common dinoflagellates in the region of Syowa Station in the antarctic seas, being frequently encountered in surface water varying in tempra-ture from −1.7 to 1.9°C.

7. ***Gymnodinium cinctum*** KOFOID & SWEZY Fig. 6

Gymnodinium cinctum: AKATSUKA, 1952, p. 28, pl. 22, fig. 21.

The body consists of a conical epicone and a hemispherical hypocone. The girdle is transversal at the middle of the body and the sulcus does not stretch to the ends. Numerous small chromatophores are scattered in the entire body. The

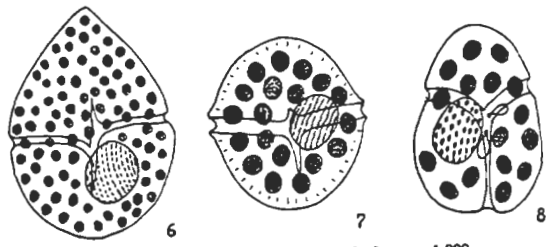


Fig. 6. Gymnodinium cinctum KOFOID & SWEZY, 1,000 ×.
Fig. 7. Gymnodinium flavum KOFOID & SWEZY, 1,000 ×.
Fig. 8. Gymnodinium baccatum BALECH, 1,000 ×.

ovoid nucleus usually exists in the posterior half of the body. Length, 27–48μ; breadth, 22–25μ.

It is a rare species of the antarctic and subantactic seas where the samples were collected for the investigation. The oblong cysts of the species were also secured. Length, 32μ; breadth, 25μ in a cyst.

8. ***Gymnodinium flavum*** KOFOID & SWEZY Fig. 7

Gymnodinium flavum: AKATSUKA, 1952, p. 28, pl. 21, fig. 14; pl. 23, fig. 2.

The rounded body has a wide, nearly straight girdle transversing at the center and a short sulcus. The surface layer of the body is more or less hardened to take a constant form. Chromatophores are many and ovoidal. The nucleus is ellipsoidal and typically near the center. Length, 30–40μ; breadth, 25–40μ.

The species was rarely observed in the samples collected from the sea neighboring Syowa Station on January 3–5, 1961.

9. ***Gymnodinium baccatum*** BALECH Fig. 8

Gymnodinium baccatum BALECH, & EL-SAYED, 1965, p. 114, pl. 1, figs. 4, 5.

The small elongate naked dinoflagellate consists of a smaller conical epicone and a larger ovate hypocone. The girdle hungs down on the ventral face and the sulcus stretches to the posterior end. A number of ovoid chromatophores are scattered in the entire body, in which two minute pulsing vacuoles of a pale pink color are typically seen. The nucleus is rather large near the center of the body. Length, 23–30μ; breadth, 14–20μ.

The present form is more or less different in deteils from one reported by BALECH (1965) from the Weddell Sea, but they are closely allied to each other in general contour. Such slight differences are probably caused by fixing samples. Therefore, the form from the sea near Syowa Station may be included in *G. baccatum* described in originally by BALECH from the Weddell Sea. The species was frequently found in the materials taken from the surface water of the cold sea, −1.5 to 0.2°C in temperature, on January 1–8, 1962. Owing to the above records, it is distinctly one of common dinoflagellates in the antarctic seas.

10. ***Gymnodinium soyai*** n. sp. Fig. 9

The small body is somewhat compressed dorse-ventrally, and consists of a conical epicone and a fairly larger hypocone rounded at the posterior end. The

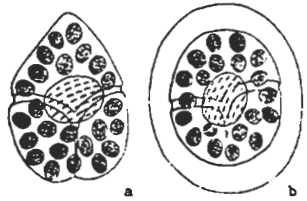


Fig. 9. Gymnodinium soyai n. sp., 1,200 ×;
a. swimming specimen; b. cyst.

girdle is curved on the ventral face, and the sulcus does not typically extend to the epicone, while the latter stretches to the antapical end. Chromatophores are many and ovoid, and the nucleous is usually central. Two pulsing vacuoles are scarcely observed. The cysts are generally ellipsoidal and covered with thick gelatinous layers. Length, 13–28μ; breadth, 10–23μ; length of cysts, 25–30μ; breadth of the same, 17–23μ.

The new species is easily distinguishable from the allied form, *G. cinctum* KOFOID & SWEZY, in smaller dimension and in fewer number and larger size of chromatophores. It is a common species in the region of the antarctic sea neighboring Syowa Station, being found in many plankton materials of surface water, of which temperature varied from −1.6 to 1.9°C when collection was made.

11. ***Gymnodinium frigidum*** BALECH Fig. 10

Gymnodinium frigidum BALECH & EL-SAYED, 1965, p. 112, pl. 1, figs. 6, 7.

The body is broadly conical with a roundly pointing apical end and a slightly concave basal flat. The girdle is wide and descends at the center of the ventral face, and the sulcus is also wide and extends to the sunken posterior end. Numerous small chromatophores are ovoid and distributed radially. The large ellipsoidal nucleus is typically at the center. Length, 45–47μ; breadth, 37–42μ.

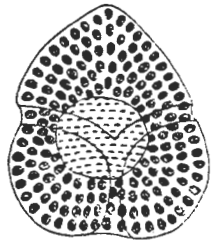


Fig. 10. Gymnodinium frigidum BALECH, 900 ×.

The specimens examined in the investigation are generally higher than those of the Weddell Sea (BALECH & EL-SAYED, 1965). The species was very rarely observed in samples collected from warmer water of 9.4 to 14.7°C in temperature of surface water.

12. ***Gymnodinium minor*** LEBOUR Fig. 11

Gymnodinium minor: HADA, 1968, p. 5, fig. 6.

The colorless form without chromatophores is small and elliptical in side view. The girdle is transverse at the middle of the body, and the sulcus slightly extends upwards, while fairly downwards from the center. The nucleus is comparatively large and ovoid at the center of the body. The pulsing vacuoles are usually seen due to absence of chromatophore. The protoplasm is more or less granular. Length, 18μ; breadth, 16μ.

Being small and delicate, the colorless dinoflagellate was found only in the

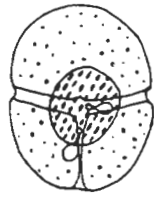


Fig. 11. Gymnodinium minor LEBOUR, 1,800 ×.

plankton material taken on January 1, 1961.

13. ***Gyrodinium lachrymum*** (MEUNIER) Fig. 12

Gyrodinium lachrymum: BALECH & EL-SAYED, 1965, p. 115, pl. 1, fig. 1.

The body is inverted fusiform with a somewhat curved prolonged apical end and a rounded or broadly conical antapical end. The sulcus is typically narrow, and the distance between the starting and finishing points of the girdle is usually as long as a quarter of the total length of the body. Having many longitudinal striae, the surface of the body is more or less rigid, and the surface layer is composed of a protoplasmic zone containing numerous minute trichocysts arranged side by side. Chromatophores are typically several and rounded. The nucleus is large and ellipsoidal near the central region. The protoplasm is so granulated that pulsing vacuoles are invisible in fixed specimens. Length, 60–135μ; 28–50μ.

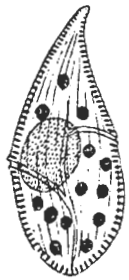


Fig. 12. Gyrodinium lachrymum (MEUNIER), 500 ×.

In the present study large specimens were frequently examined as compared with those recorded in the papers by MEUNIER (1907) and BALECH & EL-SAYED (1965). It seems to be due to satisfactory fixation of plankton samples. The large species is a representative naked dinoflagellate in the antarctic sea near Syowa Station, being common in many samples taken from surface water with temperature −1.7 to 1.7°C, and it is also apparently one of common protozoan plankton in the antarctic and subantarctic seas.

14. ***Gyrodinium glacilis*** n. sp. Fig. 13a

15. ***Gyrodinium glacilis*** var. ***microgranum*** n. var. Fig. 13b

The small body is fusiform, tapering at the apical and antapical ends. Th distance between two terminals of the girdle on the ventral face is one-third o the body. The sulcus does not reach the both ends. Many chromatophores ar ovoid and medium-sized. The nucleus is comparatively small and usually in th anterior half of the body. Length, 22–33μ; breadth, 12–13μ.

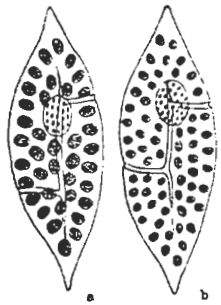


Fig. 13. a. Gyrodinium glacialis n. sp.; *b. Gyrodinium glacialis* var. *microgranum* n. var., 900 ×.

The new form is easily distinguishable from the fusiform species, *G. brianni* Kofoid & Swezy, *G. fusiforme* Kofoid & Swezy and *G. spirale* Entz, in smalle size and in having chromatophores.

It was rarely found in samples collected from the stations in Lützow-Holm Bay on January 8 and 12, 1959. Water temperatures were −1.7 to 0.9°C, whe the research was made. On the fifth voyage of the Soya the similar form wa detected in the materials taken from surface water, of which temperature wa −1.5 to 14.7°C on December 31, 1959 and January 8 and 11, 1960.

The latter form is closely allied to the new species in size and general con tour, but different in having numerous minute chromatophores. Therefore, th author decides that the latter is a variety of the new species, var. *microgranum* n var. Length, 25–42μ; breadth. 12–15μ.

Family Noctilucidae

16. ***Noctiluca scintillans*** (Macartney)

Noctiluca scintillans: Kofoid, 1931, p. 31, figs. V–BB; Hada, 1967, p. 15.

The large naked dinoflaggellate common in warm water was not found i materials taken from surface layers below 10°C in water temperature. In th present work the common species was collected only from St. 1 and St. 50 of th third voyage near the Cape of Good Hope. Temperatures of surface water a each station were respectively 11.2°C and 15.2°C, when collection was made. Ac

cording to Balech's report (1959), the lowest temperature of the ... was 9.5°C when the species was collected. Therefore, the low limit of wate ...erature of *Nortilura* seems to be roughly 10°C.

Family Nematodinidae

17. ***Warnowia rubescens*** (Kofoid & Swezy) Fig. 14

Pouchetia rubescens: Akatsuka, 1952, p. 47, pl. 3 fig. 6.

The body without chromatophores and nematocysts is ovoid... has an ocellus consisting of a black pigment mass and a discal hyaline ... the posterior region. The girdle and sulcus are spiral. The nucleus i...g at the center of the body. Length, 55μ; breadth, 42...

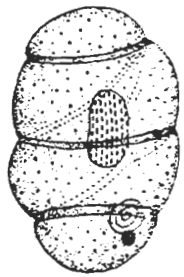


Fig. 14. Warnowia rubescens (Kofoid & Swezy), 900 ×.

The warm water species recorded from the Pacific coast of ...rica, was found in the material taken on February 3, 1960.

Family Peridinidae

The family comprises many common dinoflagellates covered ... thecae. Most of species have been already reported from the antarctic and subantarctic seas.

18. ***Diplopeltopsis minor*** (Paulsen) Fig. 15

Diplopsalis lenticula f. minor Paulsen, 1907, p. 9, fig. 9.

Diplopeltopsis minor: Balech, 1958a, p. 83, pl. 2, figs. 26–31; 1958b, p. 9...

The discal form was found in the material from the stations of surface water

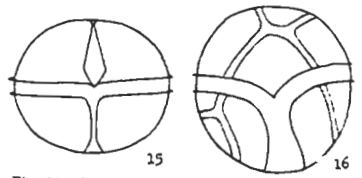


Fig. 15. Diplopeltopsis minor (Paulsen), 80... ×.

Fig. 16. Goniodoma sphaerica Murray & Whitting, 9...

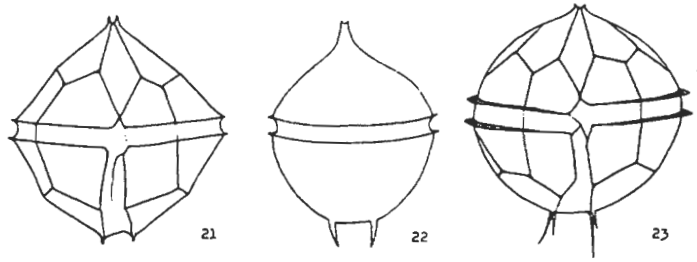


Fig. 21. Peridinium parvicollum BALECH, 600 ×.
Fig. 22. Peridinium mediocre BALECH, 600 ×.
Fig. 23. Peridinium incertum BALECH, 600 ×.

antapical spines. Length, 62μ; breadth, 70μ.

It is a rare species in the antarctic sea of Syowa Station since only one speci men was found.

27. ***Peridinium applanatum*** MANGIN Fig. 24

Peridinium applanatum BALECH, 1958*a*, p. 89, pl. 5, figs. 116–118, 122–126.

The transversally oblong theca have long horn and two slender antapica spines. Length without a horn and spines, 21μ; breadth, 35μ; length of an apica horn, 13μ; same of an antapical spine, 14μ.

The characteristic species is a rare antarctic dinoflagellate, being obtained

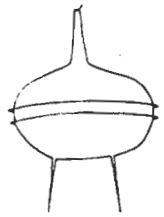


Fig. 24. Peridinium applanatum MANGIN, 700 ×.

only once from the material collected on February 13, 1958. The temperatur was 1.8°C, when surface water was collected.

28. ***Ceratium fusum*** (EHRENBERG)

Ceratium fusus: JÖRGENSEN, 1911, p. 29, figs. 51–53.
Ceratium fusum: HADA, 1967, p. 20, fig. 31A.

The cosmoplitan slender form was rarely collected from the sea above 7°C in temperature of surface water in the work. Length, 250–340μ.

29. ***Ceratium furcum*** (EHRENBERG)

Ceratium furca: JÖRGENSEN, 1911, p. 17, figs. 23a, b.
Ceratium furcum: HADA, 1967, p. 20, fig. 31B.

The elongate species commonest in Japanese waters was found from the sea warmer than 9.4°C in surface water temperature in the research. Length, 30–42μ; breadth, 22–27μ.

30. ***Ceratium lineatum*** (EHRENBERG) Fig. 25

Ceratium lineatum: JÖRGENSEN, 1911, p. 22, figs. 36, 37.

The widespread species was obtained from somewhat cold water of 6.6°C. Total length, 180–192μ; breadth, 70–90μ.

31. ***Ceratium kofoidi*** JÖRGENSEN Fig. 26

Ceratium kofoidi: JÖRGENSEN, 1911, p. 28, figs. 38, 39.

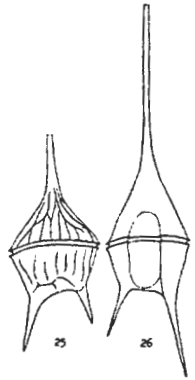


Fig. 25. Ceratium lineatum (EHRENBERG), 1,000 ×.
Fig. 26. Ceratium kofoidi JÖRGENSEN, 500 ×.

The tall form having slender apical horn was rarely observed in the material obtained on January 1, 1961. Length, 135μ; breadth, 35μ.

B. Superclass Sarcodina

The superclass comprises protozoan groups having a stage of amoeboid move ment in a life circle.

Class Rhizopodea

The class consists of the forms moving with pseudopodia.

Subclass Granuloreticulosia

The subclass includes the groups having granular pseudopodia finely anasto mosing.

Order Foraminifera

The order includes numerous testaceus amoebae moving with reticulopodia,

most of which are benthos, while a few pelagic forms usually occur in wa
waters. A single species has been only studied as a planktonic organism in t
present investigation.

Family Globigeriniidae

1. ***Globigerina bulloides*** d'ORBIGNY Fig. 27

Globigerina bulloides: HADA, 1931, p. 140; BRADSHAW, 1959, p. 33, pl. 6, figs. 1–4, text-
8; PARKER, 1960, p. 77; UCHIO, 1960, p. 4, pl. 1, figs. 4–6; BOLTOVSKOY, 1966, p.

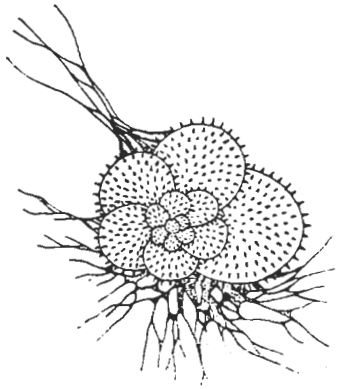


Fig. 27. Globigerina bulloides d'ORBIGNY, 200 ×; living specimen.

As shown in Fig. 27, many fixed specimens extending reticulopodia were o
served in samples taken from the sea near Syowa Station on January 4–Februar
7, 1958. Water temperature of surface layers varied from −1.7 to −0.5°C, whe
collection was made. Length, 110–250μ; breadth, 75–230μ; thickness, 57–90μ.

These pelagic specimens living at the time of collection are generally smalle
than those deposited on the bottom of the oceans, and spines on the surface
the test are typically short as compared with those of specimens occurring
warm waters. These morphological differences of the test among warm or co
water specimens, are probably due to strength of floating action influenced b
water temperature. Furthermore, it seems that living specimens of the plankton
species in the antarctic seas are usually suspended in water by extending pse
dopodia, judging from the samples examined in the present work. Besides th
species, the other pelagic foraminifera, *Globigerina pachyderma* (EHRENBERG), h
been recorded from deposits of the same sea by UCHIO (1960), but this species h
not been found in plankton materials taken from the surface layer of the se
The pelagic form, *G. bulloides* d'ORBIGNY, is evidently a worldwide spreading f
raminifera prefering cold water according to the following reports: BRADSHA
(1959) recorded the highest frequencies of the species in the area of cold wat

of the Aleutian Islands, PARKER (1960) reported that its distribution extends southward to subantarctic water in the Pacific Ocean, and also BOLTOVSKOY (1966) mentioned the similar tendency in the Atlantic Ocean. Besides the present paper, *Globigerina* sp. has been reported by BALECH & EL-SAYED (1965) from the Weddell Sea in Antarctica.

On the other group of the rhizopodial plankton from the antarctic seas, there have been only fragmentary reports. Of the Radioraria *Challengera* sp. and *Stichocorys zanclea* HERTWIG have been recorded by BALECH & EL-SAYED (1965) from the Weddell Sea, and several species has been reported by NAKASEKO (1959) from sediments of the region of Syowa Station. However, these have not been secured as a planktonic organism in the work.

C. Subphyllum Ciliophora

The subphyllum comprises the Protozoa having originally cilia as a locomotive organ.

Class Ciliatea

Subclass Holotricha

The subclass includes organisms typically ciliated on the whole surface of the body.

Order Gymnostomatida

The oral part of the body taking food inside, opens directly outside and without longer oral cilia.

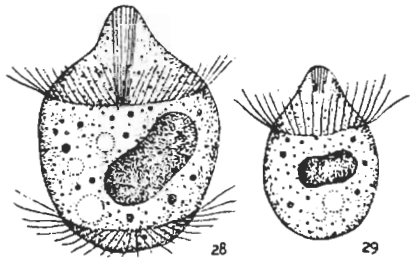
Family Didiniidae

1. ***Didinium gargantum*** MEUNIER Fig. 28

Didinium gargantua: KAHL 1933, p. 57, fig. 41; HADA, 1937, p. 148, figs. 3a, b; 1961, p. 142.

The globular body with a conical proboscis has two ciliary bands. Length, 40–95μ; breadth, 25–72μ.

The cold water form was rarely found from the antarctic sea of 1.7–1.8°C in temperature of surface water. Antarctic specimens are generally smaller than those examined from Akkeshi Bay in Hokkaido (HADA, 1937).



28 29

Fig. 28. Didinium gargantua MEUNIER, 800 ×.
Fig. 29. Didinium balbianii var. *nanum* KAHL, 800 ×.

Lionotus lamella: Roux, 1901, p. 36, pl. 2, fig. 4; Penard, 1922, p. 65, fig. 69.

The elongate form common in fresh and brackish waters was detected fr antarctic waters of a temperature of −0.2°C. Length, 48–65μ; breadth, 25–27

Order Hymenostomatida

The order includes the uniformly ciliated organisms having a buccal cav with undulating membrane and three small membranelles on the ventral side

Family Helicostomidae

7. ***Helicostoma notata*** (Möbius) Fig. 34

A few specimens looking like the brackish water species were observed in plankton materials taken from antarctic surface waters of temperatures of −1.5

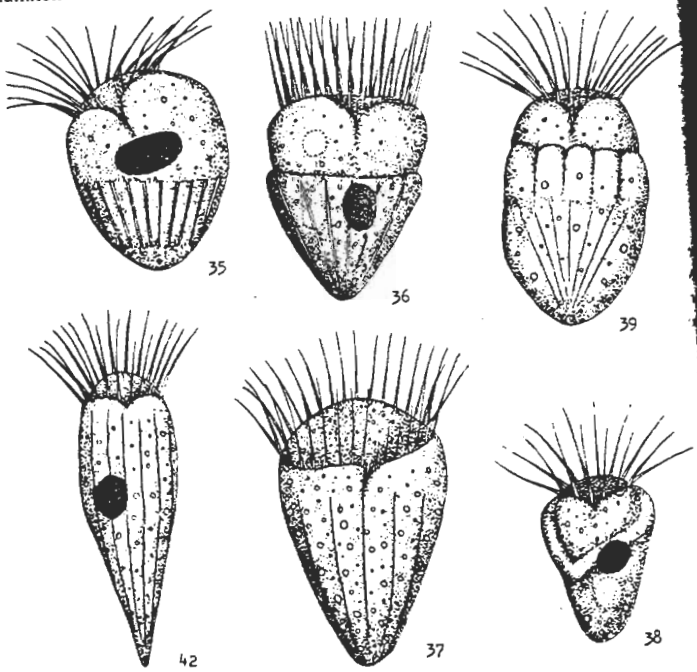


Fig. 35. Strobilidium sulcatum Claparède & Lachmann, 1,000×;
Fig. 36. Strobilidium conicum Kahl, 800×;
Fig. 37. Strobilidium striatum (Busch), 1,000×;
Fig. 38. Strobilidium diversum (Busch), 1,200×;
Fig. 39. Strobilidium antarcticum (Busch), 800×;
Fig. 42. Strobilidium elegans n. sp., 1,200×.

1.4°C on January 4–8, 1960. Length, 75–125μ; breadth, 30–38μ.

Subclass Spirotrichia

The subclass comprises ciliated protozoan groups having spare somatic cilia and a developed oral ciliature composed of many membranelles.

Order Oligotrichida

Somatic cilia are remarkably sparse or absent, and oral membranelles develope to surround the apical end of the body.

Family Strobilididae

8. ***Strobilidium sulcatum*** Claparède & Lachmann Fig. 35

Strobilidium sulcatum: Kahl, 1932, p. 496, figs. S490, 8, 16.

The marked characteristic of the species common in fresh water, is having a wide band composed of short striae in the posterior half of the body. Length, 32–37μ; breadth, 28–30μ.

This species is rare in the antarctic seas, being found in samples taken on January 1, 1960. Surface water was 0.2°C in temperature, when collection was made.

9. ***Strobilidium conicum*** Kahl Fig. 36

Strobilidium conicum: Kahl, 1932, p. 512, fig. S506, 33.

The posterior part of the body is conical with distinct oblique striae. The macronucleus is oblong, and contractile vacuoles are usually visible. Length, 30–55μ; breadth, 22–32μ.

It is a common species in the sea, where the temperature of surface water was 1.0 to 14.7°C when the research was made. The macronucleus of the specimen examined in the study is more or less different from that of Kahl's original type in form.

10. ***Strobilidium striatum*** (Busch) Fig. 37

Strobilidium striatum: Kahl, 1932, p. 504, fig. S501, 37.

The body is fusiform and usually twice as long as broad. Several striae are on the surface of the posterior conical part of the body. Length, 25–50μ; breadth, 18–27μ.

The distribution of the species is nearly equal to that of the former, *S. conicum* Kahl, in the sea where the research was carried out. It is probably common in the antarctic seas, being recorded by Busch (1930) from the Antarctic East Current.

11. ***Strobilidium diversum*** (Busch) Fig. 38

Strobilidium diversum: Kahl, 1932, p. 504, fig. S501, 35.

The small form without striae is variable in form, and has a collaring band. Length, 10–25μ; breadth, 10–25μ.

A few specimens were obtained from the samples collected from surface water of the antarctic sea of −0.9°C in temperature. The species has been also reported by Busch (1930) from the Antarctic East Current.

12. ***Strobilidium antarcticum*** (Busch) Fig. 39

Strobilidium antarcticum: Kahl, 1932, p. 504, fig. S501, 36.

The ellipsoidal species with a rounded antapical end has a wide band c
posed of several short columns and slight oblique striae on the surface of
posterior half of the body. Length, 60μ; breadth, 40μ.

The species is rare in the sea near Syowa Station, being found only once
the plankton material obtained from Lützow-Holm Bay. A temperature of surf
water was −1.8°C, when collection was made. However, it seems to be wid
distributed in the antarctic waters, being already reported by BUSCH (1930) fr
the Antarctic East Current.

13. ***Strobilidium syowaensis*** n. sp. Fig. 40

The body is large and ovoidal, and consists of a widely conical anterior cr
with well-developed membranelles, a median band figured with inverted trian
on the surface, and a roundly conical posterior region containing numerous gr
ules. A contractile vacuole usually appears. Length, 82–160μ; breadth, 67–9

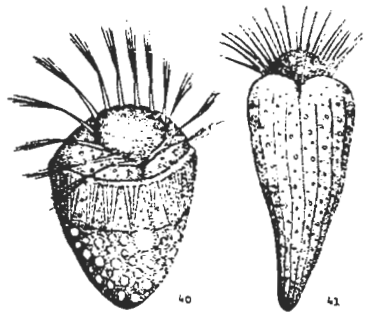


Fig. 40. Strobilidium syowaensis n. sp., 500×;
Fig. 41. Strobilidium elongatum (LEEGAARD), 500×.

The new species is different from the known forms of *Strobilidium* in hav
the median characteristic band. It is the largest species among those recor
from the antarctic seas. It was found in the materials obtained on Januar
and March 8 (1.5°C), 1960.

14. ***Strobilidium elongatum*** (LEEGAARD) Fig. 41

Strobilidium elongatum: KAHL, 1932, p. 500, figs. S501, 16.

The elongate form is fusiform with a slightly curved posterior part, and
a number of longitudinal striae on the surface. Length, 62–150μ; breadth, 27–

The species recorded from the North Atlantic Ocean is one of the comm
ciliates in the sea of the region of Syowa Station, where temperature of surf
water varied from −1.8 to −0.2°C at the times of the researches.

15. ***Strobilidium elegans*** n. sp. Fig. 42

The new form is small and slender, being more or less swollen at the mi
and highly conical in the posterior half with a somewhat acute antapical

The surface of the body is provided with a number (10–13) of longitudinal striae. The macronucleus is ovoidal near the center. Length, 25–45μ; breadth, 12–15μ.

The new species is similar to *S. elongatum* (LEEGAARD) in general contour, but it is distinguishable from the latter in smaller size, slender form, and having a conical acute antapical end. It was rarely detected from the materials obtained on January 1 and 6, and February 8, 1960.

Order Tintinnida

The order comprises the forms carrying a lorica and having tentaculoids peculiar to the species of the order, which are common in the antarctic seas. In the present work 29 species including 9 new forms have been studied, and the genera peculiar to the antarctic seas, *Laackmanniella*, *Protocymatocylis*, and *Cymatocylis*, have been secured.

Family Tintinnopsidae

16. ***Tintinnopsis glans*** MEUNIER Fig. 43

Tintinnopsis glans: BALECH, 1948, p. 12, pl. 5, figs. 53, 54.

The form with a small pot-shaped lorica is rare in the antarctic seas, being found only once in the material taken on January 6, 1960. Length, 28μ; breadth, 23μ; oral diameter, 11μ.

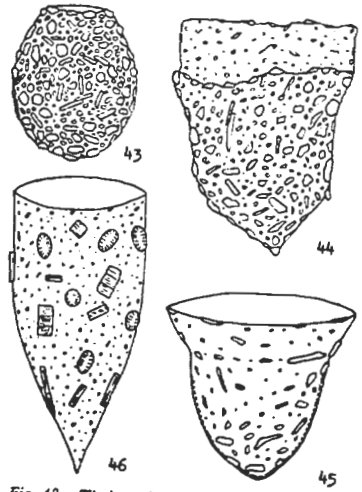


Fig. 43. Tintinnopsis glans MEUNIER, 1,000×;
Fig. 44. Tintinnopsis fimbriata MEUNIER, 1,000×;
Fig. 45. Tintinnopsis petaso n. sp., 1,000×;
Fig. 46. Tintinnopsis bacillaria n. sp., 750×.

17. ***Tintinnopsis fimbriata*** MEUNIER Fig. 44

Codonaria fimbriata BALECH, 1948, p. 15, pl. 6, figs. 69–86.

The lorica is bell-shaped, being composed of an oral flare and a main inflat cone with a pointing aboral end. Length, 27μ; oral diameter, 25μ.

A single specimen was detected from the plankton sample collected on Mar 11, 1960. The temperature of surface water was 9.4°C, when observation w made.

18. ***Tintinnopsis petasa*** n. sp. Fig. 45

The lorica consists of a low oral funnel of a quarter of the total length a a conical bowl with a broadly conical aboral end. The wall with sparse forei particles is very thin in the oral funnel, while generally thicker in the bo Length and oral diameter, 30μ.

The new species is allied to *T. schotti* BRANDT recorded from the tropical off Borneo in form, but it is easily distinguishable from the tropical form (10 110μ) in smaller size and in having a lorica composed of a thin wall.

The species characteristic in thickness of a wall of a lorica was rarely fou in the material taken from surface water of temperature of 0.7°C on January 1960.

19. ***Tintinnopsis bacillaria*** n. sp. Fig. 46

The lorica is short bullet-shaped, and composed of a thin wall with diato on the surface as adhering foreign particles. The anterior half of the lorica cylindrical, and the posterior gradually tapers to a pointing tip. Length, 63 oral diameter, 32μ.

The lorica of the new form is similar in size and shape to *T. strigosa* MEUNI examined by the author (1932) from the Sea of Okhotsk, but is different from t latter in having adhering diatoms and no spiral structure on the surface. It a rare species, being only once detected in the material taken at St. 50 of t third voyage south of the Cape of Good Hope.

20. ***Tintinnopsis radix*** (IMHOF)

Tintinnopsis radix: HADA, 1937, p. 166, fig. 18; 1938, p. 100, fig. 18; 1938, p. 100, figs. 14a,

The cosmopolitan species with an elongate tubular lorica was collected on at St. 1 of the third voyage on December 24, 1957. The temperature of surfa water was 11.2°C, when the research was made.

Family Codonellopsidae

21. ***Stenosemella nivalis*** (MEUNIER)

Stenosemella nivalis: HADA, 1937, p. 178, figs. 26a–c; 1938, p. 105, figs. 20a–c; 1961, p. 1

The species common in warm neritic waters was rarely detected in the sa material as *Tintinnopsis radix* (IMHOF). Length, 55μ; breath, 50μ; oral diamet 25μ.

22. ***Stenosemella perpusilla*** n. sp. Fig. 47

The lorica is remarkably small and consists of a short hyaline collar wi sparse foreign particles and of an ovoid bowl with a somewhat coarse surfa Length, 13μ; breadth, 11μ; oral diameter, 8μ.

The new form is different from the known species of *Stenosemella* in minute size of a lorica. It was found in the plankton sample taken from the cold sea of −1.5 to −1.0°C in temperature of surface water on January 8, 1960.

Fig. 47. Stenosemella perpusilla n. sp., 2,500×.

23. ***Stenosemella avellana*** (MEUNIER)

Stenosemella avellana: HADA, 1961, p. 143, fig. 1.

The species having an oblong lorica was examined together with *S. nivalis* (MEUNIER) from the same material obtained on December 24, 1957 near the Cape of Good Hope.

24. ***Codonellopsis soyai*** n. sp. Fig. 48

The lorical is flask-shaped and consists of a subcylindrical collar and an ovoid bowl. The low hyaline collar as long as 1/3 of the total length, is more or less flaring at the oral end, while expanded at the distal, and it is composed of 3–5 spiral turns with many small ovate fenestellae. The surface of the bowl is usually smooth, and has some cocooliths as adhering foreign particles. Length, 50–52μ; breadth, 32–38μ; oral diameter, 20–21μ.

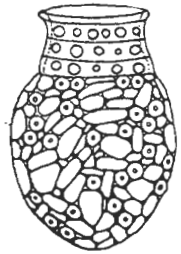


Fig. 48. Codonellopsis soyai n. sp., 800×.

The lorica of the new species is somewhat similar to *C. frigida* HADA and *C. balechi* n. nom.* in general contour, but it different from the first in having a low

* *Codonellopsis balechi* n. nom.

Codonellopsis frigida HADA, 1932, p. 45, fig. 8.

Codonellopsis frigida BALECH, 1958a, p. 78, pl. 1, figs. 4–6.

According to the specific name, *Codonellopsis frigida*, the present author has decided it as the new specific name of *Codonellopsis* for the new form of the arctic waters since 1932, therefore, BALECH's same name of 1958 for the new species of the same genus of the antarctic sea, has been invalid. Then, the author gives the new name, *Codonellopsis balechi*, to the latter antarctic species.

collar with many fenestellae and coccoliths on a surface of a bowl, and from
second in composition of a lorica consisting of a fenestrate collar and a shor
smooth bowl with coccoliths.

The new species was found in the material taken from the antarctic sea
Syowa Station on January 2, 3 and February 1, 1960. Temperature of surf
water varied from −1.7 to −1.4°C.

25. ***Codonellopsis glacilis*** (LAACKMANN) Fig. 49

Leprotintinnus glacilis LAACKMANN, 1909, p. 408, pl. 47, figs. 5–8.
Codonellopsis gaussi: BALECH, 1958b, p. 77, pl. 1, figs. 1, 2.

The lorica is cylindrical and consists of a tubular collar composed of 6
spiral turns without any fenestella and of a goblet-shaped bowl inflated sligh
in an aboral region and tapering rapidly to a distal point. The oral flare of
hyaline collar is usually not remarkable. Foreign particles attached to the surf
of the bowl are rather coarse. Length, 58–110μ; breadth, 30–35μ; length
collar, 15–56μ; oral diameter, 30–35μ.

In the work the species was rarely observed in the materials collected fr
the cold sea of 1.9–3.0°C in temperature of surface water between Antarctica
Africa. It is probably one of the common protozoan plankton of the antar
seas, being reported by LAACKMANN (1909) from the sea off the Wilhelm II L
and by BALECH (1958) from the antarctic sea south of South America.

26. ***Codonellopsis gaussi*** (LAACKMANN) Fig. 50

Leprotintinnus gaussi LAACKMANN, 1909, p. 407, pl. 47, figs. 1–4.
Codonellopsis gaussi: BALECH, 1947, p. 85, pl. 6, fig. 43; 1958a, p. 77, pl. 1, figs. 1, 2.

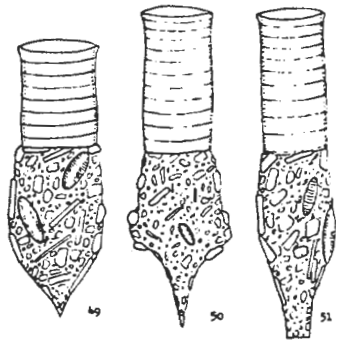


Fig. 49. Codonellopsis glacilis (LAACKMANN), 500×;
Fig. 50. Codonellopsis gaussi (LAACKMANN), 400×;
Fig. 51. Laackmanniella naviculaefera (LAACKMANN), 400×

The elongate lorica is different from one of *C. glacilis* (LAACKMANN) in having a bowl inflated remarkable in a posterior region with a tall conical aboral horn. Length, 145–150μ; breadth, 50μ; length of a collar, 68–75μ; oral diameter, 35μ.

In the study the large species was detected only in the plankton samples taken on January 4, 1960. Temperature of surface water was 0.2 to 1.4°C, when collection was made. However, it has been frequently recorded by LAACKMANN (1909) from the antarctic sea off the Wilhelm II Land, and by BALECH from the Bellingshausen Sea (1947) and the sea off the Adélie Land (1958). Therefore, it seems that the species is widely distributed in the antarctic seas.

27. ***Laackmanniella naviculaefera*** (LAACKMANN) Fig. 51

Leprotintinnus naviculaefera LAACKMANN, 1909, p. 402, pl. 46, figs. 1–9, pl. 47, figs. 9–11.
Leprotintinnus prolongatus LAACKMANN, 1909, p. 403, pl. 46, figs. 10–12, pl. 47, fig. 12, pl. 48, figs. 5–7.
Leprotintinnus prolongatus f. *ventricosa* LAACKMANN, 1909, p. 404, pl. 46, figs. 14, 15.
Laackmanniella naviculaefera: KOFOID & CAMPBELL, 1929, p. 91, figs. 182; BALECH, 1958b, p. 398, pl. 4, fig. 114.
Laackmanniella prolongata: KOFOID & CAMPBELL, 1929, p. 91, fig. 183; BALECH, 1947, p. 85, pl. 5, figs. 34–41.

The lorica of the species of *Laackmanniella* peculiar to the antarctic seas is distinguishable from that of the allied forms of *Codonellopsis* in having a distinct aboral opening at the distal end of the bowl. The tubular lorica of the single known species of the genus consists of a cylindrical hyaline collar and of a slightly inflated bowl tapering gradually to a truncated aboral end. Foreign particles attached to the surface of the bowl are more or less coarse. Length, 150μ; length of a collar, 80μ; oral diameter, 34μ; aboral opening, 12μ.

In the research a single specimen was detected in the material obtained from the antarctic sea of 1.9°C in temperature of surface water, when collection was made on February 15, 1958, but it has been frequently recorded by LAACKMANN (1909) from the sea off the Wilhelm II Land, and by BALECH from the Bellingshausen Sea (1947) and from the sea off the Adélie Land (1958). Therefore, the species is one of the common ciliates carrying a lorica in the antarctic seas. The two forms originally named by LAACKMANN (1907) as *naviculaefera* and *prolongatus*, are included in the present species. The lorica of the former is shorter and is more or less inflated in the bowl with diatoms attached to the surface as foreign particules, and that of the latter is longer and tubular without adhering diatoms, but it is difficult to make distinction between them only by the length of the lorica and the presence of adhering diatoms. At present, the author places the two forms in a single species following BALECH's opinion (1958)

Family Coxliellidae

Some species of Genus *Coxliella* belonging to the family have been reported by LAACKMANN (1909) and BALECH (1947, 1958) from the antarctic seas, but they have not been examined in the study.

28. ***Helicostomella antarctica*** HADA

Helicostomella antarctica HADA, 1961, p. 143, fig. 2.

The species having an elongate lorica with a minute oral dentation was fou in the material taken from the rather warm sea of 10.2°C in temperature of face water at the time of collection near the Cape of Good Hope. Length, 11 oral diameter, 20μ.

Species of the genus are usually common in the northern cold seas, but rare in the southern cold waters. BALECH (1944) recorded a single species, *lemairei* BALECH from the sea near the Cape Horn of South America.

Family Cyttarocylidae

The family comprises two genera, *Protocymatocylis* and *Cymatocylis*, occurr only in the antarctic seas.

29. ***Protocymatocylis pseudoconica*** HADA Fig. 52

Protocymatocylis pseudoconica HADA, 1961, p. 143, fig. 3.

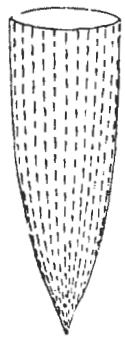


Fig. 52. Protocymatocylis pseudoconica HADA, 500×.

The lorica is simple in structure and is elongate conical. A number of l gitudinal striae composed of many short raised lines are seen on the surfa Length, 55–150μ; oral diameter, 15–40μ.

The species is widely distributed in the seas where the research was carr out. When the collection was made, the temperature of surface water was var ble from −1.4 to 11.2°C.

30. ***Protocymatocylis subrotundata*** (LAACKMANN) Fig. 53

Cymatocylis vanhöffeni f. *subrotundata* (part) LAACKMANN, 1909, p. 365, pl. 37, fig. 19, pl. 38, 1, 2.

Protocymatocylis subrotundata: KOFOID & CAMPBELL, 1929, p. 120, fig. 229.

The lorica is cup-shaped with a slight oral flare and a rounded aboral e The surface is more or less smooth. Length, 50μ; breadth, 47μ; oral diamet 35μ.

The specimen observed in the study was smaller in size and smooth on

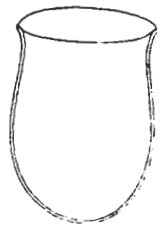


Fig. 25. Protocymatocylis subrotundata (LAACKMANN), 700×.

surface of the lorica as compared with those recorded by LAACKMANN (1909) from the antarctic sea off the Wilhelm II Land. Striae on the surface of the lorica are scarcely visible owing to a small size of a lorica.

31. ***Cymatocylis kerguelensis*** LAACKMANN Fig. 54

Cymatocylis kerguelensis LAACKMANN, 1909, p. 387, pl. 35, fig. 5; KOFOID & CAMPBELL, 1929, p. 140, fig. 236.

The lorica is rather small sac-shaped and has an oral flare with double rims making a shallow circular groove, of which the inner one is minutely denticulate. On the surface of the bowl are many lines composed of slight short striae. Length, 62μ; breadth, 50μ.

The species reported by LAACKMANN (1909) from the sea off the Wilhelm II Land, was once observed in the material obtained from the cold sea of 2.5°C in temperature of surface water between Antarctica and Africa. Therefore, it is one of the rare species in the antarctic seas.

32. ***Cymatocylis parva*** (LAACKMANN)

Cymatocylis parva LAACKMANN, 1909, p. 386, pl. 35, fig. 6; KOFOID & CAMPBELL, 1929, p. 142, fig. 256; BALECH, 1958a, p. 80, pl. 1, figs. 7–9; HADA, 1961, p. 144, fig. 4.

The lorica is more or less small bell-shaped and consists of a short collar with a backward flare and of a slightly inflated conical bowl with a minute distal cone. The oral rim is not denticulate, and the surface of the bowl is smooth. Length, 75μ; oral diameter, 53μ.

In the investigation a single specimen was found in the material taken from the sea of 1.7°C in temperature of surface water at the time of the research off Syowa Station. It is a common species distributed widely in the antarctic seas, as it was recorded by LAACKMANN (1909) from the sea off the Wilhelm II Land and by BALECH (1958) from the antarctic sea south of South America. The oral rim of the specimen studied does not have a minute dentation, though the original specimen recorded by LAACKMANN (1909) is provided with a fine dentation. In BALECH's report (1958), however, those with or without an oral dentation have been mixed. Therefore, the presence or absence of the oral dentation cannot serve as a criterion for specific determination.

33. ***Cymatocylis cristallina*** LAACKMANN Fig. 55

Cymatocylis cristallina LAACKMANN (part), 1909, p. 374, pl. 40, figs. 1–6, 9, 12; KOFOID & CAMPBELL, 1929, p. 133, fig. 237.

Cymatocylis subconica KOFOID & CAMPBELL, 1929, p. 144, fig. 328.

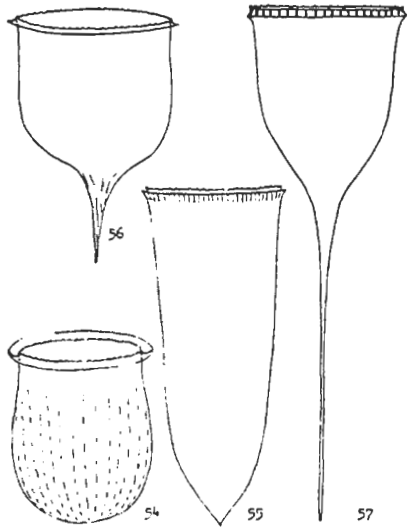


Fig. 54. Cymatocylis kerguelensis LAACKMANN, 500×;
Fig. 55. Cymatocylis cristallina LAACKMANN, 250×;
Fig. 56. Cymatocylis brevicaudata LAACKMANN, 300×;
Fig. 57. Cymatocylis calyciformis (LAACKMANN), 250×.

The lorica is tall bell-shaped without an aboral horn. The oral end h minutely denticulate rim and a slight flare with short striae on the surface. bowl tapers gradually in the main part, while rapidly to an aboral point in posterior region, and has a somewhat smooth surface. Length, 253μ; oral di eter, 107μ.

Due to difficulty in collecting forms carrying a large lorica by the pre method of collecting microplankton, the species with an elongate lorica was served only once in the material taken on February 11, 1958. When collec was made, surface water was −1.1°C in temperature. KOFOID & CAMPBELL (1 have raised to the independent species several formae of the species reported LAACKMANN (1909), but at present; these are questionable to be an depen species.

34. ***Cymatocylis brevicaudata*** LAACKMANN Fig. 56

Cymatocylis calyciformis f. *brevicaudata* LAACKMANN, 1909, p. 391, pl. 42, figs. 7–10.

Cymatocylis brevicaudata: KOFOID & CAMPBELL, 1929, p. 125, fig. 272.

The lorica is stout goblet-shaped, and has a denticulate oral rim with an inverted flare and a conical aboral horn with slight spiral ridges. The surface of the bowl is usually smooth. Length, 150μ; oral diameter, 85μ; length of a horn, 55μ.

The species was once found in the material collected at the station of the third voyage (St. 47) in the median sea between Antarctica and Africa. The temperature of surface water was 3.0°C at the time of collection. It is a rather rare species among those of *Cymatocylis* occurring in the antarctic seas. It was reported by LAACKMANN (1909) from the sea off the Wilhelm II Land.

35. ***Cymatocylis calyciformis*** (LAACKMANN) Fig. 57

Cymatocylis calyciformis LAACKMANN, 1909, p. 391, pl. 36, fig. 4; pl. 42, fig. 12; KOFOID & CAMPBELL, 1929, p. 127, fig. 265; BALECH, 1962, p. 37, figs. 86, 87.

The lorica is elongate, having a slender long aboral horn. The oral end is provided with an expanding anterior band, a minutely denticulate oral rim and a slight striation composed of short parallel striae between them. The surface of the bowl is generally smooth without any ornamentation. Length, 260–390μ; oral diameter, 130–115μ; length of a horn, 130–270μ.

Several specimens of the species were observed in plankton samples collected from the cold sea of 0.2 to 1.4°C in temperature of surface water. It seems to be a common species in the antarctic seas according to the report by LAACKMANN (1909) and BALECH (1962).

Family Petalotrichidae

The forms of the family comprising many warm water species have been scarcely reported from the antarctic and subantarctic seas.

Subfamily Craterellineae

36. ***Craterella perminuta*** n. sp. Fig. 58

The lorica is remarkably small, and is composed of a hemispherical bowl with a slight expanding oral flare. The wall is thin and transparent without any ornamentation, and the oral rim is entirely smooth. Length, 6μ; oral diameter, 9μ.

The author has decided the form carrying a small hyaline lorica as a new species of *Craterella* because of having an oral flare. The new species is different from the known forms in minute size and in hemispherical form. It was found in the

Fig. 58. Craterella perminuta n. sp., 3,000×.

material of surface water of 9.4°C taken from the sea south of Africa on Ma
11, 1960.

Subfamily Metacylineae

37. ***Metacylis corbula*** KOFOID & CAMPBELL

Metacylis corbula KOFOID & CAMPBELL, 1929, p. 199, fig. 376; HADA, 1961, p. 144, fig.

The lorica is urn-shaped and consists of a short cylindrical collar compo
of several spiral turns and of an ovoidal bowl. Length, 65μ; breadth, 55μ; o
diameter, 50μ.

The warm water species was found in the material obtained from surf
water of the subantarctic sea near South Africa. When collection was made,
water temperature was 11.2°C.

Subfamily Petalotrichineae

Genus ***Parapetalotricha*** n. gen.

The lorica of the species of the new genus differs from that of *Petalotricha*
having double collars, inner and outer. Therefore, *Petalotricha entzi* KOFOID w
an inner collar belongs to the new genus.

38. ***Parapetalotricha meridiana*** n. sp. Fig. 59

The lorica is hyaline and consists of double collars and a conical bowl. T
outer collar is low funnel-shaped, while the inner is shorter and straight. T
bowl gradually tapers to the distal end. The entire surface is smooth witho
striae and fenestellae. Length, 30μ; oral diameter of an outer collar, 22μ; one
an inner collar, 17μ.

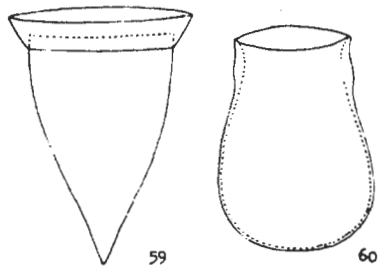


Fig. 59. Parapetalotricha meridiana n. gen., n. sp., 1,500×;
Fig. 60. Undella antarctica n. sp., 750×.

The lorica of the new species is different from that of *Parapetalotricha en*
(KOFOID) and all known forms of *Petalotricha* in complete absence of striae a
fenestellae on the lorica. The new species was detected in the material obtain
from the antarctic sea of −1.5 to −1.2°C in temperature of surface water
Syowa Station. It is a unique true cold water species among those of the Fam
Petalotrichidae.

Family Undellidae

39. ***Undella antarctica*** n. sp. Fig. 60

The hyaline lorica is sac-shaped with a broadly rounded aboral end. The anterior part composed of a thickened wall has a suboral inflated band and an inner funnel-shaped collar, which is a characteristic of the forms of the Subgenus *Proplectella* KOFOID & CAMPBELL (1929). Therefore, the precise name of the new species should be *Undella* (*Proplectella*) *antarctica* HADA. Length, 53μ; breadth, 38μ; oral diameter, 28μ.

The new species differs from the typical forms of Genus *Undella* DADAY (1887) in having an inner collar, and from those of the Subgenus *Proplectella* in having a suboral expantion. Being collected from the antarctic sea of the region of Syowa Station, it is a single form of *Undella* found from the antarctic seas.

Family Dictyocystidae

40. ***Dictyocysta polygonata*** KOFOID & CAMPBELL Fig. 61

Dictyocysta polygonata KOFOID & CAMPBELL, 1929, p. 299, fig. 557; HADA, 1938, p. 162, fig. 79.

The lorica is stout pot-shaped, and consists of a cylindrical collar composed of 6–7 rectangular windows standing side by side and of an ovoid bowl with a polygonal reticulation on the surface. Length, 62μ; breadth, 48μ; oral diameter, 40μ; length of a collar, 25μ.

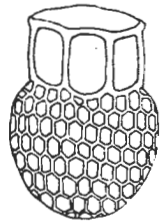


Fig. 61. Dictyocysta polygonata KOFOID & CAMPBELL, 500×.

The species of *Dictyocysta* usually occur in warm waters, and are common in tropical seas. A single specimen of the form was found in the plankton material taken from surface water of 7.0°C at St. 5 of the third voyage of the SOYA. Besides this species, *Dictyocysta* spp. have been reported by BALECH (1962) from the Scotia Sea (6.4°C) between Antarctica and South America.

Family Tintinnidae

Many forms of the family carrying a hyaline various lorica are generally planktonic organisms in warm waters, so that few species have been examined in the study.

Subfamily Amphorellineae

41. ***Bursaopsis ollula*** n. sp. Fig. 62

The small lorica is ovoid urn-shaped without a collar, and the oral aperture is more or less small. The wall is thin and transparent. Length, 15–24μ; breadth,

12–25μ; oral diameter, 6–10μ.

The new species is somewhat similar to *B. bursa* (CLEVE) in outline of lorica, but it is distinguishable from the latter in form of the lorica having collar. It was observed in the materials taken from the cold sea of −1.4 to 1.7 in temperature of surface water off Syowa Station.

42. ***Bursaopsis conicoides*** n. sp. Fig. 63

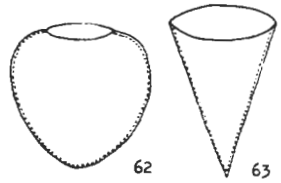


Fig. 62. Bursaopsis ollula n. sp., 1,200×;
Fig. 63. Bursaopsis conicoides n. sp., 600×.

The lorica is simple in form, and is composed of a typical cone with strai side lines. The oral aperture is large and circular, and the distal end is point Length, 25–65μ; oral diameter, 17–30μ.

The new species is distinguishable from the known forms of *Bursaopsis* in conical form of the lorica. It was found in the materials obtained from the c sea of 1.7°C in temperature of surface water off Syowa Station and from warm sea of 21.6°C off the southern coast of South Africa. Therefore, it see to be widely distributed in the sea between Antarctica and Africa. Fixed spe mens attached to the inside of a lorica were sometimes observed. Because of fact, the form is apparently an independent new species carrying a simple coni lorica, which is variable in length.

43. ***Dadayiella ganymedes*** (ENTZ) Fig. 64

Dadayiella ganymedes: HADA, 1938, p. 169, figs. 86a, b; BALECH, 1959a, p. 50, pl. 19, f 273–278.

The lorica is elongate goblet-shaped with a slight flaring oral region provid with a number of longitudinal striae. The aboral horn is conical with few spi striae. Length, 95μ; breadth, 25μ; oral diameter, 30μ.

The species common in tropical seas was found in the material collected fr the rather warm sea of 9.4 to 14.7°C in temperature of surface water off southern coast of South Africa. The lorica of the specimens examined in study has no suboral striae as that of those recorded from the Tropical W Pacific (HADA, 1938), and without a knob on an aboral horn as in the specim reported by BALECH (1959) from the Mediterranean Sea.

Subfamily Tintinnineae

44. ***Daturella frigida*** n. sp. Fig. 65.

The hyaline lorica is tubular and is gradually tapering to the curved trunc

aboral end from the somewhat flaring oral one. On the roughened surface, irregularly curved longitudinal striae run from the suboral region to the aboral end. Length, 100μ; oral diameter, 28μ.

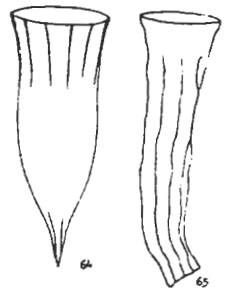


Fig. 64. Dadayiella ganymedes (ENTZ), 500×;
Fig. 65. Daturella frigida n. sp., 500×.

The new form is allied to *D. datura* (BRANDT) and *D. striata* KOFOID & CAMPBELL in presence of a curved aboral part, but it is distinguishable from them in having a wider aboral opening and longitudinal striae instead of ribbon-like fins. The known species have been generally reported from tropical seas, but this new species was detected in the material taken from Lützow-Holm Bay on January 17, 1958. When collection was made, the temperature of surface water in the bay was −1.8°C. It is a special cold water form of *Daturella*.

5. Other Zooplankton

In the plankton samples of the third voyage of the Soya (1957–58), some adu
of the Copepoda were observed in surface water of Sts. 1, 49 and 50, and naupl
larvae from Sts. 7, 11 and 49. These adults and larvae were also found in
samples of the fifth voyage. Besides the Copepoda, *Oikopleura* of the Appendicula
and a larva of the Ophiuroidea were detected in the plankton materials ta
respectively from St. 1 and St. 49 of the third voyage. These pelagic organi
were generally collected from rather warm subantarctic seas.

The low frequency of zooplankton excepting the Protozoa is evidently due
the special method of collecting materials in a small amount of surface water.
consequence, in the investigation it has been impossible to study any species
the Euphausiacea, which are common as a representative crustacean macroplank
in the antarctic seas.

Species of the Copepoda in the study were usually taken from the subantarc
seas near Africa. These probably belong to *Calanus simillimus* Giesbrecht, *C*
socalanus laticeps Farran or *Eucalanus longicepus* Matthews, since the three for
have been recognized as common species of the surface layers of the subantarc
seas (Vervoort, 1965).

6. Phytoplankton

The diatoms have been found only as phytoplankton in the plankton materials taken from the antarctic and subantarctic seas between Antarctica and Africa.

Table 3. Occurrences of the diatoms observed in the plankton samples obtained from the seas between Antarctica and Africa during the third voyage of the Soya (1957–58).

Station	1	3	4	5	7	8	9	10	11	14	15	16	20	39	40	43	44	45	46	47	48	49	50
Coscinodiscus	r	–	–	–	r	rr	–	r	rr	–	–	–	–	–	–	rr	–	rr	r	–	–	–	–
Planktoniella	rr	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thalassiosira	r	–	–	–	rr	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stephanopyxis	rr	–	–	rr	rr	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Guinardia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	rr	–	rr	rr	–	r	–
Corethron	–	–	–	rr	rr	r	r	r	c	rr	r	rr	r	r	c	–	c	r	r	r	rr	–	c
Rhizosolenia	r	–	rr	r	r	r	r	rr	–	–	rr	rr	rr	rr	–	rr	r	c	c	c	r	r	m
Bacteriastrum	c	–	–	–	–	–	rr	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chaetoceros	c	r	r	r	r	c	rr	r	r	–	–	rr	–	–	–	–	r	r	r	r	r	–	r
Biddulphia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	rr	–	–	–	–
Eucampia	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Climacodium	–	–	–	–	–	–	–	rr	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fragilaria	–	–	–	–	–	–	rr	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asterionella	rr	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Synedra	–	–	rr	rr	r	rr	–	–	–	–	–	–	–	–	–	–	r	r	r	r	r	–	r
Thalassionema	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nitzschia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	rr	–	–	–	–	–	–	–

m: many, c: common, r: rare, rr: very rare.

From surface water of the seas have been obtained species of the genera of the diatoms (Bacillariophyceae) as recorded in Table 3. The prominent genus of the antarctic sea is *Corethron*, while that of the subantarctic is *Rhizosolenia*. No form of diatoms was frequent in surface water of the ice sea near Syowa Station, though protozoan plankton was obtained. Therefore, it may be said that the frequency of occurrences of protozoan plankton is superior to that of phytoplankton in such an ice sea.

7. Distribution of the Protozoan Plankton

According to Table 4, 17 stations at which no form of Protozoa was collec
from surface water, have been umbered among 50 stations, while from 26 stat
no diatoms has been obtained as shown in the Table 3. From the results, it
be said that the protozoan plankton is more widely distributed than the dia
plankton in cold surface water of the antarctic seas. Therefore, in such water,
Protozoa is the most predominant group among various planktonic organism

In the seas between Antarctica and Africa, where the collection was m
several forms of the protozoan plankton were found in the materials taken at
stations of warm water near the coast of South Africa, at the stations of
latitude S 60° where the temperature of surface water was about 2°C, and f
open lagoons free from ice in the antarctic sea off Syowa Station.

Table 4. Distribution of 42 forms of the pelagic Protozoa found in the materials of the third voyage of the Soya taken from the antarctic and subantarctic seas between Antarctica and Africa.

Station	1	4	5	7	8	9	10	11	12	14	15	16	18	19	20	21	22	23	35	36	37	39	40	41	43	44	45	46	47	48	49	50
Distephanus speculus	r	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	c	r	c	–	–	–
Exuviaella antarctica	–	–	–	–	–	–	r	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Amphidinium acutissimum	–	–	–	–	–	r	–	–	–	–	–	r	–	–	c	–	r	–	–	–	–	r	–	–	c	c	–	–	–	–	–	r
Gymnodinium cinctum	–	–	–	–	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gymnodinium baccatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–
Gyrodinium lachrymum	r	–	–	r	r	r	r	r	–	–	r	c	–	–	r	–	–	–	–	–	–	r	c	–	c	r	r	–	–	–	–	–
Gyrodinium glaciolis	–	–	–	–	–	–	–	–	–	–	–	r	–	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Noctiluca scintillans	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–
Gonyaulax spinifera	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	r	–	–	–	–	–	–	–	–	–
Gonyaulax turbynei	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–
Peridinium curtum	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Peridinium nanum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–	–	–	–	r	c	–	–	–	–	–
Peridinium incertum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–
Ceratium fusum	r	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ceratium furcum	r	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ceratium lineatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–
Globigerina bulloides	–	–	–	–	–	–	–	–	r	r	r	–	c	c	–	–	c	c	c	r	r	–	–	r	–	–	–	–	–	–	–	–
Didinium gargantua	–	r	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	r	–	–	–	–	–	r
Didinium balbianii	–	–	–	–	–	c	–	–	–	–	–	c	–	–	c	–	r	–	–	–	–	–	r	–	r	r	–	–	–	–	–	–
Tiarina fusa	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Strobilidium conicum	–	–	–	–	–	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–
Strobilidium striatum	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–	c	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–
Strobilidium diversum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–	–	–	r	–
Strobilidium antarcticum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Strobilidium elongatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tintinnopsis bacillaria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r
Tintinnopsis radix	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stenosemella nivalis	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stenosemella avellana	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Codonellopsis glacilis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	c	–	–	–	–
Laackmanniella naviculaefera	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–
Helicostomella antarctica	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Protocymatocylis pseudoconica	c	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	r	–	–	–	–	–	–	–	–	–
Cymatocylis kerguelensis	–	–	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cymatocylis parva	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–
Cymatocylis cristallina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–	–	–
Cymatocylis brevicaudata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–
Metacylis corbula	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dictyocysta polygonata	–	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bursaopsis ollula	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	r	–	–	–	–	–	–
Bursaopsis conicoides	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	r	–	–	–	–	–	–
Daturella frigida	–	–	–	–	–	r	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Number of examined species	12	5	1	3	1	5	3	2	2	1	2	4	1	1	5	1	6	1	1	1	2	3	6	2	7	10	6	1	3	1	2	3

8. Occurrences of the Protozoan Plankton

The northern limit of drifting ice-bergs, namely the polar front, crosses nearly along the latitude of S 50° at the middle of the seas between Antarctica and Africa, where the present research was made, and the band of low salinity appers along the polar front during the summer of the Southern Hemisphere (OSTAPOFF, 1965). In the study the seas of the South Indian Ocean are separated into the antarctic sea and the subantarctic sea by the characteristic band of sea water regarding salinity.

Of 50 stations of the third voyage of the SOYA, Sts. 6 and 47 are distributed in the band of low salinities, Sts. 7–45 in the antarctic sea, and Sts. 1–5 and Sts. 48–50 in the subantarctic warm sea. Temperature of surface water at the stations shows marked degrees of 4.5 to 5.1°C between the antarctic sea south of the band and the subantarctic sea north of the same.

The protozoan plankton treated in the study consists of the following three groups related to the temperature of sea water: (1) cosmopolitan species of warm water, such as, *Distephanum speculus* (EHRENBERG), *Exuviaella marina* CIENKO, *Noctiluca scintillans* (MACRARTNEY), *Gonyaulax spinifera* (CLAPARÈDE & LACHMANN) *Ceratium fusum* (EHRENBERG) and *Ceratium furca* (EHRENBERG) of the flagellates, *Globigerina bulloides* d'ORBIGNY of the pelagic foraminifera, and *Tintinnopsis radix* (IMHOF), *Stenosemella nivalis* (MEUNIER), *Metacylis corbula* KOFOID & CAMPBELL, *Dictyocysta elegonata* KOFOID & CAMPBELL and *Dadayiella ganymedes* (ENTZ) of the ciliates; (2) cold water forms occurring either in the arctic sea or in the antarctic sea, for example, *Didinium gargantua* MEUNIER, *Tiarina fusca* (CLAPARÈDE & LACHMANN), *Tintinnopsis glans* MEUNIER and *Tintinnopsis fimbriata* MEUNIER of the ciliates; (3) species peculiar to the antarctic sea, namely *Laackmanniella naviculaefera* (LAACKMANN), *Protocymatocylis* and *Cymatocylis* spp. of the Order Tintinnida.

In surface water of the antarctic and subantarctic seas, the ciliates are most superior in number of examined forms, being 44, then the flagellates follow, as 31 have been studied from the same materials. A single species being found, the rhizopods are very poor in number of forms in these seas.

1. Chromonadea (Flagellata)

Most of 31 planktonic forms of the flagellates belong to the Order Dinoflagellida excepting a silicoflagellate, and in the order are comprised many species

of the unarmored family, Gymnodinidae, and of the common armored, Peridini
It is a remarkable characteristic of the protozoan plankton that the dinofla
lates carrying no shell are representative pelagic organisms in the antarctic
Important species are *Amphidinium acutissimum* SCHILLER and *Gyrodinium lachry*
(MEUNIER), which are common and wide-spread in the seas where the rese
was made. In the other family, Peridinidae, comprising several common ge
many forms of the three large genera, *Gonyaulax*, *Peridinium* and *Ceratium*, h
been obtained. Of these, *Ceratium* spp. have been generally found in plan
samples collected only from warm subantarctic seas. The fact shows that st
floating power of forms of the genus owing to a morphological structure, is p
ably unsuitable to plankton life in cold antarctic seas. On the other hand,
eral species of *Peridinium* peculiar to the antarctic seas, have been observed, ha
a morphological structure suitable to floating life in antarctic seas.

Besides the flagellates recorded in the paper, many dinoflagellates have
reported from the antarctic seas as follows: *Phalacroma cornutum* PETERS, *Dinop*
tuberculata MANGIN, *Diplopeltopsis granulosa* BALECH, *Podolampas antarctica* BAL
Peridinium antarcticum SCHIMPER, *P. turbinatum* MANGIN, *P. variegatum* PETER
archiovatum BALECH, *P. adeliense* BALECH, and about ten new species of *Peridi*
recorded by BALECH (1947, 1958, 1962, 1965) from the antarctic seas. From
author's and BALECH's studies on the antarctic plankton, it may be said
Peridinium spp. are the predominant planktonic organisms among pelagic fl
lates in the antarctic seas.

8.2. Rhizopodea

In the examination only one species of the pelagic foraminifera, *Globig*
bulloides d'ORBIGNY, has been studied as a planktonic organism of the Rhizopo
From the samples of the bottom depoists of the antarctic sea off Syowa Sta
the tests of *Globigerina pachyderma* (EHRENBERG) have been found by UCHIO (1
but the latter species has not been found as a pelagic organism in the exam
tion. In the study no form of the Radiolaria has been observed, but from the bo
deposits of the seas where the research was made, some antarctic and subanta
species have been reported as follows: by NAKASEKO (1959) *Liosphaera antar*
NAKASEKO, *Cenosphaera antarctica* NAKASEKO and other 4 forms of the genus,
cosphaera miocenica NAKASEKO, *T. antarctica* NAKASEKO, *Cromyosphaera nipponica* N
SEKO, and *Actinomma yosii* NAKASEKO and other 4 of the same genus, by HAYS (
Spongoplegma antarctica HAECKEL, *Lithelius nautiloides* POPOFSKY, *Tricerapyris anta*
(HAECKER), *Helotholus histricosa* JÖRGENSEN, *Peromelissa denticulata* (EHRENBERG)
Theocalyptra davisiana (EHRENBERG) as an antarctic form, and by the latter au
9 species as a subantarctic form. Besides these records, *Challengeron* sp. and *S*
lonche zanclea HERTWIZ have been reported by BALECH & EL-SAYED (1965)
plankton samples collected from the Weddell Sea.

8.3. Ciliatea

In the study the planktonic ciliates consist mainly of two large groups
and without a lorica. The former is composed of forms of the Order Tintin

and the latter of species of the genera *Didinium*, *Tiarina* and *Strobilidium* occurring usually in cold waters. Of these common genera the last, *Strobilidium*, is the largest and commonest genus among the Ciliatea in the antarctice and subantartic seas, where the research was made.

The Tintinnida carrying a lorica is the most important order of marine plankton for the following reasons: (1) many species frequently appear everywhere and are usually commonest in zooplankton; (2) most of the Tintinnida are typically so sensitive for oceanographical conditions that many forms may be useful as an indicator showing properties of sea water or characters of an oceanic current; (3) all species of the genera, *Parafavella* and *Ptychocylis*, have been found only from the arctic and subarctic seas, while those of *Laackmanniella*, *Protocymatocylis* and *Cymatocylis* without exception from the antarctic and subantarctic seas. These arctic and antarctic genera have never shown the bipolar distribution of planktonic organisms, which is generally seen in most genera of zooplankton (HADA, 1957; ZEITZSCHEL, 1969). Species of the genera having a lorica with foreign particles attached on the surface, such as *Tintinnidium*, *Tintinnopsis*, *Stenosemella*, *Codonellopsis* and *Laackmanniella*, typically occur in neritic waters. In the study 11 of these genera have been examined. Therefore, the antarctic and subantarctic seas where the research was made, are more or less neritic in property of water. The property of neritic water of the antarctic seas is probably attributed to mud, sands, gravels and rocks carried by ice-bergs to seas from the land of Antarctica. Besides the examined 9 species of the genera peculiar to antarctic waters, the following forms have been reported by LAACKMANN (1909), BALECH (1947, 1958b, 1962) and BALECH & EL-SAYED (1965) from the antarctic seas: *Protocymatocylis vas* KOFOID & CAMPBELL, *Cymatocylis convallaria* LAACKMANN, *C. affinis* LAACKMANN, *C. nobilis* (LAACKMANN), *C. ovata* LAACKMANN, *C. drygalskii* (LAACKMAMM), *C. digitulus* KOFOID & CAMPBELL, *C. fleva* LAACKMANN, *C. vanhöffeni* (LAACKMANN), ect. In addition to these, the following species reported from antarctic waters have not been examined in the present work: *Coxliella intermedia* (LAACKMANN), *Cox. frigida* (LAACKMANN) and *Cox. minor* (LAACKMANN) (LAACKMANN, 1909; BALECH, 1947, 1958; BALECH & EL-SAYED, 1965), *Epiplocyloides antarctica* BALECH (1962), *Epiplocylis mira* BALECH (1958a), *Bursaopsis quinquealata* (LAACKMANN) (1909), *Salpingella acuminatoides* (LAACKMANN) (1909), *S. costata* (LAACKMANN) (1909) and *S. laackmanni* KOFOID & CAMPBELL (LAACKMANN, 1909; BALECH & EL-SAYED, 1965). Loricae of the forms which have not been observed in the study, are generally so long or so large that it is difficult to collect them with a small amount of surface water, on which the study is based.

From Table 5 showing temperatures of surface water at the times of collecting the species of the Order Tintinnida, it may be regarded that 5°C is a rough boundary of water temperature between the antarctic sea and the subantarctic sea. The species common to the antarctic and Subantarctic seas are only 3 of 28, namely, *Tintinnopsis glans* MEUNIER, *Bursaopsis conicoides* n. sp. and *Protocymatocylis pseudoconica* HADA. The last shows the widest distribution in the seas where the research was made. Besides these, 15 have been observed only from the antarctic sea, and 10 from the subantarctic. Of those, 8 forms have been collected from

Table 5. Occurrences of the species of the Order Tintinnida in relation to surface water temperature of the antarctic and subantarctic seas.

Water temperature °C	Over 10	10 – 5	5 – 0	Under 0
Tintinnopsis glans				
Tintinnopsis fimbriata				
Tintinnopsis bacilloria				
Tintinnopsis radix				
Stenosemella nivalis				
Stenosemella perpusilla				
Stenosemella avellona				
Codonellopsis soyai				
Codonellopsis glocilis				
Codonellopsis gaussi				
Laackmanniella naviculaefera				
Helicostomella antarctica				
Protocymatocylis pseudoconica				
Protocymatocylis subrotundata				
Cymotocylis kerguelensis				
Cymatocylis parva				
Cymatocylis cristallina				
Cymatocylis brevicaudata				
Cymatocylis calyciformis				
Craterella perminuta				
Metacylis corbula				
Parapetalotrica meridiana				
Undella antarctica				
Dictyocysta polygonata				
Bursaopsis ollulo				
Bursaopsis conicoides				
Dadayiella ganymedes				
Daturella frigida				
Number of species	9	7	13	8

cold water below 0°C, while 9 from surface water warmer than 10°C, and greatest number of species (13) has been recorded from the sea of 0 to 5°C temperature of surface water. From the results of the study, it seems that antarctic protozoan plankton is fond of moderate cold water of 0 to 5°C.

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