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# The Fauna of Akkeshi Bay

## IV. The Pelagic Ciliata

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(With 56 Textfigures)

### Introduction

The marine pelagic Ciliata, especially the Tintinnoinea, represent an important group of zooplankton found in the Pacific on the south-eastern coasts of Hokkaido. The materials here dealt with were mostly collected in Akkeshi Bay several times in each month since 1932, but a few were obtained off the Bay and also in three brackish lakes, namely Lakes Akkeshi, Hijirippu, and Mochirippu. The first named is directly connected with Akkeshi Bay. It is always influenced by diurnal tides. The latter two lakes are situated close on the east of the Bay. Their sea-water contents are variable owing to temporary connections with the sea. These brackish lakes are shallow and have a luxuriant growth of eel grass on their bottoms. The water temperature of Akkeshi Bay is so fairly low, from  $-1.3^{\circ}\text{C}$  to  $20.2^{\circ}\text{C}$ , that the plankton of the Bay comprise mainly arctic or cold water forms. The collections were made by surface and vertical tows, and then by filtration and precipitation of sea-water.

Among 55 forms of free swimming Ciliata described in this report five belong to the Holotricha and 50 to the Tintinnoinea, including 11 forms new to science and 15 unrecorded ones in Japan.

The writer begs to express sincere thanks to Dr. T. Uchida, Director of the Akkeshi Marine Biological Station, for his kindly aid in the publication of this paper.

## List of Species

## Order Holotricha

## Family Holophryidae

1. *Prorodon teres* EHRENBERG                      2. *P. flavus* n. sp.

## Family Didiniidae

3. *Didinium gargantua* MEUNIER                      4. *D. balbianii* FABRE-DOMERGUE

## Family Colepidae

5. *Tiarina fusus* (CLAPARÈDE & LACHMANN)

## Order Spirotricha

## Suborder Tintinnoinea

## Family Tintinnidae

6. *Tintinnidium mucicola* (CLAPARÈDE & LACHMANN) DADAY                      8. *L. bottonicus* (NORDQVIST) JÖR-  
GENSEN  
7. *Leprotintinnus pellucidus* (CLEVE) JÖRGENSEN

## Family Codonellidae

9. *Tintinnopsis beroidea* STEIN                      18. *T. kofoidi* var. *limnetica* n. var.  
10. *T. ampla* n. sp.                                      19. *T. radix* (IMHOF) BRANDT  
11. *T. elongata* DADAY                                20. *T. tubulosa* LEVANDER  
12. *T. pusilla* n. sp.                                    21. *T. lohmanni* LAACKMANN  
13. *T. akkeshiensis* n. sp.                            22. *T. sufflata* n. sp.  
14. *T. angustior* JÖRGENSEN                        23. *T. rapa* MEUNIER  
15. *T. tenuis* HADA                                    24. *T. diversicervica* n. sp.  
16. *T. japonica* HADA                                25. *T. brevicollis* n. sp.  
17. *T. kofoidi* HADA                                    26. *T. baltica* BRANDT

## Family Codonellopsidae

27. *Stenosemella nivalis* (MEUNIER) KOFOID & CAMPBELL                      28. *Codonellopsis frigida* HADA  
29. *C. borealis* n. sp.

## Family Coxliellidae

30. *Coxliella ampla* (JÖRGENSEN) BRANDT                      32. *H. subulata* (EHRENBERG) JÖR-  
GENSEN  
31. *Helicostomella fusiformis* (MEUNIER) JÖRGENSEN

## Family Cyttarocylidae

- |   |  |
|---|--|
| 33. <i>Favella ehrenbergi</i> (CLAPARÈDE & LACHMANN) JÖRGENSEN var. | 37. <i>P. ventricosa</i> (JÖRGENSEN) KOFOID & CAMPBELL |
| 34. <i>F. taraiakaensis</i> HADA                                    | 38. <i>P. faceta</i> HADA                              |
| 35. <i>Parafavella denticulata</i> (EHRENBERG) KOFOID & CAMPBELL    | 39. <i>P. jörgenseni</i> HADA                          |
| 36. <i>P. gigantea</i> (BRANDT) KOFOID & CAMPBELL                   | 40. <i>P. longidentata</i> n. sp.                      |
|   | 41. <i>P. pacifica</i> HADA                            |
|   | 42. <i>P. subcylindrica</i> HADA                       |

## Family Ptychocylidae

- |                                      |                              |
|--------------------------------------|------------------------------|
| 43. <i>Ptychocylis obtusa</i> BRANDT | 46. <i>P. huminis</i> n. sp. |
| 44. <i>P. drygalskii</i> BRANDT      | 47. <i>P. acuta</i> BRANDT   |
| 45. <i>P. arctica</i> BRANDT         |                              |

## Family Petalotrichidae

48. *Acanthostomella norvegica* (DADAY) JÖRGENSEN

## Family Rhabdonellidae

49. *Protorhabdonella curta* (CLEVE) JÖRGENSEN

## Family Undellidae

50. *Proplectella expolita* HADA

## Family Tintinnidae

- |  |   |
|--|---|
| 51. <i>Amphorella quadrilineata</i> (CLAPARÈDE & LACHMANN) DADAY | 54. <i>T. turris</i> KOFOID & CAMPBELL                            |
| 52. <i>Tintinnus tubulosus</i> OSTENFELD                         | 55. <i>Salpingella acuminata</i> (CLAPARÈDE & LACHMANN) JÖRGENSEN |
| 53. <i>T. rectus</i> WEILES                                      |   |

## Descriptions of Species

### Order Holotricha STEIN, 1859

#### Family Holophryidae PERTY, 1852

#### Genus *Prorodon* EHRENBERG, 1833

Body ellipsoid or stout to elongate ovate, oval in cross sections; anterior end usually rounded, sometimes oblique; posterior one round, somewhat convex conical to a blunt end; mouth terminal or sub-

terminal at the anterior end, conveyed to a rod-shaped pharynx; macronucleus spherical, ovoid, or ribbon-like; contractile vacuole posterior, often single; cilia uniform except in the oral region.

Type species—*Prorodon teres* EHRENBERG.

The type species and a new species, *P. flavus*, have been described from plankton of Akkeshi Bay.

#### Key to species

1. Body small, ovate, without yellowish granules.....*P. teres* EHRENBERG
2. Body large, elongate, with yellowish granules.....*P. flavus* n. sp.

#### 1. *Prorodon teres* EHRENBERG

Fig. 1

*Prorodon teres*: CLAPARÈDE & LACHMANN, 1858, p. 319; HAMBURGER & von BUDDENBROCK, 1911, p. 16, fig. 5; KAHL, 1930, p. 30, figs. VIII, 10-13; 1933, p. 53, fig. III, 1.

*Description*:—Body ellipsoid; mouth opening terminally with an elongated conical pharynx; macronucleus oval with a micronucleus, having a clear area in the center; contractile vacuole distal; cilia of the oral margin growing forwards and those of the posterior region somewhat longer. Length, 75–160  $\mu$ .

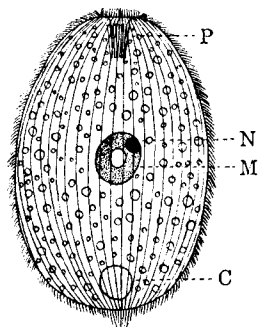


Fig. 1. *Prorodon teres*  
EHRENBERG 350 $\times$

C. Contractile vacuole; M.  
Macronucleus; N. Micro-  
nucleus; P. Pharynx.

*Occurrence*:—Several specimens were examined in plankton collected on April 19 and May 6, 1935 in surface temperatures of 4.6–5.8°C in Akkeshi Bay.

*Distribution*:—The species is found in fresh, brackish, and sea water. It has been reported in brackish waters from the Gulf of Finland and in sea-waters from the Gulf of Mexico.

*Remarks*:—*P. teres* is usually found in fresh or brackish waters, while the allied species, *P. marinus*, is known as a sea form, but the specimens are characteristic in the structure of the oral border and the macronucleus, hence the identification has been made.

2. *Prorodon flavus* n. sp.

Fig. 2

*Description*:—Body large, worm-like, 2.6–3.8 of the breadth in length, rounded in the anterior end, broadest in the suboral region, then gradually narrowing towards a blunt posterior end; mouth terminal, pharynx funnel-shaped; macronucleus spherical, central; contractile vacuole indistinct; fine yellowish granules scattered in the protoplasm. Length, 420–640  $\mu$ ; breadth, 160–170  $\mu$ .

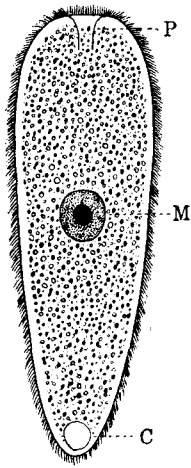


Fig. 2. *Prorodon flavus*  
n. sp. 100 $\times$

C. Contractile vacuole;  
M. Macronucleus;  
P. Pharynx

*Occurrence*:—The species was found in a vertical haul of 9 m taken on January 9, 1934 at a surface temperature of 18°C off the Marine Biological Station.

*Comparison*:—The species differs from *P. teres* Ehrenberg, *P. marinus* Claparède & Lachmann, and *P. moebiusi* Kahl in larger size and in the presence of yellowish granules and from *P. morgani* Kahl in the form of the macronucleus which is spherical in this species, but elongated in the latter.

*Remarks*:—This species seems to be the longest among species of *Prorodon*, and resembles *P. moebiusi* in general contour. If the size of the body and the colour of granules are variable in this form, this species is probably identified with *P. moebiusi*.

## Family Didiniidae POCHE, 1913

Genus *Didinium* STEIN, 1867

Body ovate, anteriorly produced to make a conical process bearing a mouth at the tip, with one, two, or more ciliary girdles; pharynx elongate, conspicuous; macronucleus arched rod-shaped; contractile vacuole terminal.

Type species—*Didinium nasutum* (O. F. MÜLLER).

The following forms were examined in plankton of Akkeshi Bay; *D. gargantua* Meunier and *D. balbianii* (Fabre-Domergue).

#### Key to species

1. Body with two ciliary bands.....*D. gargantua* MEUNIER.
2. Body with a single ciliary band.....*D. balbianii* (FABRE-DOMERGUE).

### 3. *Didinium gargantua* MEUNIER

Fig. 3

*Didinium gargantua*: MEUNIER, 1910, p. 154, pl. 15, figs. 8-15; pl. 16, figs. 1, 3, 5-12; pl. 17, figs. 1-3, 5; pl. 18, figs. 1, 2, 4, 6, 8, 10, 11; pl. 23, fig. 11; KAHL, 1930, p. 125; 1933, p. 57, fig. IV, 1.

*Description*.—Body round, 1.2 of the greatest transdiameter of the body in length; proboscis conical ( $40^\circ$ ), its length 0.26 of the total length; anterior ciliary band on the shoulder and the posterior near the aboral region. Length, 150-160  $\mu$ ; breadth, 125-128  $\mu$ .

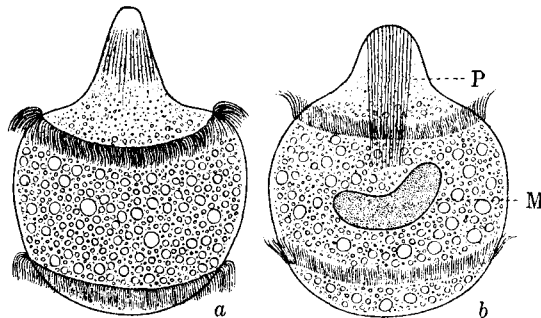


Fig. 3. *Didinium gargantua* MEUNIER 260 $\times$

a. Drawn from a living specimen; b. Figured from a fixed one.  
M. Maronucleus; P. Pharynx.

*Occurrence*.—Very rare in plankton of Akkeshi Bay early in May in water temperatures of 2.9-5.8°C.

*Distribution*.—The species was originally described from the Barents Sea by Meunier (1910).

*Comparison*.—The species differs from *D. nasutum* (O. F. Müller) in showing a stouter contour and in the aboral ciliary girde situated more posterior in position.

*Remarks*:—This marine species is discriminated from the oldest species, *D. nasutum* which occurs in fresh and brackish waters, in a more round body shape and in a lower position of the posterior ciliary band which is located near the middle part of the body in *D. nasutum*. In living specimens (Fig. 3a) the proboscis extends to form a high cone, while that of fixed ones (Fig. 3b) shows only a low rounded elevation.

#### 4. *Didinium balbianii* (FABRE-DOMERGUE)

Fig. 4

*Didinium balbianii*: HAMBURGER & von BUDDENBROCK, 1911, p. 24, fig. 18.

*Didinium balbianii*: KAHL, 1930, p. 125, fig. XVIII, 24; 1933, p. 57, fig. IV, 2.

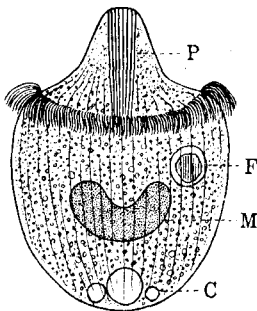


Fig. 4. *Didinium balbianii*  
FABRE-DOMERGUE 600×  
C. Contractile vacuole; F.  
Food vacuole; M. Macro-  
nucleus; P. Pharynx.

*Description*:—Body oval with a single ciliary band, 1.4 of the greatest trans-diameter in length; contractile vacuole posterior, single or more. Length, 60–96  $\mu$ .

*Occurrence*:—Very rarely found in plankton during May–August in water temperatures of 2.8–16.3°C in Akkeshi Bay.

*Distribution*:—The species has been generally reported from brackish waters.

*Comparison*:—The species differs from *D. gargantua* Meunier in its smaller size and in possessing a single ciliary band instead of two.

*Remarks*:—This species occurs more frequently than *D. gargantua* in Akkeshi Bay.

#### Family Colepidae CLAPARÈDE & LACHMANN, 1858

##### Genus *Tiarina* BERGH, 1880

Body spindle-shaped, covered with oblong plates arranged in rows running through the body; mouth located at the truncated anterior end surrounded by tooth-like processes of terminals of the oral plates;

posterior region tapering to a pointed tip; cilia rather dense on the oral border, sparse on the surface of the body.

Type species—*Tiarina fusus* (CLAPARÈDE & LACHMANN).

### 5. *Tiarina fusus* (CLAPARÈDE & LACHMANN)

Fig. 5

*Coleps fusus*: CLAPARÈDE & LACHMANN, 1858, p. 366, pl. 12, figs. 7, 8.

*Tiarina fusus*: HAMBURGER & von BUDDENBROCK, 1911, p. 23, fig. 16; KAHL, 1930, p. 137, figs. XIX, 24, 25; 1933, p. 57, fig. IV, 16.

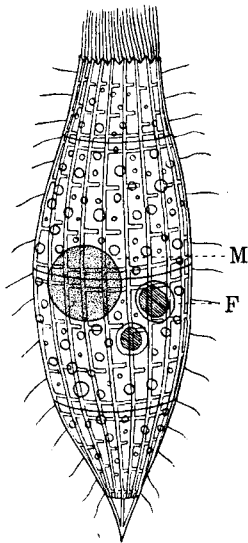


Fig. 5. *Tiarina fusus* CLAPARÈDE & LACHMANN 660×

F. Food vacuole;  
M. Macronucleus.

*Description*:—Body fusiform, length 2.7–3.0 of the greatest width; five rectangular plates lengthwise in a row, each having several knots; longitudinal rows of plates about ten in number; macronucleus single, comparatively large, spherical, placed near the center of the body; contractile vacuole invisible. Length, 90–100  $\mu$ ; breadth, 30–35  $\mu$ .

*Occurrence*:—Rare or very rare in plankton of Akkeshi Bay in August–October in water temperatures of 12–20°C, but frequently found in the surface collection of October 9, 1935 in a surface temperature of 14°C in the Bay.

*Distribution*:—This is widely distributed in temperate and neritic waters, and has been reported from the Norwegian Coasts, Skagerrak, Kiel Bay, Naples, Woods Hole, and the Gulf Stream.

*Remarks*:—This is the first record of the species from Japan. This species was also found in summer plankton of Mutsu Bay, 1930 and in plankton off the Misaki Marine Biological Station, Kanagawa Ken in April, 1936. This species is probably common in Japanese waters.

## Order Spirotricha BÜTSCHLI, 1889

## Suborder Tintinnoinea KOFOID &amp; CAMPBELL, 1929

## Family Tintinnididae KOFOID &amp; CAMPBELL, 1929

Genus *Tintinnidium* KENT, 1882

Lorica free or adherent, usually elongate sac-shaped, sometimes irregularly formed, with or without a collar; aboral end generally closed; wall soft, made of viscous materials or loosely agglomerated.

Type species—*Tintinnidium mucicola* (CLAPARÈDE & LACHMANN) DADAY.

*Tintinnidium* includes many fresh-water forms. Marine species usually occur in coastal waters.

1. *Tintinnidium mucicola* (CLAPARÈDE & LACHMANN) DADAY

Fig. 6

*Tintinnus mucicola*: CLAPARÈDE & LACHMANN, 1858, p. 209, pl. 8, fig. 12; KENT, 1882, p. 605, pl. 31, fig. 16.

*Tintinnidium mucicola*: DADAY, 1887, p. 524; BRANDT, 1906, pl. 70, figs. 8–10; 1907, p. 441; LAACKMANN, 1906, p. 16; LOHMANN, 1908, p. 292, pl. 15; JÖRGENSEN, 1927, p. 16, fig. 31; KOFOID & CAMPBELL, 1929, p. 15, fig. 1; HOFKER, 1931, p. 319, figs. 2, 3.

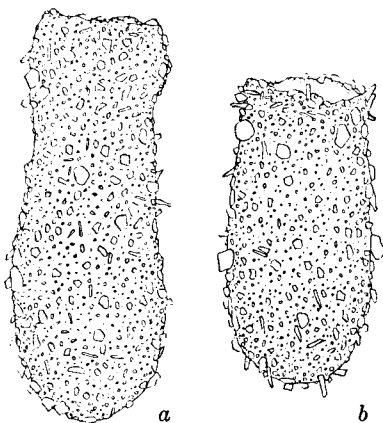


Fig. 6. *Tintinnidium mucicola* (CLAPARÈDE & LACHMANN) 530×

*Description*:—Lorica irregularly capsular, often nearly cylindrical, 2.5–3.1 oral diameters in length; near oral margin more or less constricted; oral end roughly uneven; aboral end usually rounded; wall thin, somewhat translucent, loosely covered with scarce foreign particles. Length, 75–100  $\mu$ ; oral diameter, 30–33  $\mu$ .

*Occurrence*:—Very rare in plankton of Akkeshi Bay during May–December in water temperatures of 3.5–20.0°C.

*Distribution*:—The species is distributed in neritic waters of the North, Baltic, and Mediterranean Seas.

*Variation*:—The lorica of the specimens in collections from Akkeshi Bay are uniformly cylindrical or oblong and not irregular in form as shown in Pl. 70, figs. 8, 10 by Brandt (1906).

*Comparison*:—The species differs from *T. neapolitanum* Daday in the absence of the oral expansion.

*Remarks*:—This species is a neritic and rather cold water form. The specimens from Akkeshi Bay are smaller in size as compared with those of Kiel Bay, which are 100–240  $\mu$  in length from the reports by Laackmann (1906) and Brandt (1906).

### Genus *Leprotintinnus* JÖRGENSEN, 1899

Lorica consisting of a tubular shaft opening at both ends, sometimes with an inverted aboral funnel; wall composed of a ground structure and sparsely agglomerated materials on its surface.

Type species—*Leprotintinnus pellucidus* (CLEVE) JÖRGENSEN.

Two species have been studied here: one is the type species and the other *L. bottnicus* (Nordqvist).

#### Key to species

1. Aboral region flaring .....*L. pellucidus* (CLEVE) JÖRGENSEN.
2. No flaring aboral modification .....*L. bottnicus* (NORDQVIST) JÖRGENSEN.

### 2. *Leprotintinnus pellucidus* (CLEVE) JÖRGENSEN

Fig. 7

*Tintinnus bottnicus*: BRANDT, 1896, p. 53, pl. 3, figs. 10, 11.

*Tintinnus pellucidus*: CLEVE, 1899, p. 24, pl. 1, fig. 4; MEUNIER, 1910, p. 134, pl. 11, figs. 1–10.

*Leprotintinnus bottnicus*: JÖRGENSEN, 1899, p. 10; 1900, pl. 2, fig. 13.

*Leprotintinnus pellucidus*: JÖRGENSEN, 1901, p. 18; 1927, p. 8, fig. 8; KOFOID & CAMPBELL, 1929, p. 17, fig. 12; HADA, 1932b, p. 41, fig. 1.

*Tintinnopsis? pellucida*: BRANDT, 1906, pl. 23, figs. 8, 14; 1907, p. 172; MERKLE, 1909, p. 156, pl. 2, fig. 22; OSTENFELD, 1910, p. 292, fig. 2.

*Description*:—Lorica elongate, 4–8 oral diameters in length; oral rim usually smooth, aboral one rough; shaft slightly conical (1.5°–3.0°), constricted at a point little above the posterior end, its smallest transdiameter 0.43–0.64 oral diameters; aboral end flaring

(43°–97°) with an aboral aperture of 0.7–1.0 oral diameters; wall thin, with or without spiral turns, foreign particles scattered on the surface, generally very sparse, but sometimes rich near the suboral border. Length, 223 (156–288)  $\mu$ ; oral diameter, 38 (33–42)  $\mu$ ; aboral diameter, 32 (25–35)  $\mu$ .

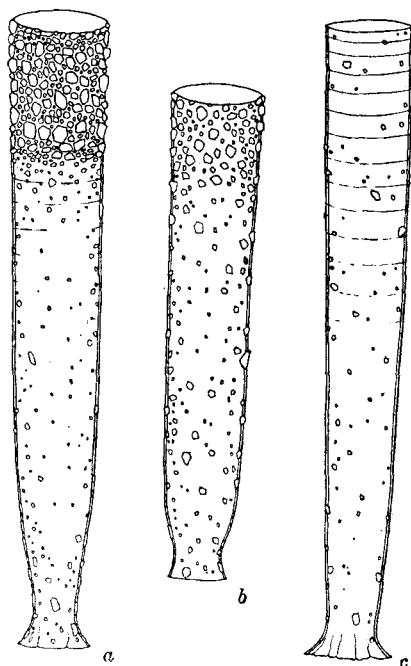


Fig. 7. *Leprotintinnus pellucidus*  
(CLEVE) 300 $\times$

*Occurrence*:—Rare in May–July and sometimes common in May in water temperatures of 2.8–14.0°C in Akkeshi Bay. The species was also found on January 27, 1933 even at a surface temperature of 0.5°C off the Marine Biological Station and on September 22, 1932 off the Bay.

*Distribution*:—It is widely distributed in the neritic North Polar Regions which cover the Norwegian Coasts, the Barents Sea, the Greenland Area, the Sea of Okhotsk, and the southern part of Kamchatka.

*Variation*:—In some specimens the shaft is more or less bent. The aboral flaring part is variable in size and form, and a number of vertical striae are often running on it. The agglutinated material is exceedingly

changeable in amount in individuals (Figs. 7 a, b) and especially crowded in the suboral region. In these specimens the spiral structure is generally inconspicuous or invisible.

*Comparison*:—The species differs from *L. bottnicus* (Nordqvist) in having an inverted funnel-shaped aboral region and from *L. nordqvisti* (Brandt) in the smaller size of the flaring aboral part and the absence of a flaring oral rim.

*Remarks*:—This is one of the arctic species occurring in neritic waters north to 50°N. Akkeshi Bay is the southern limit of the distribution of this species.

### 3. *Leprotintinnus bottnicus* (NORDQVIST) JÖRGENSEN

Fig. 8

*Tintinnus bottnicus*: MEUNIER, 1910, p. 136, pl. 11, figs. 11, 12.

*Tintinnopsis bottnica*: BRANDT, 1906, pl. 23, figs. 2, 2a, 6, 7, 16; 1907, p. 171.

*Tintinnopsis? pellucida*: BRANDT (pt.), 1906, pl. 23, fig. 15; 1907, p. 172.

*Leprotintinnus bottnicus*: KOFOID & CAMPBELL, 1929, p. 17, fig. 11; HOFKER, 1931, p. 321, figs. 4 a-c.

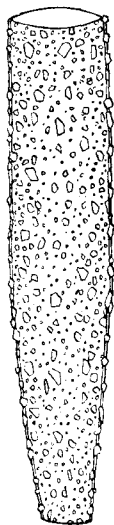
*Description*:—Lorica tubular, 5.3 oral diameters in length; shaft gradually tapering to the opening aboral end without an aboral expansion; wall usually having no spiral structure. Length, 208  $\mu$ ; oral diameter, 39  $\mu$ ; aboral diameter, 23  $\mu$ .

*Occurrence*:—A few specimens of the species was detected in catches of January in 1933 in water temperatures of  $-0.5-1.0^{\circ}\text{C}$  in Akkeshi Bay.

*Distribution*:—The species is known in brackish waters, such as the Gulf of Botonia, the Gulf of Finland, the mouth of the Elbe and Tocantins, the Kiel Canal, and the Zuider Zee, and from sea waters as follows, the coasts of Norway, the Karajak Fiord in Greenland, the Barents Sea, the Strait of Messina in the Mediterranean, and the Cook Strait in New Zealand.

*Variation*:—The specimens found in Akkeshi Bay have an aboral aperture rather wider than in those of the other localities. The spiral structure has been observed in individuals collected from the Zuider Zee and the Karajak Fiord.

Fig. 8. *Leprotintinnus bottnicus* (NORDQVIST) 310 $\times$



*Comparison*:—The species differs from *L. pellucidus* (Cleve) in the lack of a flaring aboral region and from *L. simplex* Schmidt in the presence of a posterior constriction.

*Remarks*:—This species, neritic in cold and temperate waters, is very rare in winter in Akkeshi Bay.

## Family Codonellidae KENT, 1882

Genus *Tintinnopsis* STEIN, 1867

Lorica variously shaped, with or without an aboral horn; aboral opening sometimes present; wall composed of a thin ground structure and agglomerated particles attached to the surface of the lorica.

Type species—*Tintinnopsis beroidea* STEIN.

In this genus are included many neritic marine and a few fresh and brackish forms. The identification of species in *Tintinnopsis* is rather difficult, because the form of the lorica is variable within a species on account of the irregular agglomeration of particles. In the present investigation 18 neritic forms have been studied, among which *T. tenuis* Hada and *T. kofoidi* var. *limnetica* n. var. are brackish water inhabitants. Most of these species are distributed in cold or temperate waters, but *T. beroidea* Stein and *T. radix* (Imhof) are cosmopolitan, and *T. elongata* Daday occurs also in tropical waters. There have been examined many species with an aboral opening, such as *T. pusilla* n. sp., *T. akkeshiensis* n. sp., *T. kofoidi* Hada, *T. kofoidi* var. *limnetica* n. var., *T. radix* (Imhof), *T. sufflata* n. sp., *T. rapa* Meunier, and *T. diversicervica* n. sp. These species were observed always to have the aboral opening. It is obvious that the aboral aperture is by no means caused by accidents or due to deformation of the lorica. The aboral aperture seems to serve as the principal identification of species in *Tintinnopsis*, but the character only seems to be insufficient to distinguish species, because the opening is liable to be overlooked.

## Key to species

- A. Lorica cylindrical in the main part.
  - a. Aboral region conical, without an aboral opening.
    - 1. Lorica small, with a slight spiral structure . . . . . *T. beroidea* STEIN.
    - 2. Lorica large, with a spiral structure . . . . . *T. ampla* n. sp.
    - 3. Lorica large, without a spiral structure . . . . . *T. elongata* DADAY.
  - b. Aboral region conical, with an aboral opening.
    - 4. Lorica minute, without a spiral structure, agglomerated particles sparse . . . . . *T. pusilla* n. sp.
    - 5. Lorica moderately sized, with a spiral structure, agglomerated particles arranged radially at the oral end . . . . . *T. akkeshiensis* n. sp.
  - c. Aboral end rounded or bluntly conical.
    - 6. Lorica slender; aboral region conical; spiral structure invisible. . . . . *T. angustior* JÖRGENSEN.

7. Lorica small; aboral end rounded; brackish water inhabitant.....  
.....*T. tenuis* HADA.
8. Lorica large, rounded at the aboral end, with a spiral structure....  
.....*T. japonica* HADA.
- d. Lorica with an aboral horn.
  9. Aboral region abruptly narrowed.....*T. kofoidi* HADA.
  10. Lorica fusiform.....*T. kofoidi* var. *limnetica* n. var.
  11. Aboral region gradually tapering.....*T. radix* (IMHOF) BRANDT.
- B. Lorica consisting of a cylindrical collar and a bowl.
  - e. No aboral opening.
    12. Lorica usually elongated; wall thin, without a spiral structure....  
.....*T. tubulosa* LEVANDER.
    13. Lorica stout, with a spiral structure.... *T. lohmanni* LAACKMANN.
  - f. Aboral opening present.
    14. Lorica with a tall collar and a slightly inflated bowl.....  
.....*T. sufflata* n. sp.
    15. Lorica small, fusiform, with a short collar.....*T. rapa* MEUNIER.
    16. Lorica fusiform, with a low collar different in structure from the  
bowl.....*T. diversicervica* n. sp.
- C. Lorica consisting of a flaring collar and a bowl.
  17. No aboral opening.....*T. brevicollis* n. sp.
  18. Aboral opening present.....*T. baltica* BRANDT.

#### 4. *Tintinnopsis beroidea* STEIN

Fig. 9

*Tintinnopsis beroidea*: JÖRGENSEN, 1899, p. 23, pl. 1, fig. 5; ENTZ Jr. (pt.), 1909, pl. 8, fig. 11, pl. 20, figs. 27, 45, pl. 21, fig. 8; MERKLE, 1909, p. 149, pl. 2, fig. 30; MEUNIER, 1910, p. 140, pl. 12, figs. 14–18; JÖRGENSEN, 1924, p. 66, fig. 72; 1927, p. 7, fig. 5; KOFOID & CAMPBELL, 1929, p. 28, fig. 26; HOFKER (pt.), 1931, p. 334, figs. 17a, b; HADA, 1932b, p. 41, fig. 2; 1932c, p. 554.

*Codonella beroidea*: ENTZ Sr. (pt.), 1884, p. 411, pl. 24, figs. 2–9.

*Tintinnopsis beroidea* var. *acuminata*: DADAY (pt.), 1887, p. 547, pl. 19, figs. 4, 5.

*Description*:—Lorica bullet-shaped, 1.6–2.0 oral diameters in length; bowl cylindrical, posteriorly conical (70°–80°); aboral end acute or bluntly pointed; wall with a faint spiral structure. Length, 63–73  $\mu$ ; oral diameter, 35–40  $\mu$ .

*Occurrence*:—Very rare in Akkeshi Bay in summer in surface temperatures of 11–18°C, but occasionally numerous in June.

*Distribution*:—This is one of the cosmopolitan species widely distributed in temperate neritic waters of the world.

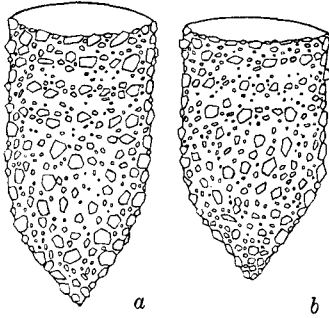


Fig. 9. *Tintinnopsis beroidea*  
STEIN 500×

*Variation*:—In specimens examined in other localities the spiral structure is generally invisible, but in those of Akkeshi Bay (Figs. 9 a, b) it is faintly visible.

*Comparison*:—The species differs from *T. acuminata* Daday in stouter proportions and coarser agglomeration and from *T. parvula* Jörgensen in the absence of an aboral bulge.

*Remarks*:—This species, the oldest in *Tintinnopsis*, very frequently occurs in coastal waters of the temperate zone, and is often confused with allied species, especially *T. parvula*. The writer has identified it after Jörgensen's opinion.

##### 5. *Tintinnopsis ampla* n. sp.

Fig. 10

*Description*:—Lorica comparatively large, generally bullet-shaped; 1.73–2.56 oral diameters in length; oral margin entire; bowl cylindrical or very slightly tapering (up to 7°); aboral region tapering abruptly (77°–100°), rarely having a short aboral horn; aboral end blunt or acute; wall thickened, composed of rather coarse agglomerated materials, spiral structure visible, when well-developed sides of the bowl becoming uneven. Length, 157 (130–192) $\mu$ ; oral diameter, 73 (70–75) $\mu$ .

*Occurrence*:—Very rare in collections of Akkeshi Bay in August–October when a surface temperature is over 11.7°C.

*Variation*:—The new species is remarkably variable in form, represented by several different forms. The general contour of most individuals is gradually tapering in the bowl, straight on sides of the lorica, and destitute of an aboral horn, but some (Fig. 10e) are rugged in appearance on account of the well-developed spiral structure and of the presence of a stout aboral horn. In specimens without an aboral horn the aboral end is typically blunt or acute and occasionally rounded (Fig. 10d). There are a few intermediate forms (Fig. 10f).

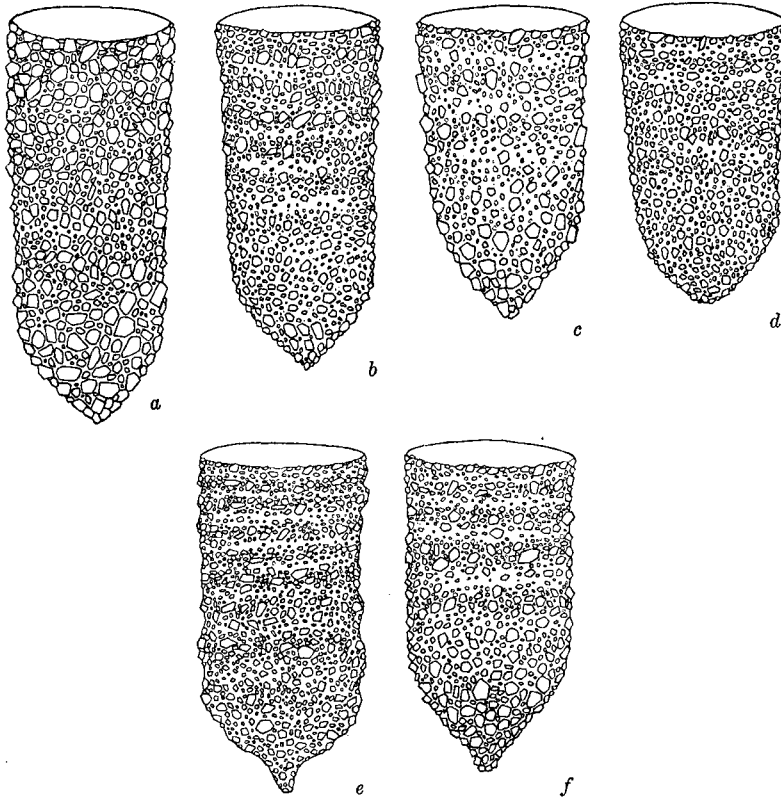


Fig. 10. *Tintinnopsis ampla* n. sp. 290 $\times$

*Comparison*:—The species differs from *T. beroidea* Stein in larger size, from *T. japonica* Hada in the conical aboral region and the coarser agglomeration of the wall, and from *T. elongata* Daday in the presence of the spiral structure and the shape of the aboral region.

*Remarks*:—This species is larger than *T. beroidea*. Elongated conical individuals of the species closely resemble *T. elongata* in general outline, but are distinguishable from the latter by the presence of a spiral structure and by the abruptly narrowed aboral region.

### 6. *Tintinnopsis elongata* DADAY

Fig. 11

*Tintinnopsis vosmaeri* var. *elongata*: DADAY, 1887, p. 550, pl. 19, figs. 13, 15.

*Tintinnopsis elongata*: KOFOID & CAMPBELL, 1929, p. 34, fig. 80.

*Description*:—Lorica large, slightly conical ( $7^{\circ}$ – $10^{\circ}$ ) in the anterior 0.5–0.6 of the total length, then gradually narrowing ( $40^{\circ}$ – $46^{\circ}$ ) to an aboral end, its length 2.3–2.6 oral diameters; oral margin entire or ragged; aboral end bluntly pointed or irregularly formed; wall coarsely agglomerated, without a spiral structure. Length, 125–138  $\mu$ ; oral diameter, 52–55  $\mu$ .

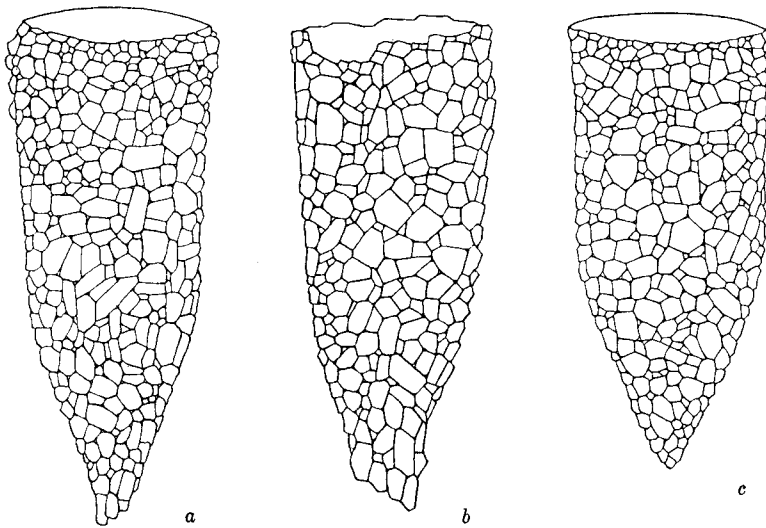


Fig. 11. *Tintinnopsis elongata* DADAY 470 $\times$

*Occurrence*:—Rare in Akkeshi Bay. Collected in October, 1933 in a surface temperature of  $15.5^{\circ}\text{C}$ .

*Distribution*:—The species has been described only from the Bay of Naples.

*Variation*:—The oral rim is smooth in most specimens (Figs. 11a, c), but rough as being broken in a few specimens (Fig. 11b). The aboral end is often irregularly shaped by coarse agglomeration of particles.

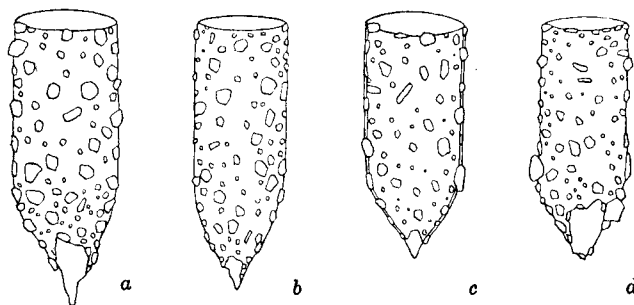
*Comparison*:—The species differs from *T. vosmaeri* Daday in the slender lorica and from *T. ampla* n. sp. in the more tapering aboral region and the lack of a spiral structure.

*Remarks*:—As the species is a warm water form, it was only once detected in Akkeshi Bay.

7. *Tintinnopsis pusilla* n. sp.

Fig. 12

*Description*:—Lorica minute, bullet-shaped, its length 2.2–3.0 oral diameters; oral margin entire, more or less ragged; bowl cylindrical; aboral region conical ( $43^{\circ}$ – $65^{\circ}$ ), laterally or obliquely opening to form an irregular aboral aperture and thence the aboral tip broken or cut off; wall thin, with scarce agglomerated particles, spiral structure absent. Length, 45 (39–50) $\mu$ ; oral diameter, 16 (15–18) $\mu$ .

Fig. 12. *Tintinnopsis pusilla* n. sp. 750 $\times$ 

*Occurrence*:—Rare in September and common in October in Akkeshi Bay. When the collections were made, surface temperatures were 13.0–18.2 $^{\circ}$ C.

*Variation*:—The aboral opening is variable in size and shape. It is sometimes very small, but rarely fairly large (Fig. 12d).

*Comparison*:—The species differs from *T. beroidea* Stein and *T. angustior* Jørgensen in the presence of an aboral opening.

*Remarks*:—This species is often met with in Akkeshi Bay in mid-autumn, when phytoplankton decreases and a water temperature is not so low. It is similar to *T. minimus* Entz (1909) from the Bay of Naples and Laackmann's (1913) *T. beroidea* var. b from Kiel Bay in the form of the lorica, but is different in having an aboral opening.

8. *Tintinnopsis akkeshiensis* n. sp.

Fig. 13

*Description*:—Lorica bullet-shaped, 1.9–3.6 oral diameters in length; oral rim irregular; bowl cylindrical, aborally conical ( $55^{\circ}$ –

70°); aboral end pointed; wall thin, agglomerated particles comparatively sparse, arranged radially on the oral margin and irregularly on the surface of the bowl, spiral structure sometimes scarcely visible, aboral opening characteristically situated laterally and rarely obliquely. Length, 78 (50–112)  $\mu$ ; oral diameter, 30 (24–34)  $\mu$ .

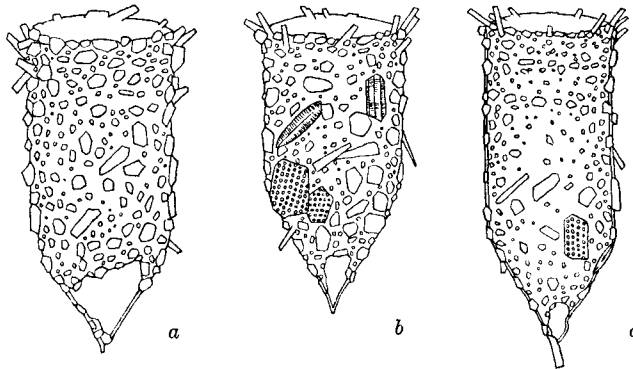


Fig. 13. *Tintinnopsis akkeshiensis* n. sp. 550 $\times$

**Occurrence:**—Rarely found in May–July in Akkeshi Bay. Water temperature from 8.0°C to 15.3°C.

**Variation:**—The considerable variations are seen in dimensions, proportions, and irregularity of the aboral opening.

**Comparison:**—The species differs from *T. beroidea* Stein and *T. acuminata* Daday in the presence of oral radial processes and of an aboral aperture, from *T. baltica* Brandt in the absence of a bulge, from *T. tubulosoides* Meunier in a smaller size and in the existence of a posterior opening, and from *T. pusilla* n. sp. in a larger size and possessing a peculiar oral structure.

**Remarks:**—This new species has been found in Akkeshi Bay in company with *T. beroidea* and *T. baltica*, both allied to this species. It is easy to separate this species from *T. beroidea* from the presence of an aboral opening, but it is fairly difficult to distinguish it from slender specimens of *T. baltica*, though distinguishable by careful examination of the shape of the bowl and the thickness of the wall.

## 9. *Tintinnopsis angustior* JÖRGENSEN

Fig. 14

*Tintinnopsis beroidea* var. b: BRANDT (pt.), 1906, pl. 19, fig. 22; 1907, p. 138.

*Tintinnopsis beroidea* var. *angustior*: JÖRGENSEN, 1924, p. 68, fig. 73.

*Tintinnopsis angustior*: KOFOID & CAMPBELL (pt.), 1929, p. 20, fig. 43.

*Description*.—Lorica slender bullet-shaped, 2.1–3.2 oral diameters in length; bowl cylindrical in the main part; aboral region usually conical ( $60^{\circ}$ – $70^{\circ}$ ), sometimes rounded; distal end blunt; wall thin, bearing a few foreign particles, no spiral structure. Length, 60 (42–65)  $\mu$ ; oral diameter, 20 (20–22)  $\mu$ .

*Occurrence*.—Rare during June–August in Akkeshi Bay in surface temperatures of  $15.0^{\circ}$ – $18.8^{\circ}$ C, but once abundantly found in the surface collection taken on August 30, 1932.

*Distribution*.—The species is recorded from off Barcelona, Spain, Norwegian Coasts, and the Bay of Naples.

*Variation*.—Aboral region conical in most specimens of Akkeshi Bay, but in a few cases (Fig. 14b) round like *T. tenuis* Hada. Lorica somewhat variable in elongation. Individuals shorter than 55  $\mu$  are very rare in the Bay.

*Comparison*.—The species differs from *T. beroidea* Stein

in the slender lorica, from *T. acuminata* Daday in smaller size and having a blunt terminal, from *T. tenuis* Hada in the conical aboral region and slender contour, and from *T. sufflata* n. sp. in sparse agglomeration of the wall and the lack of a posterior bulge.

*Remarks*.—This form was referred by Kofoid & Campbell (1929) to *T. acuminata* described by Daday (1887) together with Entz's (1909) *T. minimus* and Laackmann's (1913) *T. beroidea* var. b. The specimens studied by Daday from the Bay of Naples, however, are 72–78  $\mu$  long and 45–50  $\mu$  wide, and those recorded by Entz from the same locality are 40–50  $\mu$  long and 8–10  $\mu$  wide. *T. beroidea* var. *acuminata* Daday is longer and *T. minimus* Entz is smaller and more slender as compared with this species. Besides these differences, they are pointed at the apical end, but this feature is bluntly conical in the present species. The specimens reported as *T. beroidea* var. b by Laackmann from Kiel Bay closely resemble this species in size

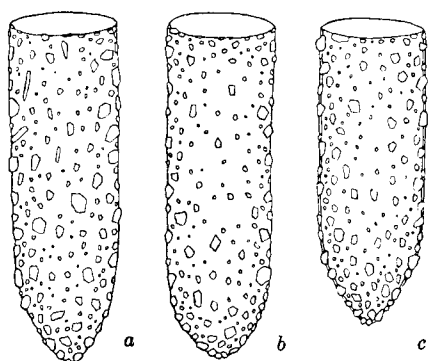


Fig. 14. *Tintinnopsis angustior*  
JÖRGENSEN 750 $\times$

and general appearance, but differ in the acute aboral end. A few specimens of this species are rounded at the aboral end and are similar to some specimens of the brackish water inhabitant, *T. tenuis*, with a comparatively conical end.

#### 10. *Tintinnopsis tenuis* HADA

Fig. 15

*Tintinnopsis tenuis*: HADA, 1932c, p. 555, fig. 1.

*Description*:—Lorica capsular, 1.9–2.5 oral diameters in length; bowl generally tubular, sometimes very slightly dilated in its posterior part, 1.0–1.1 oral diameters in transdiameter at the broadest; wall thin occasionally with a faint spiral structure in the suboral region, bearing fine and sparse agglomerated particles. Length, 50 (43–55) $\mu$ ; oral diameter, 22 (21–23) $\mu$ .

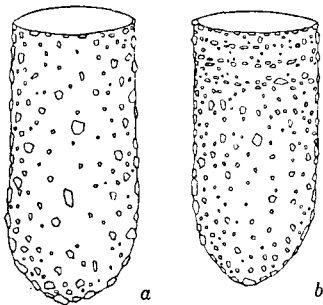


Fig. 15. *Tintinnopsis tenuis*  
HADA 750 $\times$

*Occurrence*:—The species is a brackish water one. It has been collected from Lakes Akkeshi and Hijirippu in summer and autumn.

*Distribution*:—This species is also found in Mutsu Bay, Japan.

*Variation*:—The slight variation observed in the shape of the posterior half of the lorica has been mentioned just above.

*Comparison*:—The species differs from *T. beroidea* Stein in delicacy of the lorica and the rounded aboral end, from *T. rotundata* Jörgensen in the thin wall and sparse agglomeration of the wall, and from *T. angustior* Jörgensen in stouter contour and the form of the aboral region.

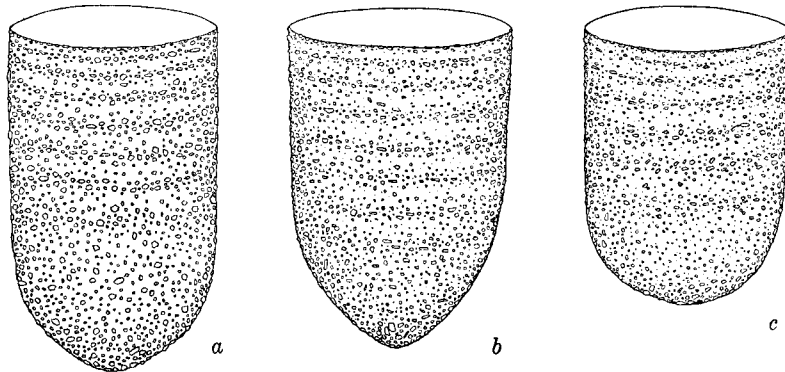
*Remarks*:—The specimens of the present investigation are smaller and more variable in form in comparison with those of Mutsu Bay. It is distinguishable from the allied species, *T. rotundata*, distributed in warm and tropical waters by the wall which is thicker and coarsely agglomerated in the latter.

11. *Tintinnopsis japonica* HADA

Fig. 16

*Tintinnopsis japonica*: HADA, 1932a, p. 209, fig. 1.

*Description*:—Lorica large, sac-shaped, 1.2–1.8 oral diameters in length; oral rim entire; bowl cylindrical, aborally hemispherical or convex conical; wall neatly agglomerated, with a slight spiral structure. Length, 205 (175–227)  $\mu$ ; oral diameter, 134 (117–145)  $\mu$ .

Fig. 16. *Tintinnopsis japonica* HADA 200 $\times$ 

*Occurrence*:—Common in Akkeshi Bay in spring and rare or very rare in winter and summer in water temperatures of  $-1.0$ – $11.5^{\circ}\text{C}$ .

*Distribution*:—The species is recorded off the Pacific coast of Aomori Ken.

*Variation*:—The aboral region of the lorica is often broadly rounded (Fig. 16c), but sometimes conical ( $90^{\circ}$ ) (Fig. 16b). The spiral structure is seen throughout the cylindrical part of the lorica in some specimens, however, in others it appears only in the suboral part of the lorica.

*Comparison*:—The species differs from *T. elongata* Daday in the rounded aboral end and fine agglomeration of the test.

*Remarks*:—In Akkeshi Bay this large species usually commences to appear at the middle of December, increases in collections in March–May when the surface temperature is  $0.4$ – $8.7^{\circ}\text{C}$ , then disappears early in August. A giant abnormal individual was examined; is  $352\ \mu$  in length and  $128\ \mu$  in oral diameter.

## 12. *Tintinnopsis kofoidi* HADA

*Tintinnopsis davidoffi* var. *cylindrica*: WAILES, 1929, pl. 2, fig. 1.

*Tintinnopsis davidoffi* var. *cylindrica* f. *annulata*: WAILES, 1929, pl. 2, fig. 3?

*Tintinnopsis kofoidi*: HADA, 1932a, p. 210, figs. 2, 3; 1932b, p. 44, fig. 6; 1932c, p. 560, text-fig. 9.

*Description*:—Lorica elongate, cylindrical with an aboral horn, its length 3.5–6.5 oral diameters; aboral horn tubular, obliquely opening at the tip, its length 0.15–0.31 of the total length; wall rather coarsely agglomerated, without spirality. Length, 155 (115–227)  $\mu$ ; oral diameter, 33 (33–35)  $\mu$ ; length of the aboral horn, 30 (25–40)  $\mu$ .

*Occurrence*:—The species is found in the vicinity of Akkeshi including the brackish lakes during May–October in surface temperatures of 8.7–18.2°C. In the Bay it occurs frequently in July and rarely in other months.

*Distribution*:—The species is known in Matsushima Bay, Mutsu Bay, the Sea of Okhotsk, and the Strait of Georgia, Canada.

*Variation*:—Individual variation is observable in the length and shape of the aboral opening.

*Comparison*:—The species differs from *T. cylindrica* Daday and *T. radix* (Imhof) in the abruptly tapering aboral part, the cylindrical aboral horn, and the absence of spiral organization.

*Remarks*:—The species occurs in the season of comparatively high water temperatures in Akkeshi Bay, because it is distributed in fairly warm waters but never in tropical seas. It was also found in materials captured from the brackish lakes, Akkeshi and Hijirippu. When the collection was made on November 5, 1932 in Lake Hijirippu, connection with the sea was interrupted, and salinity was 21.33‰ at a surface temperature of 11.5°C.

## 13. *Tintinnopsis kofoidi* var. *limnetica* n. var.

Fig. 17

*Description*:—Lorica small, fusiform, 3.3–4.5 oral diameters in length; oral margin entire; bowl somewhat dilated in the posterior region, its greatest transdiameter 1.1–1.2 oral diameters; aboral horn short, 0.08–0.13 of the total length, having an irregularly formed opening; wall thin with scarce agglomerated particles, spiral struc-

ture absent. Length, 84 (70–100) $\mu$ ; oral diameter, 22 (21–24) $\mu$ ; transdiameter of the bulge, 26 (25–29) $\mu$ ; length of the aboral horn, 9 (8–10) $\mu$ .

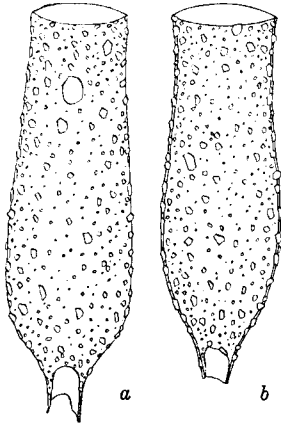


Fig. 17. *Tintinnopsis kofoidi* var. *limnetica* n. var. 540 $\times$

*Occurrence*:—The new variety was observed in plankton taken on November 18, 1934 in Lake Hijirippu. At that time the water temperature was changeable within 2.8–5.5°C and salinity within 12.21–12.85‰ according to depth and locality.

*Variation*:—No notable variation.

*Comparison*:—The variety differs from the typical form of *T. kofoidi* Hada in smaller dimension, having a posterior expansion of the bowl, and fewer foreign particles on the surface.

*Remarks*:—The variety is peculiar to brackish water and thence characteristic in this form.

#### 14. *Tintinnopsis radix* (IMHOF) BRANDT

Fig. 18

*Codonella radix*: IMHOF, 1886, p. 103.

*Tintinnopsis fracta*: BRANDT, 1906, pl. 23, figs. 1, 3–5, 9–13; pl. 31, fig. 8; 1907, p. 174; OKAMURA, 1907, p. 137, pl. 6, fig. 57.

*Tintinnopsis Davidoffii*: DADAY, 1887, p. 552, pl. 19, fig. 23.

*Tintinnopsis Davidoffii* var. *cylindrica*: DADAY (pt.), 1887, p. 553, pl. 19, fig. 25.

*Tintinnopsis Davidoffii* var. *longicauda*: DADAY, 1887, p. 553, pl. 19, fig. 26.

*Tintinnopsis radix*: BRANDT, 1907, p. 20; LAACKMANN, 1913, p. 17, pl. 2, figs. 17–20, 27–28; JÖRGENSEN (pt.), 1924, p. 69; KOFOID & CAMPBELL, 1929, p. 45, fig. 93; PAULSEN, 1931, p. 96; HADA, 1932b, p. 560, text-fig. 10; MARSHALL, 1934, p. 636, text-fig. 10; HADA, 1935, p. 244.

*Tintinnopsis radix* forma *typica*: LAACKMANN, 1913, p. 22.

*Tintinnopsis radix* forma *curta*: LAACKMANN, 1913, p. 23, pl. 2, figs. 21–24, 26.

*Tintinnopsis radix* forma *cylindrica*: LAACKMANN, 1913, p. 23, pl. 2, figs. 25, 29–31.

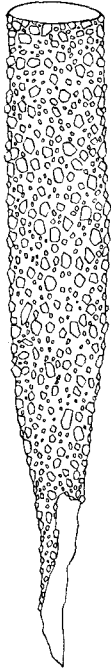


Fig. 18. *Tintinnopsis radix*  
(IMHOF) 300×

*Description*:—Lorica elongate, tubular, 6.58 oral diameters in length; bowl cylindrical, aborally narrowing to an aboral horn opening obliquely; wall more or less thin, with a weakly developed spiral structure. Length, 296  $\mu$ ; oral diameter, 45  $\mu$ .

*Occurrence*:—A single specimen was detected in the catch from Akkeshi Bay obtained on August 11, 1932 in a surface temperature of 17.3°C.

*Distribution*:—This species is widely distributed in neritic waters in the Mediterranean and the Indo-Pacific.

*Comparison*:—The species differs from *T. kofoidi* Hada in the aboral region which is gradually tapering and in the thin wall.

*Remarks*:—Being a warm water species, only a small specimen has been examined.

### 15. *Tintinnopsis tubulosa* LEVANDER

Fig. 19

*Tintinnopsis tubulosa* (pt.): BRANDT, 1907, p. 167; MERKLE, 1909, p. 154, pl. 2, figs. 3, 4; KOFOID & CAMPBELL, 1929, p. 45, fig. 39; HOFKER, 1931, p. 338, figs. 18, 18A.

*Description*:—Lorica consisting of a cylindrical collar and a bowl, its length 2.1–3.5 oral diameters; collar 0.25–0.50 of the total length long; bowl somewhat inflated, broadest in the posterior 0.33–0.40 of the lorica, its greatest transdiameter 1.05–1.25 oral diameters; aboral region usually conical (75°–90°) to an acute distal end or rarely rounded with a blunt end; wall rather thin, but irregular in appearance, no spiral structure. Length, 113 (85–140)  $\mu$ ; oral diameter, 40 (38–45)  $\mu$ ; greatest transdiameter of the bowl, 48 (42–57)  $\mu$ .

*Occurrence*:—Rare in March–June and often common in May in water temperatures of –0.7–12.0°C in Akkeshi Bay.

*Distribution*:—The species occurs in the Gulf of Finland, the North Sea, and the Zuider Zee.

*Variation*:—The length of the dilated part is comparatively constant, but that of the collar is variable. Most of the specimens from Akkeshi Bay (Figs. 19 a–c) are ragged on the surface of the lorica on account of the fragments of diatoms mingled in agglomerated particles.

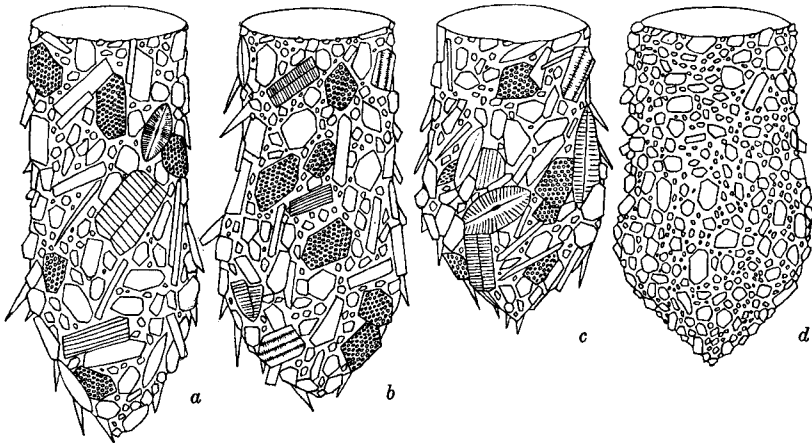


Fig. 19. *Tintinnopsis tubulosa* LEVANDER 450×

*Comparison*:—The species differs from *T. subacuta* Jörgensen in the lack of a short aboral horn, from *T. tubulosoides* Meunier in possession of a posterior inflation, and from *T. pistillum* Kofoid & Campbell in the conical aboral region.

*Remarks*:—The species occurs in Akkeshi Bay in spring when phytoplankton remarkably increases; they, therefore, bear many diatoms mixed in the agglomerated material of the wall. As the species was reported from brackish waters, such as the Gulf of Finland and the Zuider Zee, it is possibly distributed in Lake Akkeshi.

## 16. *Tintinnopsis lohmanni* LAACKMANN

Fig. 20

*Tintinnopsis lohmanni*: LAACKMANN, 1906, p. 20, pl. 1, figs. 10, 11, pl. 2, fig. 23; HOFKER, 1913, p. 331, figs. 12–14; HADA, 1932c, p. 556, fig. 3.

*Tintinnopsis* sp.: BRANDT, 1906, pl. 17, figs. 1, 3; 1907, p. 180.

*Tintinnopsis nucula*? BRANDT, 1906, pl. 16, figs. 1, 3.

*Tintinnopsis turbo*: KOFOID & CAMPBELL, 1929, p. 44, fig. 19.

*Tintinnopsis vasculum*: KOFOID & CAMPBELL, 1929, p. 50, fig. 29.

*Description*:—Lorica vase-like with a cylindrical collar and a bowl, 1.3–2.2 oral diameters in length; collar usually short, 0.16–0.40 of the total length in length; bowl expanding to its greatest transdiameter of 1.06–1.24 oral diameters; aboral region rounded or convex conical; wall coarsely agglomerated, a few spiral turns appearing in the collar. Length, 72 (58–110)  $\mu$ ; oral diameter, 48 (35–52)  $\mu$ ; length of the collar, 20 (10–50)  $\mu$ ; greatest transdiameter of the bowl, 55 (40–62)  $\mu$ .

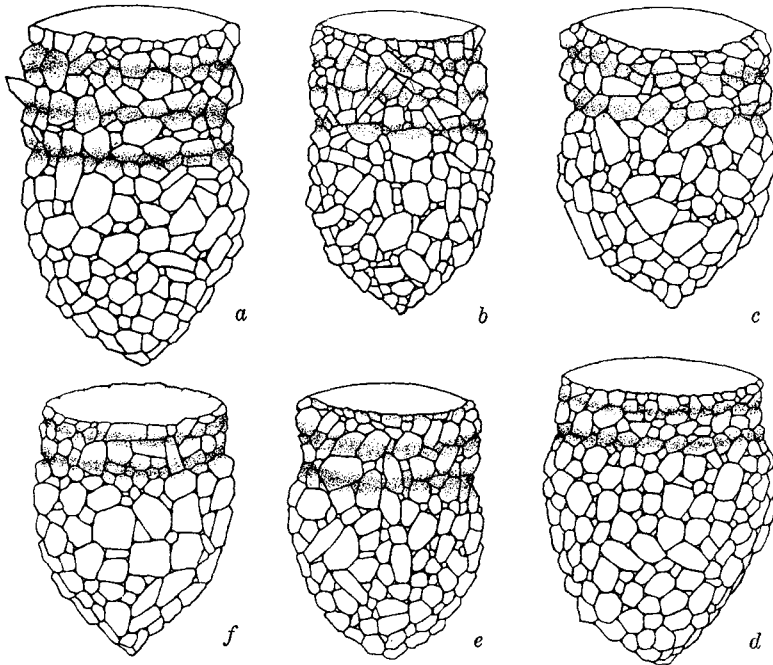


Fig. 20. *Tintinnopsis lohmanni* LAACKMANN 500  $\times$

*Occurrence*:—Rare or common throughout the year in Akkeshi Bay, but very rare in brackish water of Lake Mochirippu which was connected with the sea when the collection was made.

*Distribution*:—The species is known from Kiel Bay, the Flemish Sea, the Zuider Zee, the Kiel Canal, and Mutsu Bay.

*Variation*:—The seasonal variation in length was observed as follows: larger specimens of an average length of 73  $\mu$  generally

occur in autumn and smaller ones of an average length of  $69\ \mu$  are found in spring and summer. The collar is widely variable in length. The specimens bearing a short collar like *T. turbo* are more frequently found than those having the long one in Akkeshi Bay. Variation of the aboral end is not remarkable, and there have not been found any specimens provided with a rounded aboral end as in those from Mutsu Bay.

*Comparison*:—The species differs from *T. subacuta* Jörgensen in proportion of the collar to the bowl and from *T. tubulosa* Levander in posterior inflation and the presence of the spiral structure.

*Remarks*:—This is one of the common species occurring all the year round in Akkeshi Bay. Specimens are mostly conical and very rarely rounded at the aboral region as in Laackmann's (1906, Pl. 1, fig. 10) and Hada's (1932, text-fig. 3) figures. Round ended specimens sometimes appear in Mutsu and Matsushima Bays. Judging from this fact it is probable that conical specimens generally occur in cold waters, while rounded ones are frequent in warmer waters.

This species is considerably variable, and some species described as distinct one seem to be referred to this species. For example in *T. turbo* and *T. vasculum* reported by Meunier (1919) from the Flemish Sea, the former is a form having a short collar and a conical bowl and the latter is one of the varieties with an elongate bowl having a blunt end.

### 17. *Tintinnopsis sufflata* n. sp.

Fig. 21

*Tintinnopsis beroidea* var. b: BRANDT (pt.), 1906, pl. 16, fig. 15; 1907, p. 138.

*Description*:—Lorica stout finger-shaped, 2.5–3.4 oral diameters in length; oral rim rough; bowl cylindrical in the upper half of the lorica, somewhat dilated in the anterior 0.52–6.8 of the total length, its greatest transdiameter 1.05–1.15 oral diameters; aboral region convex conical ( $50^{\circ}$ – $68^{\circ}$ ), terminating to a blunt end; aboral opening present, irregularly formed, laterally or obliquely placed near the aboral end, its width 0.3–0.5 oral diameters; wall coarsely agglomerated without a spiral structure. Length, 60 (50–65) $\mu$ ; oral diameter, 21 (19–21) $\mu$ .

*Occurrence*:—Very rare in Akkeshi Bay during August–November in surface temperatures of 7.0–16.3°C.

*Variation*:—No marked variation. Some specimens are fairly ill-formed by coarse agglomeration of particles.

*Comparison*:—The species differs from *T. beroidea* Stein in its slender size and the presence of an aboral aperture, from *T. angustior* Jörgensen in coarser agglomeration and opening at the aboral region, and from *T. rapa* Meunier in the posterior position of the widened part.

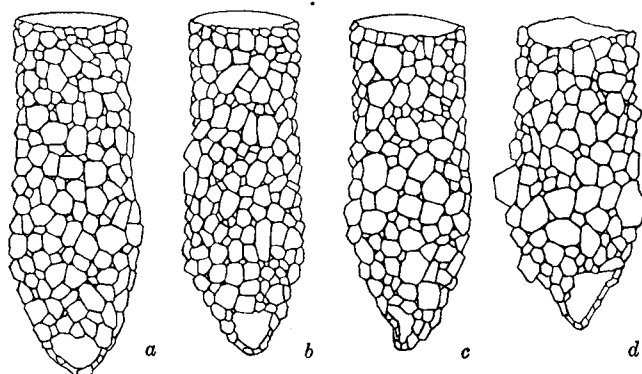


Fig. 21. *Tintinnopsis sufflata* n. sp. 750×

*Remarks*:—This species closely resembles *T. angustior* and *T. rapa* in size and form among species of *Tintinnopsis* detected in Akkeshi Bay. But in having lorica made of coarse particles and provided with a posterior bulge it is distinct from *T. angustior*, in which the wall is finely structured and bowl entirely cylindrical with a neat feature. It is also distinct from *T. rapa* in which there is an expansion located at the anterior part of lorica. The individual recorded by Brandt (1906) in Pl. 16, fig. 15 from the coast of Norway is similar in size and shape of the lorica, but is somewhat doubtful in having an aboral aperture.

### 18. *Tintinnopsis rapa* MEUNIER

Fig. 22

*Tintinnopsis beroidea* var. a? BRANDT, 1906, pl. 16, fig. 6; 1907, p. 138.

*Tintinnopsis rapa*: MEUNIER, 1910, p. 142, pl. 12, figs. 29, 35; KOFOID & CAMPBELL, 1929, p. 45, fig. 24?

*Description*:—Lorica fusiform, consisting of a short cylindrical collar and a conical bowl, its length 1.8–3.4 oral diameters; oral rim entire; collar 0.1–0.2 of the total length, occasionally showing a peculiar structure different from that of the main part; bowl inflated in the anterior 1.2–0.4 of the lorica, its greatest transdiameter 1.1–1.3 oral diameters, then tapering ( $30^{\circ}$ – $70^{\circ}$ ) to a blunt aboral end; aboral region provided with a lateral opening just on or a little above the aboral end; wall coarsely agglomerated, without a spiral structure. Length, 50 (37–65) $\mu$ ; oral diameter, 20 (18–23) $\mu$ ; greatest transdiameter of the bowl, 24 (22–27) $\mu$ .

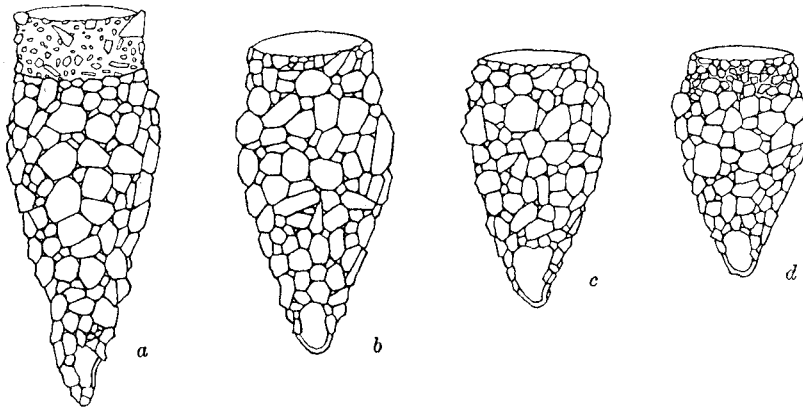


Fig. 22. *Tintinnopsis rapa* MEUNIER 750 $\times$

*Occurrence*:—Rare and sometimes very rare in Akkeshi Bay throughout the year.

*Distribution*:—The species has been recorded by Meunier (1910) from the Kara and Barents Seas. Prior to his report a similar form from off the Norwegian coast was described by Brandt (1907) as a variety of *T. beroidea*.

*Variation*:—A seasonal diversity of size occurs in the species. Small specimens (40–45  $\mu$ ) usually appear in summer and large ones (50–60  $\mu$ ) are often found in materials at the end of each year. Variations of form are seen in length, structure, and extension of the conical aboral region. In specimens of Akkeshi Bay are a few ones (Fig. 22a) having a finely agglomerated collar which has been probably made later than the other coarser part as shown in Meunier's Pl. 12, fig. 29, but the writer has secured no individual

with so long a collar as drawn in Pl. 12, fig. 33 by Meunier (1910). The aboral opening is subuniform in size and the terminal of the aboral end is always left.

*Comparison*:—The species differs from *T. beroidea* Stein in the presence of a bulge of the bowl and an aboral aperture, and from *T. sufflata* n. sp. in having a suboral inflation instead of a posterior one.

*Remarks*:—Meunier (1910) did not show an aboral opening in the specimens found in collections of the Kara and Barents Seas, however, his figures (Pl. 12, figs. 35–33) seem to show a pore at the aboral region. The specimen reported by Brandt (1906) in Pl. 16, fig. 6, from the coast of Norway has no aboral opening, but is very similar to those of Akkeshi Bay in size and form. It cannot be decided whether the absence of an aboral aperture in Brandt and Meunier's specimens is due to their oversight or to the individual variation. An aboral aperture is difficult of observation, because it is situated laterally and it is rather small.

### 19. *Tintinnopsis diversicervica* n. sp.

Fig. 23

*Description*:—Lorica consisting of a short cylindrical collar and a fusiform bowl, its length 2–3 oral diameters; oral rim smooth; collar erect, low, 0.07–0.15 of the total length; bowl broadest in the suboral shoulder border, its greatest transdiameter 1.14–1.36 oral diameters; aboral region conical ( $50^{\circ}$ – $70^{\circ}$ ); aboral end usually bluntly pointed when present; wall generally thin, neatly agglomerated in the collar, thicker and composed of comparatively coarser particles in the bowl; aboral opening present, usually placed laterally and occasionally obliquely; no spiral structure. Length, 74 (60–92) $\mu$ ; oral diameter, 32

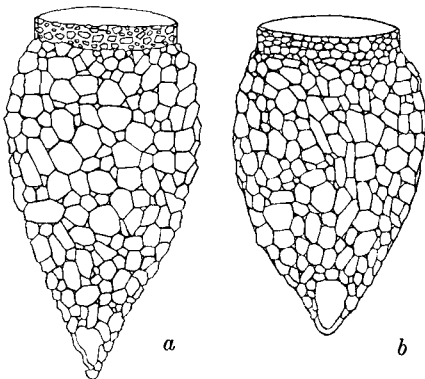


Fig. 23. *Tintinnopsis diversicervica*  
n. sp. 530 $\times$

(28–38)  $\mu$ ; length of the collar, 6 (4–13)  $\mu$ ; greatest transdiameter of the bowl, 40 (36–45)  $\mu$ .

*Occurrence*:—Rare in May–December and sometimes common in autumn in Akkeshi Bay. Water temperature varies from 4.3°C to 15.0°C.

*Variation*:—In general the wall of the collar is apparently different from that of the bowl in construction, and is possible to discriminate from that of bowl (Fig. 23b). An aboral aperture opens laterally along the conical side of the aboral region in many specimens, but obliquely in few specimens with an aboral end cut off.

*Comparison*:—The species differs from other species of *Tintinnopsis* in that the structure of the collar is easily distinguishable from that of the bowl.

*Remarks*:—The oral part of the wall is rarely different in structure in fully developed forms of *Tintinnopsis* as shown in this species. This species bears some resemblances to the genera *Codonellopsis* or *Stenosemella* as in *T. bermudensis* and *T. bermudensis* var. a reported by Brandt (1906) from near Bermudas.

## 20. *Tintinnopsis brevicollis* n. sp.

Fig. 24

*Tintinnopsis ventricosa*: BRANDT (pt.), 1906, pl. 18, figs. 1, 2; 1907, p. 154.

*Description*:—Lorica stout campanulate, consisting of a low funnel-shaped collar and a stouter fusiform bowl, its length 1.12–1.45 of the greatest transdiameter of the bowl; oral rim usually entire; collar short, flaring (80°–90°), variable in length and sometimes scarcely visible; its oral aperture 0.82–1.00 of the greatest transdiameters of the bowl; bowl broadest a little above the middle, aborally convex conical (75°–110°) to a bluntly pointed end; wall made of coarse agglomerated particles, without a spiral structure. Length, 74 (63–95)  $\mu$ ; oral diameter, 53–65  $\mu$ ; greatest transdiameter of the bowl, 55–66  $\mu$ .

*Occurrence*:—The species occurs almost throughout the year in Akkeshi Bay. It is often frequently found during months of comparatively low water temperatures, but rarely or scarcely in summer.

*Distribution*:—The peculiar form of this species was described from the Kiel Fjord by Brandt (1906).

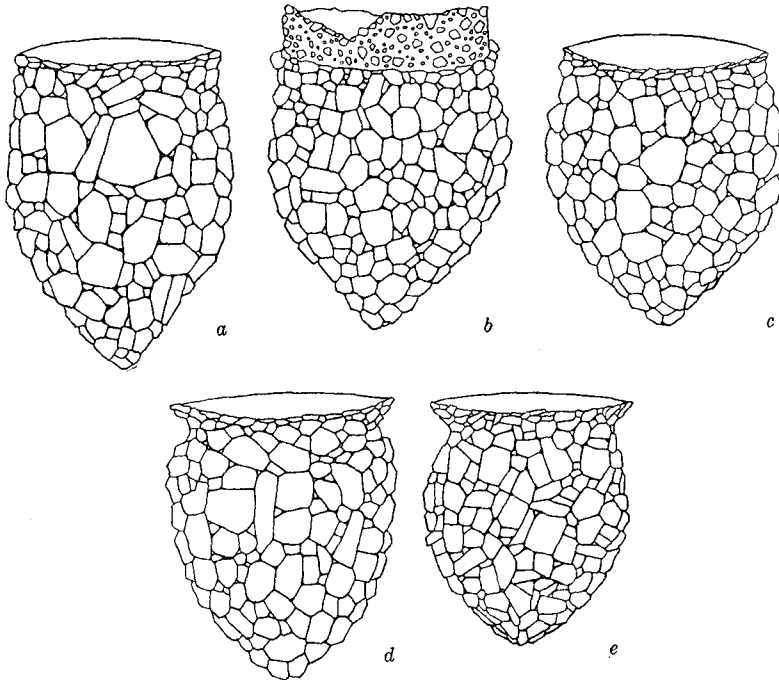


Fig. 24. *Tintinnopsis brevicollis* n. sp. 450 ×

*Variation*:—A conspicuous variation is recognizable in form of the collar. The typical forms (Figs. 24 d, e) are shallow dish-like and are marked in nuchal constriction, but the constriction in some ones (Figs. 24 a, c) is hardly visible, and a few individuals (Fig. 24b) have a newly made part above the original collar as shown by Brandt (1906) in his figures (Pl. 18, figs. 1, 2). Variation in length of the bowl is seen. Large specimens of an average length of 82  $\mu$  occur usually in spring among rich phytoplankton, and small ones of an average length of 65  $\mu$  are found in autumn when phytoplankton is very poor.

*Comparison*:—The species differs from *T. fimbriata* Meunier and *T. meunieri* Kofoid & Campbell in uniformity on the oral margin and in the more blunt aboral end, from *T. schotti* Brandt in the smaller collar, and from *Stenosemella ventricosa* Claparède & Lachmann in the lack of a low hyaline collar.

*Remarks*:—The new species is similar to *Stenosemella ventricosa* in general form, but it has no hyaline collar characteristic of *Steno-*

*semella*. Specimens from Akkeshi Bay are very closely similar to Brandt's figures (Pl. 18, figs. 1, 2, 1906) which have no hyaline collar and seem to belong to this new species, but are described as *S. ventricosa*. The species also resembles *T. schotti* described from tropical waters, but it is distinct in size of the collar. The difference of this species from *T. fimbriata* lies in the oral rim and the aboral end; moreover, *T. fimbriata* is found only in brackish waters in Belgium and the Zuider Zee, while this species occurs only in sea-water.

## 21. *Tintinnopsis baltica* BRANDT

Fig. 25

*Tintinnopsis baltica*: BRANDT, 1896, p. 56; 1906, pl. 15, fig. 6, 8? 9?; 1907, p. 141; JÖRGENSEN, 1927, p. 16; KOFOID & CAMPBELL, 1929, p. 27, fig. 50.

*Description*:—Lorica campanulate, 1.6–2.5 greatest transdiameters in length; aboral margin flaring, roughened with agglomerated

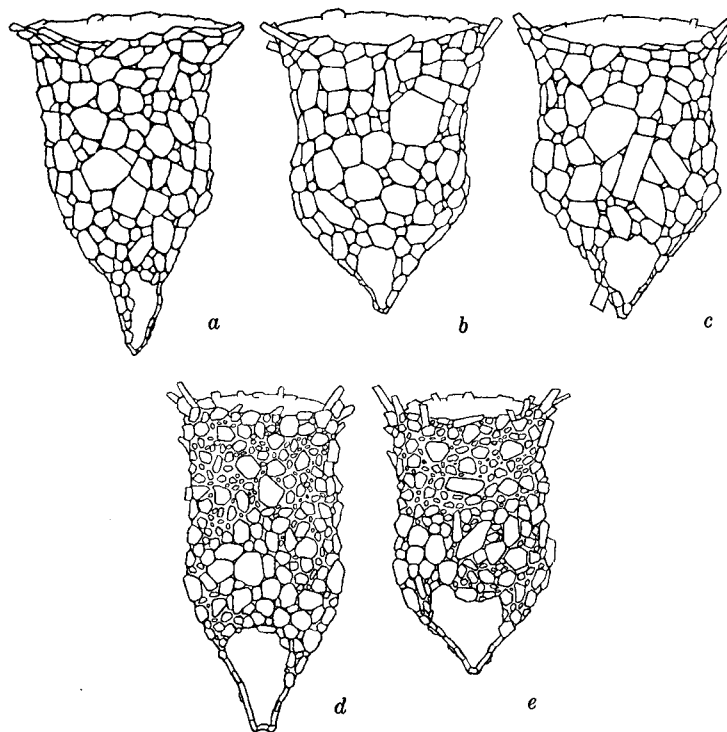


Fig. 25. *Tintinnopsis baltica* BRANDT 600×

materials, its oral diameter 1.6–2.5 of the greatest transdiameter; bowl more or less inflated in the posterior 0.4–0.6 of the lorica; aboral region conical ( $50^{\circ}$ – $80^{\circ}$ ), occasionally tapering to an inconspicuous stout aboral horn; aboral end usually bluntly pointed; aboral opening usually lying laterally, often comparatively large; wall rather coarsely agglomerated, sometimes with a few slight spiral turns in the suboral region. Length, 62 (50–80) $\mu$ ; oral diameter, 30–43  $\mu$ ; greatest transdiameter, 30–37  $\mu$ .

*Occurrence*:—Rare or very rare in Akkeshi Bay and Lake Akkeshi in May–January in water temperatures of  $-1$ – $17.3^{\circ}\text{C}$  and sometimes common in May in a water temperature of  $8$ – $10^{\circ}\text{C}$ , the latter probably being the optimum temperature for this species.

*Distribution*:—The species is known from Kiel Bay, the Baltic Sea, and the Kattegat.

*Variation*:—All the specimens in the collection have a somewhat flaring collar and an aboral opening such as has not been described in those obtained in the Baltic sea. In stouter specimens (Figs. 25 b, c, e) the funnel-shaped collar is generally short and the bowl is broader narrowing abruptly towards the aboral end, while in slender ones (Figs. 25 a, d) the collar is usually elongate showing a tendency to being tubular, and the bowl is made of a slight bulge extending into an indistinct aboral horn. The spiral structure on the collar is faintly visible in individuals (Figs. 25 d, e) whose wall is composed of comparatively fine foreign particles.

*Comparison*:—The species differs from *T. brevicollis* n. sp. in dimension and the smaller bowl opening aborally, and from *T. akkeshiensis* n. sp. in the presence of the posterior dilation.

*Remarks*:—These Japanese specimens are different from those of the Baltic Sea in the presence of an aboral opening and the lack of or a weak development of the spiral structure which is characteristic of specimens in the Baltic sea as shown in Brandt's figure in Pl. 15, fig. 6 and Pl. 16, fig. 4 (1906). They are, however, so closely related to those of the Baltic Sea in the general form of the lorica, that the writer has identified them with the species.

#### Family Codonellopsidae KOFOID & CAMPBELL, 1929

##### Genus *Stenosemella* JÖRGENSEN, 1924

Lorica minute, ovoid, consisting of low collar and an ovate bowl; collar short, hyaline, without spiral turns; bowl usually broadest in

the anterior region; aboral end acute or rounded; wall of the bowl made of a reticulated structure or covered with agglomerated particles upon the ground structure.

Type species—*Stenosemella ventricosa* (CLAPARÈDE & LACHMANN) JÖRGENSEN.

Most of species of this genus are neritic inhabitants. A single cosmopolitan species, *S. nivalis* (Meunier) Kofoid & Campbell, has been found in this collection.

## 22. *Stenosemella nivalis* (MEUNIER) KOFOID & CAMPBELL

Fig. 26

*Codonella ventricosa*: ENTZ, Sr., 1884, p. 413, pl. 24, fig. 24.

*Tintinnopsis ventricosa*: DADAY, 1887, pp. 546, 559, pl. 20, figs. 19, 20.

*Tintinnopsis nucula* (pt.): LAACKMANN, 1906, pl. 19, pl. 1, figs. 4, pl. 3, figs. 48–50; CAMPBELL, 1929, pp. 179–236, pl. 12–15, text-figs. A–G.

*Tintinnopsis nivalis*: MEUNIER, 1910, p. 143, pl. 13, figs. 26, 27.

*Stenosemella nucula*: JÖRGENSEN, 1924, p. 96, fig. 108; 1927, p. 8, fig. 7; HOFKER, 1913, p. 362, figs. 40, 41.

*Stenosemella nivalis*: KOFOID & CAMPBELL, 1929, p. 69, fig. 136; HADA, 1932c, p. 561, text-fig. 11; MARSHALL, 1934, p. 638.

*Description*:—Lorica ovate, its length 1.81–2.15 oral diameters, collar low, without windows; bowl expanding upwards to form a shoulder, its greatest transdiameter 1.75–2.00 oral diameters, conical in the lower region; aboral end bluntly pointed; wall of the bowl with coarse agglomerated materials. Length, 40 (38–43) $\mu$ ; oral diameter, 20 (20–21) $\mu$ ; greatest transdiameter of the bowl, 38 (35–40) $\mu$ .

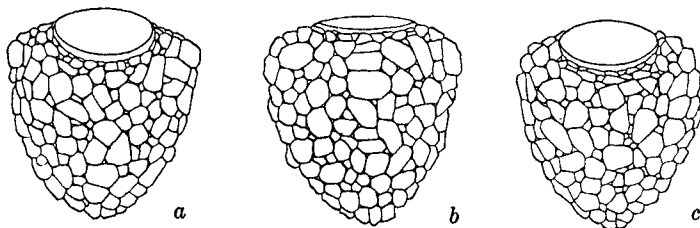


Fig. 26. *Stenosemella nivalis* (MEUNIER) 650 $\times$

*Occurrence*:—Rare in Akkeshi Bay in November with water temperatures of 7.0–9.8°C.

*Distribution*:—This species is widely distributed in cold and warm waters even in tropical seas. In Japanese waters it occurs in Mutsu Bay throughout the year.

*Variation*:—The collar in some individuals is very low and scarcely visible. The collar of specimens found in Akkeshi Bay is generally shorter than that of ones from Mutsu Bay.

*Comparison*:—The species differs from *S. ventricosa* (Claparède & Lachmann) in being smaller in size and from *S. oliva* (Meunier) in being stouter in form.

#### Genus *Codonellopsis* JÖRGENSEN, 1924

Lorica consisting of a collar and a bowl, both easily distinguished in structure; collar hyaline, annulated with spiral turns, usually elongate and cylindrical with a somewhat shouldered oral rim, sometimes having elliptical pores between annular lines; bowl globose or ellipsoidal, with or without aboral horn; cavity of the horn separated from that of the bowl by a basal wall; wall of the collar composed of a ground secreted substance, that of the bowl having agglomerated materials on the surface.

Type species—*Codonellopsis orthoceras* (HAECKEL) JÖRGENSEN.

In this genus many neritic species are included; most of them occur in warm waters. The neritic species have a roughened surface with coarse agglomerated particles, while the oceanic ones bear a smooth reticulated surface on account of the lack of terrestrial particles. In the present collection two species were found; one is neritic and the other oceanic.

#### Key to species

1. Wall of the bowl finely agglomerated; aboral end rounded... *C. frigida* HADA.
2. Wall of the bowl coarsely agglomerated; aboral end provided with a horn...  
..... *C. borealis* n. sp.

#### 23. *Codonellopsis frigida* HADA

Fig. 27

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

*Description*:—Lorica flask-shaped, 2.0–3.1 oral diameters in length; collar subcylindrical with a more or less flaring oral margin, composed of 4–6 coiled bands on which fenestrae are sometimes

present, narrowest in the suboral part, its length 0.33–0.46 of the total length; bowl spherical to ellipsoid, 1.4–1.5 oral diameters in greatest transdiameter; aboral end generally rounded and rarely conical; wall of the collar and the bowl comparatively thin, on the latter agglomerated materials scarce. Length, 60 (52–78)  $\mu$ ; oral diameter, 25 (23–28)  $\mu$ ; length of the collar, 25 (20–32)  $\mu$ ; greatest transdiameter of the bowl, 35 (34–40)  $\mu$ .

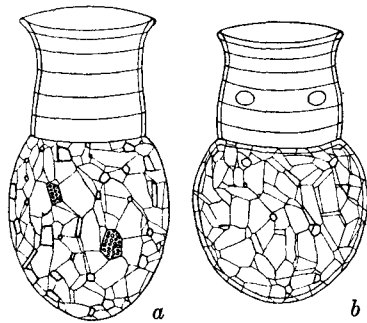


Fig. 27. *Codonellopsis frigida*  
HADA 650 $\times$

*Variation*:—A marked variation occurs in size and form of the lorica. Rotund specimens (Fig. 27b) are generally composed of a short collar and a round bowl as is figured by the present author (1932), but elongate ones (Fig. 27a) consist of a tall collar and an oblong bowl. The fenestration on the collar is generally visible in specimens found outside Akkeshi Bay. The aboral region of the bowl is usually round, but occasionally inclines to point to the distal end.

*Comparison*:—The species differs from *C. morchella* (Cleve) in dimensions and the finer structure of the wall.

*Remarks*:—This species seems to be an oceanic inhabitant in cold water currents, because it occurs more frequently off Akkeshi Bay than in the Bay and has foreign particles sparsely attached to the wall.

*Occurrence*:—A few specimens were observed in plankton captured on January 27, 1933, on May 19, 1934, and on April 19, 1935 in water temperatures of  $-0.6$ – $12.0^{\circ}\text{C}$  in Akkeshi Bay. Some were also found in the vertical collection at 100 m taken on August 2, 1936 in a surface temperature of  $13.8^{\circ}\text{C}$  off the Bay.

*Distribution*:—This species has been recorded in the Sea of Okhotsk.

#### 24. *Codonellopsis borealis* n. sp.

Fig. 28

*Description*:—Lorica consisting of a cylindrical collar and an ovate bowl with a short aboral horn, 3 oral diameters in length;

collar with a low funnel-shaped oral rim, more or less dilated in the post-median part, in length 0.36 of the total length, 7–8 spiral turns visible on it; bowl provided with a short aboral horn of 0.80–0.11 of the total length, 1.3–1.4 oral diameters in greatest transdiameter; aboral end blunt or acute; wall of the bowl rather coarsely agglomerated with minute quartz grains and pieces of diatoms and coccolithes. Length, 75–82  $\mu$ ; oral diameter, 25–27  $\mu$ ; length of the collar, 28–30  $\mu$ ; length of the bowl, 52–57  $\mu$ ; length of the aboral horn, 6–10  $\mu$ ; greatest transdiameter of the bowl, 33–38  $\mu$ .

*Occurrence*:—Only two specimens of this species were secured in collections taken in Akkeshi Bay on January 16, 1933 and on February 4, 1935 respectively in surface temperatures of  $-1.0^{\circ}\text{C}$  and  $-0.7^{\circ}\text{C}$ .

*Variation*:—One (Fig. 28b) of the two specimens has an oblong bowl with a somewhat neat surface and a short conical aboral horn, but the other (Fig. 28a) an urn-shaped bowl with a coarse surface and a stout roundly ended aboral horn.

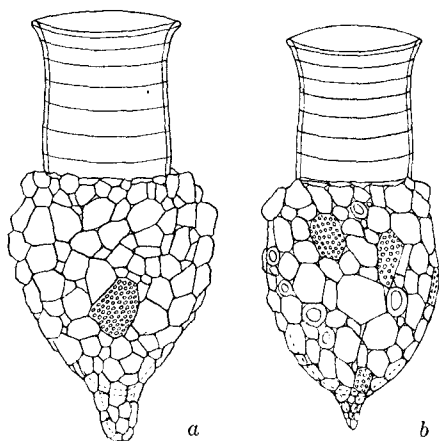


Fig. 28. *Codonellopsis borealis* n. sp. 660 $\times$

*Comparison*:—The species differs from *C. turgida* Kofoid & Campbell, *C. minor* (Brandt), *C. pura* (Brandt), and *C. parva* Kofoid & Campbell in its smaller size and the lack of a short upper cylindrical region of the bowl. Besides, this species occurs in neritic and cold waters in which the water temperature was below zero.

*Remarks*:—This species seems to be an arctic form, because it was found in sea-water in which ice-packs were drifting.

#### Family Coxiellidae KOFOID & CAMPBELL, 1929

##### Genus *Coxiella* BRANDT, 1907

Lorica elongated vase-shaped, with or without an aboral horn, with spiral annular bands; oral margin entire or irregularly uneven;

wall sometimes imperfectly reticulated, composed of an inner and an outer lamella, each usually separated.

Type species—*Coxiella laciniosa* (BRANDT) BRANDT.

The cold water form, *C. ampla* (Jørgensen) Brandt belonging to subgenus *Protocochliella* has been examined in this collection.

## 25. *Coxiella ampla* (JÖRGENSEN) BRANDT

Fig. 29

*Amphorella ampla*: JÖRGENSEN, 1899, p. 17, pl. 1, figs. 4a, b.

*Cyttarocylis?* (*Coxiella*) *ampla*: BRANDT, 1907, p. 272.

*Amphorella* sp.: MEUNIER, 1910, p. 130, pl. 11, fig. 19.

*Cyttarocylis spiralis*: MEUNIER, 1910, p. 119, pl. 9, figs. 18–20, pl. 14, fig. 5.

*Coxiella ampla*: JÖRGENSEN, 1924, p. 72, fig. 81; 1927, p. 13, fig. 21; KOFOID & CAMPBELL, 1929, p. 103, fig. 194.

*Description*:—Lorica sac-shaped, 1.25–2.35 oral diameters in length; oral margin usually entire; bowl nearly cylindrical; aboral end rounded or subacute; wall with 6–10 spiral turns, composed of slightly separated hyaline laminae, reticulated structure almost invisible. Length, 65–165  $\mu$ ; oral diameter, 52–89  $\mu$ .

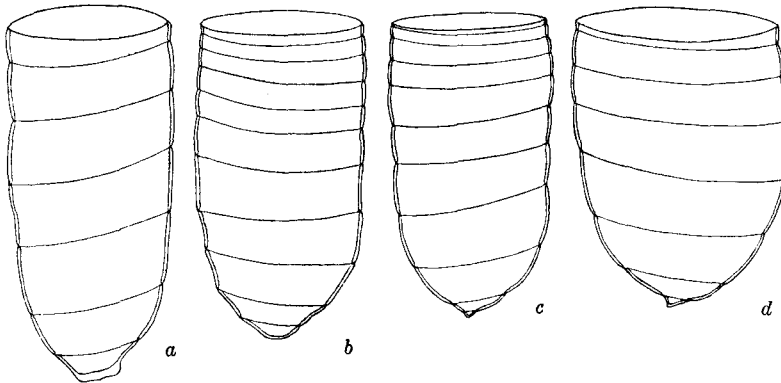


Fig. 29. *Coxiella ampla* (JÖRGENSEN) 300 $\times$

*Occurrence*:—Very rare in Akkeshi Bay in August–October in water temperatures of 10.5–18.8°C. One individual was exceptionally found in the Bay on February 29, 1936 in a surface temperature of –0.6°C.

*Distribution*:—The species is known from Bergen, Norway, Skagerrak, Kattegat, and the Barents and Kara Seas in the Arctic Ocean.

*Variation*:—The lorica of specimens in Akkeshi Bay is very variable in size and shape; some individuals are elongated and cylindrical like *Cyttarocylis spiralis* figured by Meunier (1910), but some are stout and similar to the figure given by Jörgensen (1924). Although the diameter of the oral aperture is approximately equal in most species in the Tintinnoinea, that of this species shows a considerable variation. The specimens of the North Sea and the Arctic Ocean have a rounded aboral end, but some of Akkeshi Bay bear a small subacute aboral process (Figs. 29 c, d).

*Comparison*:—The species differs from *C. annulata* (Daday) in its smaller size and the simpler wall, and from *C. pseudoannulata* (Jörgensen) in the more weakly developed reticulation and the imperfectly separated wall.

*Remarks*:—This seems to be a cold water species.

#### Genus *Helicostomella* JÖRGENSEN, 1924

Lorica elongate, tubular; oral margin with or without minute triangular teeth; bowl cylindrical in the suboral part with a number of spiral turns, inflated or gradually tapering in the posterior half; aboral region conical with an aboral horn; wall thin.

Type species—*Helicostomella subulata* (EHRENBERG) JÖRGENSEN.

The following two species were detected in summer plankton of Akkeshi Bay.

#### Key to species

1. Lorica smaller, with a slight dilated part in the posterior region. . . . .  
 . . . . . *H. fusiformis* (MEUNIER) JÖRGENSEN.
2. Lorica longer, with a cylindrical bowl. . *H. subulata* (EHRENBERG) JÖRGENSEN.

#### 26. *Helicostomella fusiformis* (MEUNIER) JÖRGENSEN

Fig. 30

*Amphorella subulata*: MEUNIER, 1910, p, 131, pl. 10, figs. 14, 15.

*Amphorella fusiformis*: MEUNIER, 1919.

*Helicostomella subulata* (pt.): JÖRGENSEN, 1924, p. 25, fig. 26a.

*Helicostomella subulata* var. *fusiformis*: JÖRGENSEN, 1927, p. 10, fig. 15.

*Helicostomella fusiformis*: KOFOID & CAMPBELL, 1929, p. 105, fig. 27; HADA, 1932b, p. 46, fig. 9.

*Description*:—Lorica fusiform, 5.0–6.5 oral diameters in length; oral margin more or less everted, with about 30 minute triangular teeth; bowl cylindrical, annulated with 5–10 spiral turns in the sub-or al region, slightly dilated and tapering to an aboral horn in the posterior half, its greatest transdiameter 1.05–1.20 oral diameters; aboral horn somewhat curved, often with some striae, its length 0.11–0.33 of the total length. Length, 113 (100–136) $\mu$ ; oral diameter, 21 (20–22) $\mu$ ; length of the aboral horn, 17 (13–45) $\mu$ .

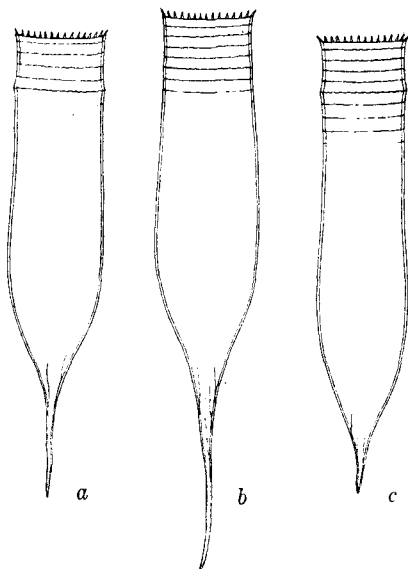


Fig. 30. *Helicostomella fusiformis*  
(MEUNIER) 550 $\times$

*Comparison*:—The species differs from *H. subulata* (Ehrenberg) in the stouter contour and the presence of a posterior slight inflation of the bowl.

*Remarks*:—The species is an inhabitant of comparatively cold waters, though it was seen in summer in Akkeshi Bay.

*Occurrence*:—Rarely found in summer plankton of Akkeshi Bay in water temperatures of 7.8–20.2°C. Many individuals were often obtained when the surface temperature of the Bay approaches to 15°C which is probably the optimum temperature for the species.

*Distribution*:—The localities of the species are the Kara, Barents, and North Seas and the eastern coast of Kamchatka.

*Variation*:—The deviation of length of the aboral horn is so remarkable that it becomes equal to total length of the lorica.

27. *Helicostomella subulata* (EHRENBERG) JÖRGENSEN

Fig. 31

*Tintinnus subulata*: CLAPARÈDE & LACHMANN, 1858, p. 205, pl. 8, fig. 15; KENT, 1882, p. 604, pl. 31, fig. 5; BRANDT, 1896, p. 52; LAACKMANN, 1906, p. 17, pl. 3, fig. 47; BRANDT (pt.), 1906, pl. 65, figs. 1-4; 1907, p. 393.

*Tintinnus Ussowi*: MERESCHKOWSKY, 1879, p. 160, pl. 10, fig. 40; KENT, 1882, p. 609, pl. 31, fig. 4.

*Amphorella subulata*: DADAY, 1887, p. 534, 536, pl. 18, fig. 7; CLEVE, 1900a, p. 18; 1902, p. 21; 1903, p. 31.

*Helicostomella subulata*: JÖRGENSEN, 1924 (pt.), p. 25, fig. 26b, 1927, p. 100, fig. 14; KOFOID & CAMPBELL, 1929, p. 107, fig. 209; HOFKER, 1931, p. 349; HADA, 1932b, p. 47, fig. 10.

**Description:**—Lorica slender, 7.0–9.8 oral diameters in length; oral rim with 24–32 flaring teeth; bowl cylindrical, wound with 5–25 spiral bands in the suboral part, tapering posteriorly to an aboral horn, its length 0.13–0.35 of the total length. Length, 180 (143–225)  $\mu$ ; oral diameter, 21 (21–23)  $\mu$ ; length of the aboral horn, 41 (20–65)  $\mu$ .

**Occurrence:**—Rare in plankton during June–November in Akkeshi Bay in water temperatures of 7.2–18.8°C.

**Distribution:**—The species was originally described from Kiel Bay by Ehrenberg (1833). It is one of common species in the North, Baltic, and Mediterranean Seas. It has been also reported from the Sea of Okhotsk.

**Variation:**—A marked variation is observed in length of the aboral horn as in *H. fusiformis*.

**Comparison:**—The species differs from *H. fusiformis* (Meunier) in the size of the lorica and the lack of an aboral bulge of the bowl.

**Remarks:**—This slender species, together with *H. fusiformis* is the commonest representative of the Tintinoinea in summer plankton of Akkeshi Bay.

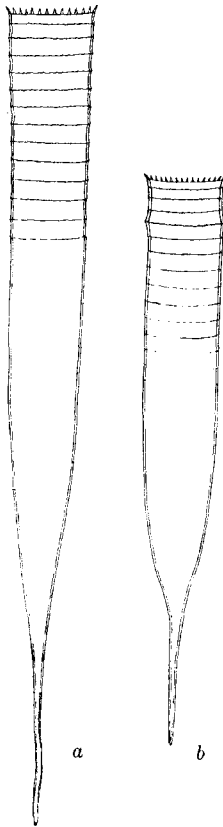


Fig. 31. *Helicostomella subulata* (EHRENBERG) 500 $\times$

## Family Cyttarocyclidae KOFOID &amp; CAMPBELL, 1929

Genus *Favella* JÖRGENSEN, 1924

Lorica bell-shaped, sometimes provided with a collar consisting of a number of spiral turns; oral rim entire or denticulate; bowl campanulate, rounded or convex conical in the aboral region; aboral horn usually present, often having wings, fins, or ridges; wall bi- or trilamellate, compact in an aboral horn, composed of a fine polygonal reticulation.

Type species—*Favella ehrenbergi* (CLAPARÈDE & LACHMANN) JÖRGENSEN.

Only two forms have been secured in this research, of which *F. taraiikaensis* Hada is found abundantly in summer plankton of Akkeshi Bay.

## Key to species

1. Lorica subcylindrical; aboral horn with fins; reticulation of the wall regular. . . . . *F. ehrenbergi* (CLAPARÈDE & LACHMANN) JÖRGENSEN var.
2. Lorica with a suboral inflation; aboral horn ornamented with longitudinal striae; reticulation of the wall rather irregular. . . . . *F. taraiikaensis* HADA.

28. *Favella ehrenbergi* (CLAPARÈDE & LACHMANN)  
JÖRGENSEN var.

Fig. 32

*Tintinnus Ehrenbergii*: CLAPARÈDE & LACHMANN, 1858, p. 203, pl. 8, figs. 6, 7.

*Favella ehrenbergii*: KOFOID & CAMPBELL, 1929, p. 152, fig. 280.

*Description*:—Lorica campanulate, 2.87–3.23 oral diameters in length; oral rim uneven; collar short, usually built with a single band; bowl subcylindrical, broadest near the middle; aboral region round; aboral horn 0.13–0.18 of the total length, provided with oblique fins, its tip blunt; wall perfectly separated except the basal part of the aboral horn, reticulation regular, comparatively coarse in appearance. Length, 256 (238–275)  $\mu$ ; oral diameter, 84 (83–85)  $\mu$ ; length of the aboral horn, 40 (30–50)  $\mu$ .

*Occurrence*:—Rare in September and more rare in October in Akkeshi Bay in water temperatures of 12.0–18.2°C.

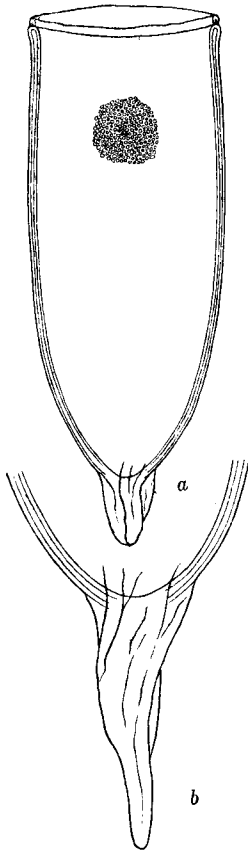


Fig. 32. *Favella ehrenbergi* (CLAPARÈDE & LACHMANN) var. a. Side view 290 $\times$ ; b. Aboral region with an aboral horn 750 $\times$

*Variation*:—The aboral horn is diverse in size and form as shown in Fig. 22.

*Comparison*:—The variety differs from *F. taraikaensis* Hada in more cylindrical bowl, the presence of fins on the aboral horn, and the regular reticulation of the wall.

*Remarks*:—*F. ehrenbergi* is the oldest and cosmopolitan species in *Favella*. There have been described many varieties and forms of the species. Kofoid & Campbell (1929) have referred to *F. ehrenbergi* many species, varieties, and formae which consist of a cylindrical bowl having an entire oral margin and a rounded aboral region, and of an aboral horn provided with lateral fins. The collar marked by spiral turns has not been regarded by them as an important character for identification, but other authors, viz., Daday (1887), Cleve (1900), Brandt (1907), Okamura (1907), Laackmann (1913), and Jörgensen (1924, 1927), have separated the collared forms from the typical ones without a collar given by Claparède & Lachmann (Pl. 8, figs. 6, 7, 1858) as a different species, *F. claparèdei*, or as a variety of this species, *F. ehrenbergi* var. *claparèdei*.

In this work it has been impossible to examine enough specimens to observe variations of this form, so they have been recorded in this paper as one of the varieties of *F. ehrenbergi*.

## 29. *Favella taraikaensis* HADA

Fig. 33

*Favella taraikaensis*: HADA, 1932b, p. 47, fig. 11.

*Description*:—Lorica elongate goblet-shaped, 2.2–3.5 oral diameters in length; oral rim without a dentation; collar more or less

flaring, made of a few spiral bands; bowl somewhat inflated below the nuchal constriction, its greatest transdiameter 1.00–1.06 oral diameters; aboral region gradually narrowing; aboral horn conical, usually elongate, 0.08–0.31 of the total length, ornamented with longi-

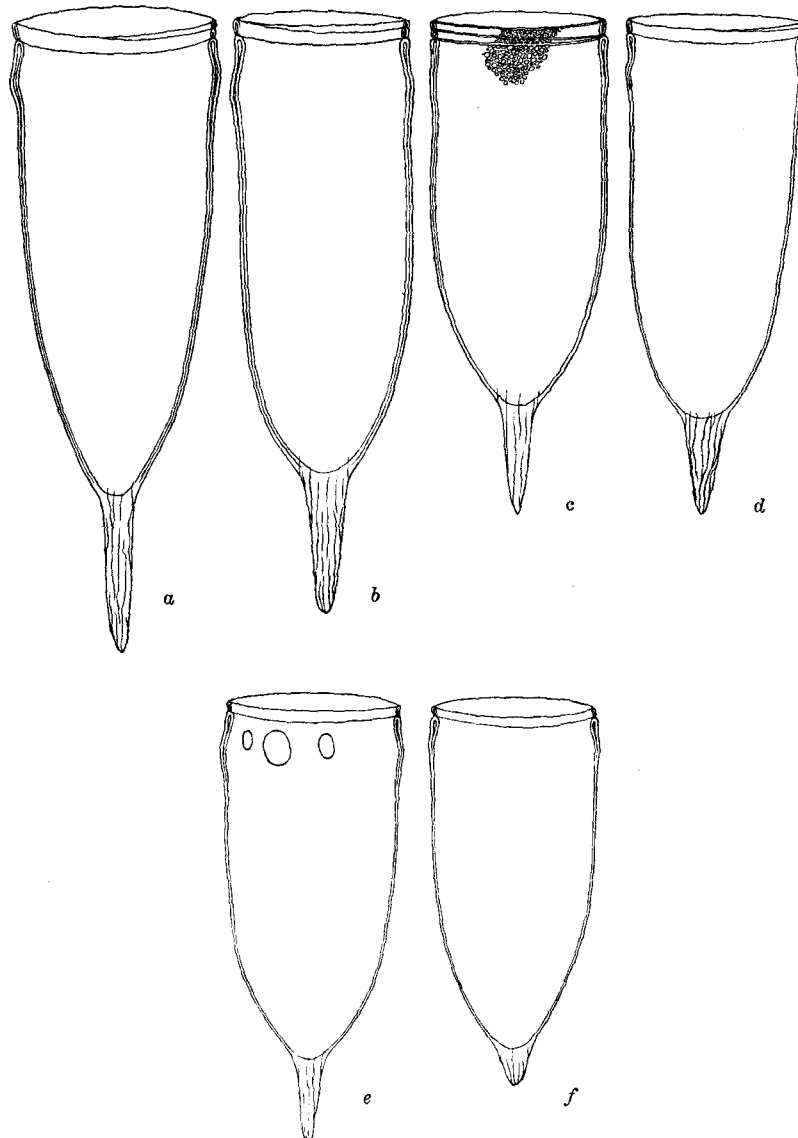


Fig. 33. *Favella taraikaensis* HADA 300×

tudinal striae on the surface, its tip bluntly pointed; wall completely separated in large specimens, but incompletely in small ones; reticulation irregular, rarely disappearing as seen in ovate fenestrae in the anterior dilated region. Length, 148–288  $\mu$ ; oral diameter, 68–90  $\mu$ ; height of the collar, 5–8  $\mu$ ; length of the aboral horn, 12–90  $\mu$ .

*Occurrence*:—The species first appears in Akkeshi Bay at the end of May or the beginning of June and disappears in November. It occurs in water temperatures above 7°C. It usually occurs abundantly during July and August, and frequently in September and October in the vicinity of Akkeshi.

*Distribution*:—The species is known from Taraika Bay in the Sea of Okhotsk.

*Variation*:—As a seasonal variation the lorica of summer specimens (260  $\mu$  in average length) are observed to be generally larger than those of autumn ones (170  $\mu$  in average length). The aboral region is variable in shape and the aboral horn in length and form. The horn (Fig. 33f) is sometimes short and stout, but has neither wings nor ridges as in other species of *Favella*. The wall is entirely separated in the bowl of larger specimens (Figs. 33 a, b), but only in the upper part of the bowl of smaller ones (Figs. 33 d–f). Some specimens from outside Akkeshi Bay have ovoid clear areas in the anterior region of the lorica as shown in Fig. 33e.

*Comparison*:—The species differs from *F. ehrenbergi* (Claparède & Lachmann) in possession of a suboral inflation and of striae on the aboral horn instead of wings, and from *F. panamensis* Kofoid & Campbell in the lack of fins on the aboral horn.

*Remarks*:—In September this species occurs in company with a variety of *F. ehrenbergi* which is rare in Akkeshi Bay, but is easily distinguishable by differences of form of the suboral region and the aboral horn, and of the structure of the wall.

#### Genus *Parafavella* KOFOID & CAMPBELL, 1929

Lorica bell- or goblet-shaped; oral margin often denticulate; aboral region usually concave conical with a short or elongate aboral horn, rarely rounded or ending in a pointed tip when an aboral horn is absent; wall trilamellate, with a regular hexagonal reticulation.

Type species—*Parafavella denticulata* (EHRENBERG) KOFOID & CAMPBELL.

Eight species comprising the type species have been examined. Members of the genus are common next to those of *Tintinnopsis*. The genus and *Ptychocylis* are cold water forms and circumboreal in distribution. Species belonging to the genus are often variable especially in length of the aboral horn and in oral dentation. Entirely edentate specimens have been observed in *P. gigantea*, *P. ventricosa*, and *P. pacifica*, and imperfectly denticulate ones in all the species here dealt with. Some specimens of *P. pacifica* were furnished with irregularly formed teeth.

#### Key to species

- A. Lorica comparatively large, with an elongate aboral horn.
  - 1. Lorica delicate; aboral region gradually tapering.....  
.....*P. denticulata* (EHRENBERG) KOFOID & CAMPBELL.
  - 2. Lorica coarse; aboral region abruptly narrowing.....  
.....*P. gigantea* (BRANDT) KOFOID & CAMPBELL.
  - 3. Lorica fragile; aboral horn rather stout.....  
.....*P. ventricosa* (JÖRGENSEN) KOFOID & CAMPBELL.
- B. Lorica comparatively small, with or without an aboral horn.
  - a. Lorica generally conical.
    - 4. Aboral region with a short, stout aboral horn.....*P. faceta* HADA.
    - 5. Aboral end pointed without an aboral horn.....*P. jørgenseni* HADA.
  - b. Lorica more or less inflated; aboral region rounded.
    - 6. Lorica tall, with slender oral teeth and a stout aboral horn.....  
.....*P. longidentata* n. sp.
    - 7. Lorica rotund, with a short, stout aboral horn.....*P. pacifica* HADA.
    - 8. Lorica cylindrical, without or with a trace of an aboral horn.....  
.....*P. subcylindrica* HADA.

### 30. *Parafavella denticulata* (EHRENBERG)

KOFOID & CAMPBELL

Figs. 34, 35

*Tintinnus denticulatus*: CLAPARÈDE & LACHMANN, 1858, p. 201, pl. 8, figs. 1, 1a; KENT, 1882, p. 607, pl. 31, figs. 18, 19.

*Cyrtarocylis denticulata*: DADAY, 1887, pp. 575, 583; BRANDT, 1896, pp. 60, 62; JÖRGENSEN (pt.), 1899, p. 31; 1901, p. 4; CLEVE, 1899, p. 21; 1900a, p. 15; 1900b, p. 18; 1902, p. 22; 1903, p. 31; BRANDT (pt.), 1907, p. 220; MERKLE, 1909, pp. 157 (pt.), 179, pl. 3, figs. 39-61.

*Cyrtarocylis denticulata* var. *α typica*: JÖRGENSEN, 1901, pp. 8, 9, 12; BRANDT (pt.), 1906, pl. 37, figs. 9, 10, 15-17; 1907, pp. 220 (pt.), 232; MERKLE, 1909, pp. 158, 168, pl. 2, fig. 27, pl. 3, figs. 31-38, 68, 72, 73; OSTENFELD (pt.), 1911, p. 292, fig. 3.

*Favella denticulata*: JÖRGENSEN, 1927, pp. 10, 11.

*Parafavella denticulata*: KOFOID & CAMPBELL, 1929, p. 163, fig. 310; HADA, 1932b, p. 50, fig. 15; 1932c, p. 564.

*Description*:—Lorica tall goblet-shaped, 3–7 oral diameters in length; oral rim denticulated with 30–42 slender teeth; bowl gradually tapering aborally to an aboral horn, its length 0.16–0.40 of the

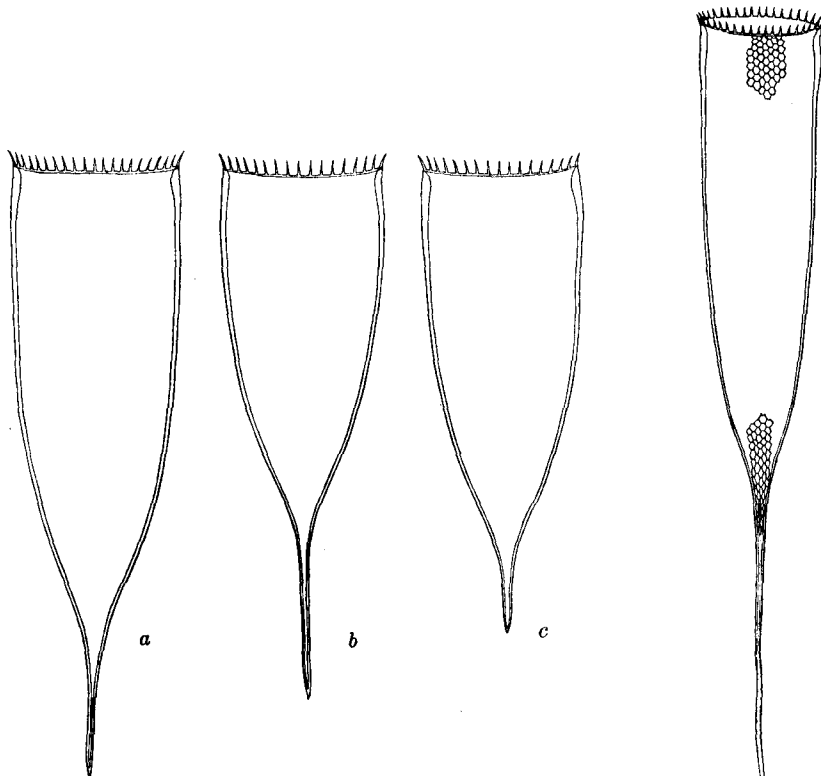


Fig. 34. *Parafavella denticulata* (EHRENBERG) 460×

Fig. 35. *Parafavella denticulata* (EHRENBERG) 300×

total length. Length, 170 (132–333)  $\mu$ ; oral diameter, 46 (45–48)  $\mu$ ; length of the aboral horn, 20–136  $\mu$ ; length of a tooth, 5–6  $\mu$ .

*Occurrence*:—Usually very rare during January–August in Akkeshi Bay, but sometimes common in May. Water temperatures

when collections were made ranged  $-0.5-16.3^{\circ}\text{C}$ , and the optimum temperature for the species is near  $8^{\circ}\text{C}$ .

*Distribution*:—The species is widely distributed in cold waters near the Arctic Ocean.

*Variation*:—The species shows a great diversity in form and dimensions, especially in length of the aboral horn. The specimen showing in Fig. 35 is the longest one examined by the writer, and provided with an extraordinary elongate horn.

*Comparison*:—The species differs from *P. gigantea* (Brandt) in the gradually narrowing aboral region and delicacy of the wall.

*Remarks*:—The species often occurs in company with *P. gigantea* allied to it. This species is easily distinguished by the slender and delicate appearance of the aboral region gradually tapering to a slender horn and by the thin and colourless wall of fine reticulation from the latter, which is apparently rigid in the rapidly narrowed aboral region and in the thick and brownish coloured wall of a coarse reticulation.

### 31. *Parafavella gigantea* (BRANDT) KOFOID & CAMPBELL

Fig. 36

*Cyttarocyclus gigantea*: BRANDT, 1896, p. 63, pl. 3, figs. 21, 24; MEUNIER, 1910, p. 109, pl. 8, figs. 1? 2-7.

*Cyttarocyclus denticulata* var.  $\delta$  *gigantea*: JÖRGENSEN, 1899, p. 35, pl. 3, figs. 26-28.

*Cyttarocyclus denticulata* var. *gigantea*: CLEVE, 1899, p. 21; JÖRGENSEN, 1901, pp. 9, 14, pl. 2, fig. 21; BRANDT, 1906, pl. 38, figs. 2, 3, 8, 8a, 9; 1907, p. 233; OSTENFELD, 1911, p. 294, fig. 4.

*Cyttarocyclus denticulata* var. *elongata*: JÖRGENSEN, 1901, pp. 8, 14, pl. 3, figs. 23, 24.

*Cyttarocyclus cuspidata*: MEUNIER (pt.), 1919, p. 113, pl. 10, figs. 8, 9.

*Parafavella gigantea*: KOFOID & CAMPBELL, 1929, p. 155, fig. 311; HADA, 1932b, p. 51; 1932c, p. 565.

*Parafavella brandti*: HADA, 1932b, p. 52, fig. 17.

*Description*:—Lorica elongate goblet-shaped, 3.9-8.8 oral diameters in length; oral rim denticulated with 45-55 stout teeth; bowl slightly constricted above the middle, narrowing abruptly towards the aboral horn; aboral horn usually straight, 0.25-0.33 of the total length. Length, 350 (224-528) $\mu$ ; oral diameter, 64 (58-68) $\mu$ ; length of the aboral horn, 95 (65-176) $\mu$ .

*Occurrence*:—The species appears in small numbers, but especially in autumn, through the year in Akkeshi Bay.

*Distribution*:—The species was first recorded from the Karajak Fjord, Greenland by Brandt (1896). Distribution is almost the same as that of *P. denticulata*.

*Variation*:—The length of the lorica is exceedingly variable as shown in Fig. 36. The oral denticulation is not a constant character of this species as in other species of *Parafavella*, because there are some specimens which are partly denticulate or perfectly edentate as in the figures given by Brandt (Pl. 3, fig. 23, 1896; Pl. 38, fig. 2, 1906), Meunier (Pl. 8, figs. 3, 5, 1910), and Hada (Fig. 17, 1932, described as *P. brandti*).

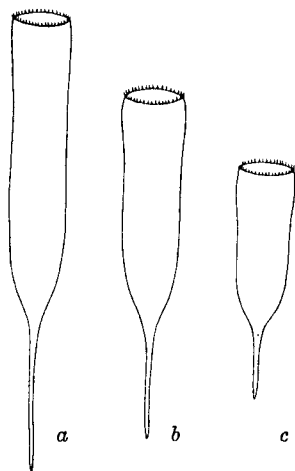


Fig. 36. *Parafavella gigantea* (BRANDT) 120×

*Comparison*:—The present species differs from *P. denticulata* (Ehrenberg) in coarser appearance and the abruptly narrowing aboral region.

*Remarks*:—*P. brandti* described by the writer from the Sea of Okhotsk seems to be an edentate form of this species.

### 32. *Parafavella ventricosa* (JÖRGENSEN) KOFOID & CAMPBELL

Fig. 37, 38

*Cyttarocyllis denticulata* var.  $\beta$  *cylindrica* forma *ventricosa*: JÖRGENSEN, 1899, p. 34, pl. 3, fig. 30.

*Parafavella ventricosa*: KOFOID & CAMPBELL, 1929, p. 171, fig. 314; HADA, 1932c, p. 566, fig. 18.

*Description*:—Lorica shaped like an elongate gourd, 5.0–8.5 oral diameters in length; oral rim usually denticulate with 36–50 minute triangular teeth which occasionally are partly or entirely absent; bowl constricted near the middle; aboral region convex conical (40°–60°), gradually terminating to a stout horn; aboral horn conical (10°–15°), its length 0.10–0.23 of the total length. Length, 385 (272–544) $\mu$ ; oral diameter, 60 (55–65) $\mu$ ; length of the aboral horn, 64 (27–104) $\mu$ .

*Occurrence*:—Very rare in July–September and December–February in Akkeshi Bay, but rather common outside the Bay. Water temperatures at the time of collections were  $-1.2-18.8^{\circ}\text{C}$ .

*Distribution*:—The species is reported from the Norwegian Coasts and Mutsu Bay, Japan.

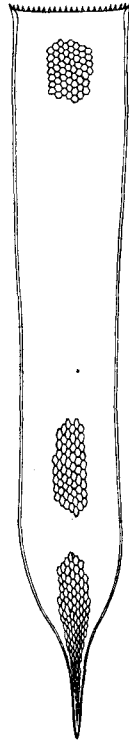


Fig. 37. *Parafavella ventricosa* (JÖRGENSEN) 250×

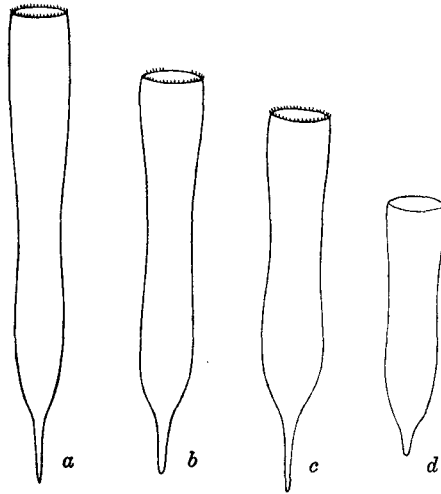


Fig. 38. *Parafavella ventricosa* (JÖRGENSEN) 120×

*Variation*:—The length of the lorica is considerably variable, the largest individuals are twice as long as the smallest. The oral teeth are not always present, because a few specimens lack partially or entirely an oral dentation.

*Comparison*:—The species differs from *P. gigantea* (Brandt) and *P. cylindrica* (Jörgensen) in having a distinct median constriction.

*Remarks*:—The species is the longest among the Tintinnoinea found in Akkeshi Bay. Curiously enough it appears only in the seasons of high and low water temperatures, and not in the intermediate ones.

33. *Parafavella faceta* HADA

Fig. 39

*Parafavella faceta*: HADA, 1932c, p. 565, text-fig. 17.

**Description:**—Lorica elongate bell-shaped, 2.3–3.0 oral diameters in length; oral margin denticulate with numerous teeth (46–50); bowl gradually narrowing distally; aboral region convex conical (65°–70°) with a conical aboral horn of 0.07–0.15 of the total length. Length, 110–138  $\mu$ ; oral diameter, 45–48  $\mu$ ; length of the aboral horn, 7–21  $\mu$ .

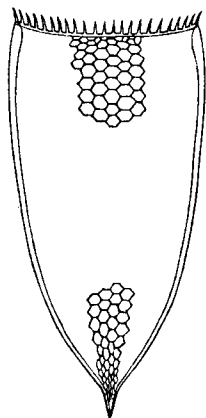


Fig. 39. *Parafavella faceta* HADA 500 $\times$

**Occurrence:**—Very rare in Akkeshi Bay in January in surface temperatures of  $-1-1^{\circ}\text{C}$ .

**Distribution:**—The species was first found in Mutsu Bay, Japan.

**Variation:**—Specimens from Akkeshi Bay are generally smaller than those from Mutsu Bay.

**Comparison:**—The species differs from *P. denticulata* (Ehrenberg), *P. parumdentata* (Brandt), and *P. obtunsangula* (Ostenfeld) in the abruptly narrowed aboral region.

**Remarks:**—This species is probably one of the cold water forms, because it appears in January when the water temperature is the lowest.

34. *Parafavella jørgenseni* HADA

Fig. 40

*Cyttarocyclus denticulata* var. *calycina* forma *acuta*: JØRGENSEN (pt.), 1901, pp. 7, 10, pl. 1, fig. 5.

*Cyttarocyclus edentata* var. *parumdentata*: BRANDT (pt.), 1906, pl. 37, fig. 6; 1907, p. 230.

*Cyttarocyclus hemifusus*: MEUNIER (pt.), 1910, p. 117, pl. 8, fig. 19.

*Parafavella acuta*: KOFOID & CAMPBELL (pt.), 1929, p. 158.

*Parafavella jørgenseni*: HADA, 1932b, p. 48, fig. 12.

**Description:**—Lorica tall chalice-shaped, 1.8–2.4 oral diameters in length; oral margin dentate with about 50 minute teeth; bowl broadest in the suboral region, then gradually convex conical (40°–55° at the aboral region) to a pointed terminal. Length, 95 (80–110)  $\mu$ ; oral diameter, 45 (40–46)  $\mu$ .

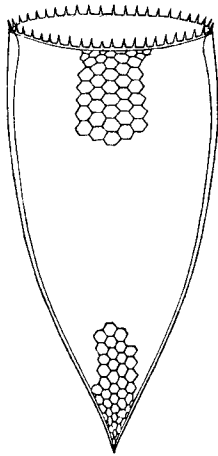


Fig. 40. *Parafavella jørgenseni* HADA 600 $\times$

lorica, and is probably to be considered an aberrant form of the latter.

*Occurrence*:—Very rare in winter in Akkeshi Bay in water temperatures of  $-1.1$ – $1.1^{\circ}\text{C}$  and also in a vertical haul collected on September 22, 1932 off the Bay in a surface temperature of  $13.5^{\circ}\text{C}$ .

*Distribution*:—The species is recorded from the North Sea, the Novaya Zemlya Region, the Labrador Current, and off the east and west coasts of Kamchatka.

*Variation*:—Specimens from Akkeshi Bay have more oral teeth than those of the vicinity of Kamchatka.

*Comparison*:—The species differs from *P. acuta* (Jørgensen) in being stouter and conical.

*Remarks*:—The species closely resembles *P. acuta*, but is different only in the low

### 35. *Parafavella longidentata* n. sp.

Fig. 41

*Description*:—Lorica tall goblet-shaped, 2.6–3.9 oral diameters in length; oral rim denticulated with 22–26 slender teeth; bowl broadest at the middle or a little below it, its greatest transdiameter 1.1 oral diameter; aboral region roundly conical ( $90^{\circ}$ – $115^{\circ}$ ) with a short horn 0.08–0.12 of the total length; reticulation comparatively coarse. Length, 147 (110–162) $\mu$ ; oral diameter, 43 (42–45) $\mu$ ; length of the aboral horn, 13 (8–20) $\mu$ ; length of a tooth, 8 $\mu$ .

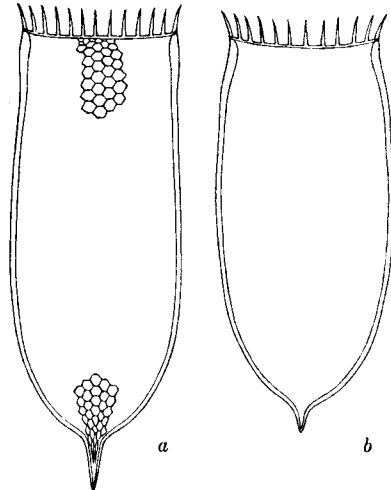


Fig. 41. *Parafavella longidentata* n. sp. 450 $\times$

*Occurrence*:—Small numbers of this species were found in the material taken on September 19, 1932 in Akkeshi Bay and only a few in a vertical collection off the Bay on the 22nd of the same month. When the collections were made, the surface temperature was near 13°C.

*Variation*:—Conspicuous variation is seen in length of the aboral horn. The general contour of the lorica is also somewhat variable: some specimens (Fig. 41a) are slender and tubular, but some (Fig. 41b) are rotund.

*Comparison*:—The species differs from most species in *Parafavella* in having elongate and slender teeth.

*Remarks*:—The long teeth are characteristic of the new species. This species often associates with *P. pacifica* which is allied to it in general respects, but differs in the above mentioned characters.

### 36. *Parafavella pacifica* HADA

Fig. 42

*Parafavella pacifica*: HADA, 1932b, p. 49, fig. 13; 1932c, p. 565.

*Description*:—Lorica dilated bell-shaped, 2.2–2.7 oral diameters in length; oral rim denticulated with comparatively fewer teeth (26–32); bowl broadest near the middle, its greatest transdiameter 1.11–1.26 oral diameters; aboral region abruptly narrowing (95°–115°); aboral horn forming a low cone of 20°–55°, its length 0.05–0.12 of the total length. Length, 92 (88–113) $\mu$ ; oral diameter, 43 (40–46) $\mu$ ; length of the aboral horn, 8 (5–13) $\mu$ .

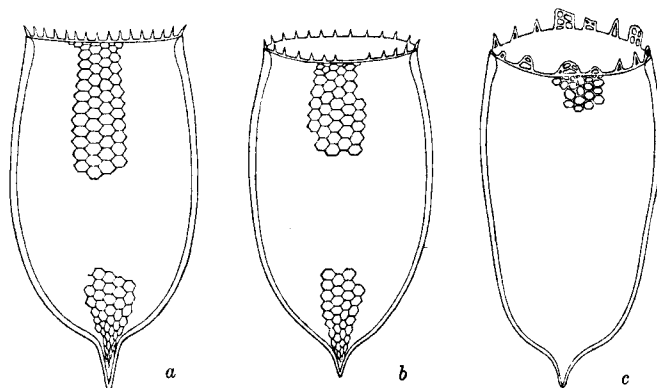


Fig. 42. *Parafavella pacifica* HADA 460 $\times$

*Occurrence*:—Rare in a vertical collection obtained from outside Akkeshi Bay on September 22, 1932 in a surface temperature of 14.2°C and very rare in plankton of the Bay on January 27, 1933 in a surface temperature of -0.5°C.

*Distribution*:—The species is known from the south part of the Sea of Okhotsk and from Mutsu Bay in summer.

*Variation*:—The teeth are rather widely variable in shape; some of wide ill-formed triangle and some of irregular rectangle form as shown in Fig. 43c. Sometimes teeth are partially deficient.

*Comparison*:—The species differs from *P. parumdentata* (Brandt) in having the aboral region abruptly narrowed, and from *P. subrotundata* (Jørgensen) in having a stouter and round contour.

*Remarks*:—Specimens collected from the vicinity of Akkeshi Bay are shorter in general than those of Mutsu Bay. Moreover, this species occurs in Akkeshi Bay even in winter, but only in summer in Mutsu Bay.

### 37. *Parafavella subcylindrica* HADA

Fig. 43

*Parafavella subcylindrica*: HADA, 1932b, p. 54, fig. 20.

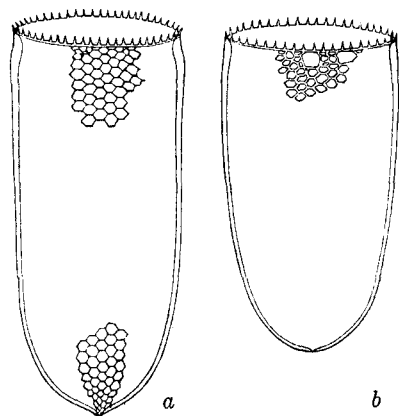


Fig. 43. *Parafavella subcylindrica*  
HADA 500×

*Description*:—Lorica sac-shaped, 1.9–2.6 oral diameters in length; oral rim denticulate with numerous small teeth (about 50); bowl slightly inflated in the suboral region; aboral region rounded, with or without a small elevation which is a rudimental aboral horn. Length, 82–108  $\mu$ ; oral diameter, 42  $\mu$ .

*Occurrence*:—Very rare in plankton of January in Akkeshi Bay in a water temperature below 0°C.

*Distribution*:—The species was first described by the present author from the south of Kamchatka.

*Variation*.:—Some specimens (Fig. 43b) have a round aboral end without aboral horn as given in the original figure, but others show a slight development of an aboral horn (Fig. 43a).

*Comparison*.:—The species differs from *P. rotundata* (Jørgensen) in having a stouter contour, and from *P. subrotundata* (Jørgensen) in the smaller size and development of the aboral horn.

*Remarks*.:—Specimens exhibiting a slight elevation at the aboral end are similar to *P. subrotundata*, but smaller and stouter than the latter.

### Family Ptychocylidae KOFOID & CAMPBELL, 1929

#### Genus *Ptychocylis* BRANDT, 1896

Lorica bell-shaped with two suboral expansions; oral rim usually denticulate with numerous minute triangular teeth; aboral region with or without an aboral cone or horn; aboral end rounded or acute; wall composed of incompletely separated lamellae, generally thickened at the suboral bulge and the aboral end; surface usually ornamented with a fine polygonal reticulation.

Type species—*Ptychocylis urnula* (CLAPARÈDE & LACHMANN) BRANDT.

The species belonging to this genus are found in cold waters. Therefore, they may be utilized as an indicator for plankton of cold waters. Five species have been secured. It is difficult to separate them from one another, because some of them fairly closely resemble each other.

#### Key to species

- A. Wall thick, with separated lamellae.
  - 1. Lorica tall (over 100  $\mu$ ), with a distinct aboral cone...*P. obtusa* BRANDT.
  - 2. Lorica stout (below 77  $\mu$ ), with an insignificant aboral cone.....*P. drygalskii* BRANDT.
- B. Wall thin, with scarcely separated lamellae.
  - a. Aboral cone absent.
    - 3. Aboral end rounded.....*P. arctica* BRANDT.
  - b. Aboral cone present.
    - 4. Lorica stout; aboral cone low.....*P. humilis* n. sp.
    - 5. Lorica rather slender; aboral cone tall.....*P. acuta* BRANDT.

38. *Ptychocylis obtusa* BRANDT

Fig. 44

*Ptychocylis obtusa*: BRANDT, 1896, p. 56, pl. 3, fig. 15; CLEVE (pt.), 1899, p. 23; BRANDT, 1906, pl. 57, fig. 8; 1907, p. 311; OSTENFELD (pt.), 1911, p. 296, fig. 6; KOFOID & CAMPBELL, 1929, p. 188, fig. 349; HADA, 1932b, p. 55, fig. 2; 1932c, p. 567.

*Ptychocylis urnula* var. *obtusa*: JÖRGENSEN, 1901, p. 18, pl. 3, fig. 32.

*Ptychocylis obtusa* var. *drygalskyi*: BRANDT (pt.), 1906, pl. 56, fig. 4; 1907, p. 126.

*Ptychocylis drygalskii*: MEUNIER (pt.), pl. 8, figs. 26, 29–31; pl. 9, figs. 9, 14.

*Ptychocylis media*: MEUNIER, 1910, pl. 9, fig. 1, pl. 10, fig. 4.

*Ptychocylis duplicata*: MEUNIER, 1910, pl. 10, figs. 2?, 5.

*Description*:—Lorica goblet-shaped, 1.55–1.75 oral diameters in length, oral margin minutely dentate; two suboral elevated bands nearly equal in diameter, its transdiameter 1.15–1.25 oral diameters; aboral region convex conical ( $95^{\circ}$ – $120^{\circ}$ ) with a marked aboral cone of which length 0.1–0.2 of the total length; wall thickened. Length, 105 (100–125) $\mu$ ; oral diameter, 65 (60–67) $\mu$ .

*Occurrence*:—Rare in Akkeshi Bay during March–August in surface temperatures of 1.5–17.3°C.

*Distribution*:—Localities of the species are the Davis Strait, the Labrador Current, the Kara and Barents Seas, Spitzbergen, the Norwegian Coasts, the Okhotsk Sea, and Mutsu Bay.

*Variation*:—An individual variation is seen in shape and height of the aboral cone which is narrow and tall in some specimens, but wide and low in others.

*Comparison*:—The species differs from *P. drygalskii* Brandt in its greater length and having the differentiated aboral cone, and from *P. acuta* Brandt in the stouter form, the rounded aboral region, and the broad aboral cone.

*Remarks*:—This species appears commonly with *P. drygalskii* in cold waters of the northern part of Japanese waters. This may be used as an indicator of cold currents.

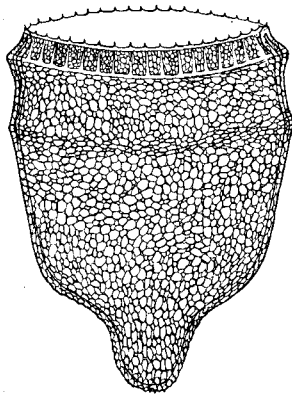


Fig. 44. *Ptychocylis obtusa*  
BRANDT 450 $\times$

39. *Ptychocylis drygalskii* BRANDT

Fig. 45

*Ptychocylis Drygalskii*: BRANDT, 1896, p. 59, fig. 14; MEUNIER (pt.), 1910, pl. 8, fig. 23, pl. 9, figs. 10, 12; KOFOID & CAMPBELL (pt.), 1929, p. 188; HADA, 1932c, p. 567, text-fig. 19.

*Ptychocylis obtusa* (pt.): CLEVE, 1899, p. 23; OSTENFELD, 1911, p. 296, fig. 6.

*Ptychocylis obtusa* var. *drygalskyi*: BRANDT (pt.), 1906, pl. 56, figs. 3, 3a, pl. 57, fig. 10; 1907, p. 312.

*Ptychocylis glacialis*: MEUNIER (pt.), 1910, pl. 8, fig. 27, pl. 9, fig. 16.

*Ptychocylis ventricosa*: MEUNIER, 1910, pl. 10, fig. 3.

*Description*:—Lorica stout, 1.4–1.5 oral diameters in length; oral rim more or less constricted with a minute dentation; anterior expansions 1.1–1.2 oral diameters in diameter, equal or scarcely larger than

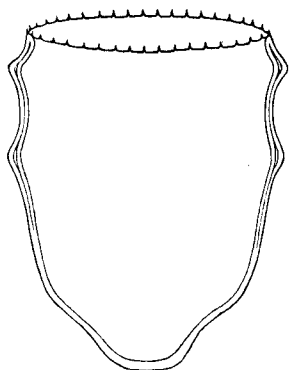


Fig. 45. *Ptychocylis drygalskii* BRANDT 600 $\times$

the posterior, each situated along the suboral 0.07 and 0.35 of the lorica; bowl somewhat constricted ( $15^{\circ}$ – $35^{\circ}$ ) below the promedian bulge; aboral region abruptly conical, gradually terminating to a low aboral cone; aboral end broadly rounded; wall thickened. Length, 72 (65–77) $\mu$ ; oral diameter, 50 (48–52) $\mu$ ; diameter of the anterior expansion, 60 (56–61) $\mu$ .

*Occurrence*:—In Akkeshi Bay a few specimens of the species are generally found in winter in surface temperatures of  $-1.4$ – $1.3^{\circ}\text{C}$ . Off the Bay several specimens were detected in vertical hauls

obtained on September 22, 1932 in a surface temperature of  $14.5^{\circ}\text{C}$  and on August 2, 1936 in a surface temperature of  $13.8^{\circ}\text{C}$ .

*Distribution*:—The species was reported from the Karajak Fjord in Greenland, the Davis Strait, the Kara, Barents, and Greenland Seas, the Labrador Current, and Mutsu Bay.

*Variation*:—The size of the lorica and the form of the aboral region are slightly variable.

*Comparison*:—The species differs from *P. obtusa* Brandt in dimension and proportion besides the shape of the posterior half of the lorica.

*Remarks*:—It is very difficult to distinguish this species from *P. obtusa* on account of close resemblances in general contour and thickness of the wall. They can be separated, however, by size of the lorica, proportion, and form of the aboral cone. In specimens from Akkeshi Bay the lorica of this species is not over  $77\ \mu$  long, while that of *P. obtusa* is over  $100\ \mu$ , and the ratio between the length of lorica and the oral diameter is 1.5:1.0 in the largest individual of the former, but 1.55:1.00 in the smallest one of the latter.

This species seems to be rather rare in neritic waters, but frequent among oceanic plankton.

#### 40. *Ptychocylis arctica* BRANDT

Fig. 46

*Ptychocylis arctica*: BRANDT, 1896, p. 60, pl. 3, fig. 17; 1906, (pt.), pl. 56, fig. 5, pl. 57, fig. 11; 1907 (pt.), p. 312; KOFOID & CHAMPBELL, 1929, p. 187, fig. 351.

*Description*:—Lorica tall sac-shaped, 1.5 oral diameter in length, having two elevated bands, anterior and posterior respectively existing around the upper 0.07 and 0.27 of the total length; aboral region nearly hemispherical; aboral end more or less flattened without an aboral cone; wall thin. Length,  $87\ \mu$ ; oral diameter,  $58\ \mu$ .

*Occurrence*:—Very rare in Akkeshi Bay; only one specimen was found in a vertical collection of May 19, 1934 in water temperatures varying from  $4.0^{\circ}\text{C}$  to  $12.5^{\circ}\text{C}$  according to depth.

*Distribution*:—The species is known from the Davis Strait and the coasts of Norway.

Fig. 46. *Ptychocylis arctica*  
BRANDT 500 $\times$

*Comparison*:—The species differs from *P. basicurvata* Meunier in the flat aboral end. *P. basicurvata* has a lorica nearly straight on the sides and hemispherical in the aboral region.

*Remarks*:—This is the first report of the present species from the Pacific. The individual obtained in Akkeshi Bay is smaller than Brandt's specimens in the collections from the Davis Strait and off

Holstensborg, Greenland. It is probable that this species is a member of the arctic plankton and widely distributed in the cold area surrounding the Arctic Ocean, although only a few records have hitherto been published.

#### 41. *Ptychocylis humilis* n. sp.

Fig. 47

*Ptychocylis obtusa* var. *drygalskyi*: BRANDT (pt.), 1906, pl. 55, figs. 1, 2; 1907, p. 312.

*Ptychocylis urnula* var. *pelagica*: WAILES, 1929, pl. 3, figs. 11, 12.

*Ptychocylis drygalskii*: KOFOID & CHAMPBELL (pt.), 1929, p. 188, fig. 350.

*Distribution*:—Lorica low bell-shaped with two suboral bulges, its length 1.07–1.15 oral diameters; oral margin erect, denticulated with numerous triangular teeth; first and second bulges located respectively in the anterior 0.1 and 0.3 of the total length, former usually a little

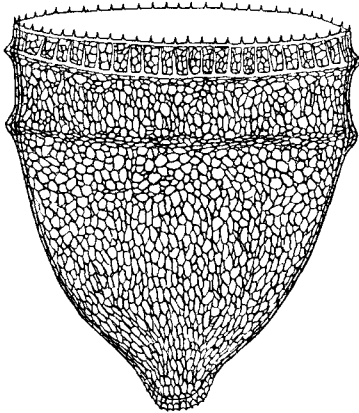


Fig. 47. *Ptychocylis humilis*  
n. sp. 500×

wider in diameter than the latter, its diameter 1.05 oral diameter; bowl conical ( $32^{\circ}$ – $37^{\circ}$ ) in the middle; aboral region broadly conical ( $82^{\circ}$ – $90^{\circ}$ ), provided with a low aboral cone, its height 0.1 of the total length; wall thin, scarcely separated in the widened portions, reticulation of the surface most marked in the aboral end. Length, 82–105  $\mu$ ; oral diameter, 76–91  $\mu$ .

*Occurrence*:—Very rare in a 10 m vertical collection off the Marine Biological Station, made on July 16, 1933 in a surface temperature of  $14.5^{\circ}\text{C}$ .

*Distribution*:—The species was first reported from the western area of Spitzbergen and afterwards off the Norwegian Coast and the Strait of Georgia, Canada.

*Variation*:—Specimens figured by Brandt (1906) in Pl. 55, figs. 1, 2 from the former two localities above mentioned, have an aboral region somewhat concave and an aboral cone imperfectly developed, but specimens from Akkeshi Bay have a convex aboral region and a distinct cone.

*Comparison*:—The species differs from *P. drygalskii* Brandt in the larger size, the thin wall, and the erect oral rim.

*Remarks*:—Among specimens of Akkeshi Bay and Brandt's (1906) materials, there can be found two different forms; viz., one is comparatively large and thin in wall and has a wide aperture, but the other is generally of a small size and has a thick wall which is one of the important characters of *P. drygalskii* according to Brandt (1896). The writer is of the opinion that the thin-walled specimens might be separated as a new independent species (*P. humilis*) from the typical thick-walled ones (*P. drygalskii*).

#### 42. *Ptychocyclus acuta* BRANDT

Fig. 48

*Ptychocyclus acuta*: BRANDT, 1896, p. 59, pl. 3, figs. 13, 16; CLEVE, 1899, p. 23; 1902, p. 22; KOFOID & CAMPBELL, 1929, p. 187, fig. 353.

*Ptychocyclus urnula* var. b: BRANDT, 1906, pl. 56, figs. 1, 2, 6, 6a, pl. 57, fig. 7.

*Ptychocyclus urnula* var. *acuta*: BRANDT, 1907, p. 309.

*Ptychocyclus elongata*: MEUNIER, 1910, p. 122, pl. 8, fig. 24.

*Description*:—Lorica elongate bell-shaped, its length 2.1 oral diameter; oral rim denticulated with numerous teeth (over 40); first suboral bulge 1.07–1.13 oral diameters in transdiameter, usually a

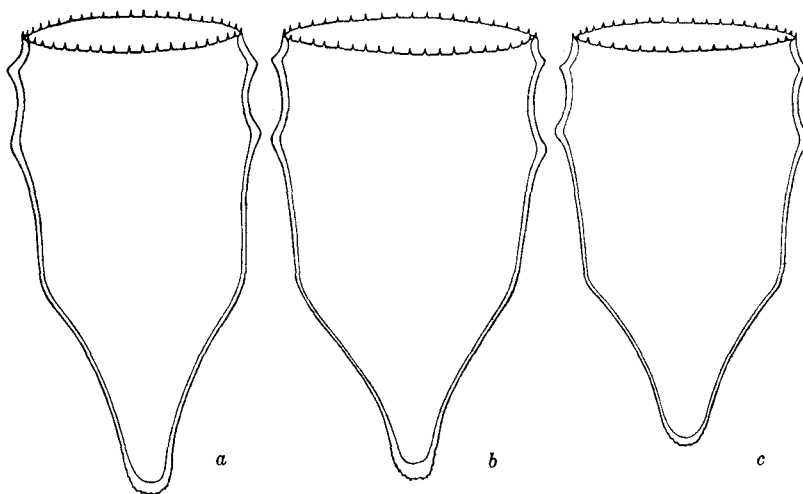


Fig. 48. *Ptychocyclus acuta* BRANDT 500×

little smaller than but rarely equal to the second in diameter; bowl below the posterior expansion slightly narrowing ( $13^{\circ}$ – $23^{\circ}$ ); aboral region tapering ( $57^{\circ}$ – $75^{\circ}$ ) gradually into an aboral cone with a blunt apical tip, occasionally concave conical; wall thin, thickened at the aboral end, where reticulation is coarser. Length, 115 (100–134)  $\mu$ ; oral diameter, 61 (58–68  $\mu$ ); diameter of the anterior expansion, 68 (64–78)  $\mu$ .

*Occurrence*:—Rare in spring and summer in Akkeshi Bay in water temperatures of 1.0–17.3°C.

*Distribution*:—The species is known from the Davis Strait, the Karajak Fjord, the Kara and Barents Seas, and the coasts of Norway.

*Variation*:—Dimensions of the lorica of specimens from Akkeshi Bay are smaller on the average as compared with those of the Davis Straits which are 120–145  $\mu$  long and 75–82  $\mu$  broad. The length of the lorica is generally variable in proportion to the aboral cone which is variable in form. A specimen provided with an apical spine at the aboral end was exceptionally observed in the collection taken on May 19, 1934.

*Comparison*:—The species differs from *P. obtusa* Brandt in its slender contour, the thinner wall, and the conical posterior region of the bowl.

*Remarks*:—Distributed in the subarctic region as above mentioned, this species is a typical inhabitant of cold waters and a useful indicator of the cold currents. By the occurrence of this species in summer in Akkeshi Bay it is shown that the Oyashiwo having its source in the Arctic Ocean and the Bering Sea enters the Bay in summer.

This species is distinguishable from *P. obtusa* in angular appearance, the shape of the aboral region, the thin wall, and a respect that the diameter of the posterior expansion is generally greater than that of the anterior.

#### Family Petalotrichidae KOFOID & CAMPBELL, 1929

##### Genus *Acanthostomella* JÖRGESEN, 1927

Lorica small, stout goblet-shaped; inner and outer collars developed to form a shallow trough between them, former erect and entire, latter flaring outwards and denticulated with a number of

minute triangular teeth; aboral end rounded, pointed, or having a short spine; wall hyaline, fine prismatic structure sometimes visible.

Type species—*Acanthostomella norvegica* (DADAY) JÖRGENSEN.

In this paper the type species is only barely reported.

### 43. *Acanthostomella norvegica* (DADAY) JÖRGENSEN

Fig. 49

*Tintinnus* sp.: CLAPARÈDE & LACHMANN, 1858, p. 210, pl. 8, fig. 16; KENT, 1882, pl. 31, fig. 17.

*Amphorella norvegica*: DADAY, 1887, p. 543; CLEVE, 1902, p. 21; MEUNIER (pt.), 1910, p. 131, pl. 10, figs. 20–26.

*Tintinnus norvegicus*: BRANDT, 1896, p. 54; 1907, p. 405; MERKLE, 1909, p. 164, pl. 2, fig. 15.

*Cyttarocyclus norvegica* var. *minuta*: JÖRGENSEN, 1901, p. 15, pl. 2, fig. 27.

*Tintinnus norvegicus* var. *b minutus*: BRANDT, 1906, p. 30, pl. 62, fig. 6.

*Acanthostomella norvegica*: JÖRGENSEN, 1927, p. 13, fig. 23; KOFOID & CAMPBELL, 1929, p. 193, fig. 363; HADA, 1932b, p. 56, fig. 22; HADA, 1932c, p. 567, text-fig. 20.

*Description*:—Lorica cup-like, 1.5 oral diameter in length; inner collar a little higher than the outer spreading outwardly and having a diameter of 1.1–1.2 oral diameters; bowl slightly inflated in the post-median portion; aboral region rounded, but tapering into a short aboral spine. Length, 36–38  $\mu$ ; oral diameter, 23–24  $\mu$ .

*Occurrence*:—Very rare in plankton collected from outside Akkeshi Bay on September 22, 1932.

*Distribution*:—The species is widely distributed in cold waters of the Atlantic and Pacific.

*Variation*:—Specimens in this collection are smaller in size than those of the Atlantic (Brandt, 1907: length, 40–50  $\mu$ ) and Mutsu Bay (Hada, 1932: length, 43–47  $\mu$ ).

*Comparison*:—The species differs from *A. gracilis* (Brandt) in a slight posterior inflation.

*Remarks*:—It is the oldest species of *Acanthostomella* distributed in cold waters.

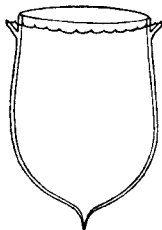


Fig. 49. *Acanthostomella norvegica* (DADAY) 730 $\times$

## Family Rhabdonellidae KOFOID &amp; CAMPBELL, 1929

Genus *Protorhabdonella* JÖRGENSEN, 1924

Lorica small, elongate or stout goblet-shaped; oral rim circular, sometimes with a fairly developed oral groove; bowl usually conical, tapering into an aboral horn in some species; wall single-layered, hyaline, a number of ribs running longitudinally or somewhat spirally on the surface.

Type species—*Protorhabdonella simplex* (CLEVE) JÖRGENSEN.

Only a minute species, *P. curta* (Cleve), has been examined in the present investigation, because most of the species of this genus are warm water forms.

44. *Protorhabdonella curta* (CLEVE) JÖRGENSEN

Fig. 50

*Cyttarocylis amor* var. *curta*: BRANDT, 1907, p. 328.

*Cyttarocylis striata* forma *curta*: OKAMURA, 1912, p. 21, pl. 5, fig. 100.

*Protorhabdonella curta*: JÖRGENSEN, 1924, p. 57, fig. 65; KOFOID & CAMPBELL, 1929, p. 207, fig. 393; MARSHALL, 1934, p. 646.

*Description*:—Lorica minute, chalice-shaped, 1.78–2.00 oral diameters in length; oral margin simple, entire, slightly flaring; bowl somewhat dilated in the promedian part, then conical (55°–60°) to the moderately acute aboral end; surface ornamented with numerous ribs running longitudinally through the entire lorica and sometimes branching. Length, 53 (50–55)  $\mu$ ; oral diameter, 28 (26–29)  $\mu$ .

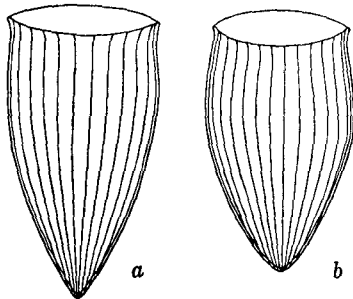


Fig. 50. *Protorhabdonella curta*  
(CLEVE) 700 $\times$

*Occurrence*:—A few specimens were found in plankton obtained in and off Akkeshi Bay during September and October, 1932 in surface temperatures of 13.3–13.9°C.

*Distribution*:—The species has been reported in the South Atlantic and Indian Oceans, the Red and Mediterranean Seas, the Japanese Current, and the Great Barrier Reef.

*Variation*:—No variation in size and form of the lorica of specimens found from the Akkeshi Region.

*Comparison*:—The species differs from *P. simplex* (Cleve) in its greater number of ribs and the simpler structure of the oral rim.

*Remarks*:—This species is a member of plankton of warm waters, but a few specimens appeared only in the autumn of 1932 in the vicinity of Akkeshi. It is surmised that they were exceptionally carried here by the warm current.

#### Family Undellidae KOFOID & CAMPBELL, 1929

#### Genus *Proplectella* KOFOID & CAMPBELL, 1929

Lorica urn- or vase-shaped, having an inner collar formed through a thickening and inward projection of the wall; outer collar rarely seen; aboral region usually rounded or conical with a pointed aboral end, occasionally flattened; wall trilamellate, hyaline without ornamentation on the surface, thickened at the basal portion of the inner collar, becoming thin rapidly on the oral margin, but gradually towards the aboral end.

Type species—*Proplectella claparèdei* (ENTZ) KOFOID & CAMPBELL.

The species of *Proplectella* are generally eupelagic and found in warm currents, but are rare in cold and neritic waters. A single species, *P. expolita* Hada, has been examined in this work.

#### 45. *Proplectella expolita* HADA

Fig. 51

*Proplectella expolita*: HADA, 1932c, p. 568, text-fig. 22.

*Description*:—Lorica consisting a short tubular collar and a spherial bowl, 2.0–2.3 oral diameters in length; collar 0.30–0.34 of the total length; bowl 1.9 oral diameter in transdiameter; aboral end broadly rounded. Length, 55–58  $\mu$ ; oral diameter, 25–27  $\mu$ ; length of the collar, 16–20  $\mu$ ; transdiameter of the bowl, 47–50  $\mu$ .

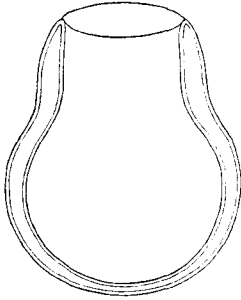


Fig. 51. *Proplectella exposita* HADA 660×

*Occurrence*:—Several specimens were rarely found in a vertical collection of 50 fathoms made on September 22, 1932 off Akkeshi Bay in a surface temperature of 15.9°C.

*Distribution*:—The species is known from Mutsu Bay.

*Variation*:—In specimens of Mutsu Bay the length of the collar and the shape of the bowl are variable in individuals.

*Comparison*:—The species differs from other species of *Proplectella* in having a well-developed outer collar.

*Remarks*:—No specimen was found in plankton of Akkeshi Bay.

#### Family Tintinnidae CLAPARÈDE & LACHMANN, 1858

##### Genus *Amphorella* DADAY, 1887

Lorica vase-shaped, consisting of a funnel-like collar and an elongate bowl; oral margin generally circular, entire; bowl always provided with 3 or 4 well-marked fins; aboral end usually truncated; wall hyaline, thickened and trilamellated in the collar, thin and single-layered in the bowl.

Type species—*Amphorella quadrilineata* (CLAPARÈDE & LACHMANN) DADAY.

#### 46. *Amphorella quadrilineata* (CLAPARÈDE & LACHMANN) DADAY

Fig. 52

*Tintinnus quadrilineatus*: CLAPARÈDE & LACHMANN, 1858, p. 201, pl. 9, fig. 3; KENT, 1882, p. 606, pl. 31, fig. 13.

*Amphorella quadrilineata*: DADAY, 1887, p. 535, pl. 18, fig. 5; JÖRGENSEN, 1899, p. 12, pl. 1, fig. 2; 1924 (pt.), p. 16, fig. 11; 1927, p. 10, fig. 12; KOFOID & CAMPBELL, 1929, p. 311, fig. 587; HOFKER, 1931, p. 384, fig. 80; MARSHALL, 1934, p. 654, fig. 37; HADA, 1935, p. 247.

*Tintinnus amphora* var. *quadrilineata*: BRANDT (pt.), 1907, p. 434.

*Amphorella brandti*: HADA, 1932c, p. 570, text-fig. 23.

*Description*:—Lorica tall urn-shaped, 2.5 oral diameters in length; collar low funnel-shaped, its basal diameter 0.68–0.78 oral

diameters; bowl circular in cross section in the anterior part, but gradually triangular in the posterior on account of development of three conspicuous fins extended through the entire bowl; aboral end truncate, more or less concave in its center. Length, 100–108  $\mu$ ; oral diameter, 40–42  $\mu$ .

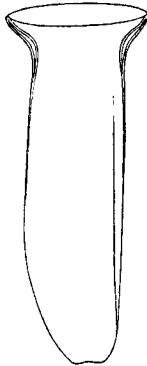


Fig. 52. *Amphorella quadrilineata* (CLAPARÈDE & LACHMANN) 450  $\times$

*Occurrence*:—A few specimens were detected in a vertical haul drawn off Akkeshi Bay on September 22, 1932 in a surface temperature of 14.2°C.

*Distribution*:—It is widely distributed in temperate and tropical waters of the world. In Japanese waters it has been reported from Mutsu Bay as *A. brandti*.

*Variation*:—Because the lower part of the lorica is triangular, frontal and side views of a specimen are different.

*Comparison*:—The species differs from *A. brandti* Jörgensen in having a stouter form and from *A. infundibulum* Kofoid & Campbell in the structure of the collar and fins.

*Remarks*:—Although a careful examination was made during 1932–1936, no specimen has been secured in Akkeshi Bay, so this cosmopolitan species seems to be rare in cold currents of the northwestern Pacific.

#### Genus *Tintinnus* SCHRANK, 1803

Lorica elongate, tubular, opening at both ends; oral end often flaring and thickened to make a brim, usually entire, sometimes denticulated; shaft generally tapering gradually to an aboral end; wall hyaline, single-layered.

Type species—*Tintinnus lusus-undae* ENTZ.

*Tintinnus* is the oldest genus of the Tintinnoinea. From Akkeshi Bay three species, one cosmopolitan and others distributed in the North Pacific, have been detected.

#### Key to species

- A. Oral rim smooth.  
 1. Lorica consisting of a small simple shaft without an oral brim.....  
 .....*T. tubulosus* OSTENFELD.

- B. Oral rim denticulate.
2. Shaft stout, over 182 $\mu$  long; oral teeth numerous (about 40).....*T. rectus* WEILES.
  3. Shaft slender, 95–110 $\mu$  long; oral teeth fewer in number (26–30).....*T. turris* KOFOID & CAMPBELL.

#### 47. *Tintinnus tubulosus* OSTENFELD

Fig. 53

*Tintinnus lusus-undae*: DADAY, 1887, pp. 526, 527, pl. 18, figs. 3, 14; HOFKER, 1913, p. 387, fig. 84.

*Tintinnus tubulosus*: OSTENFELD, 1899, p. 439, fig. 2f; KOFOID & CAMPBELL, 1929, p. 340, fig. 651; HADA, 1935, p. 274.

*Tintinnus lusus-undae* var. *a tubulosa*: BRANDT, 1906, pl. 65, fig. 14; 1907, p. 421.

*Tintinnus lusus-undae* var. *tubulosus*: JÖRGENSEN, 1924, p. 10, fig. 2; 1927, p. 9, fig. 9.

*Description*:—Lorica forming a simple truncated conical tube without an oral brim, 4.7–4.9 oral diameters in length; sides nearly straight; aboral aperture 0.83–0.89 oral diameters. Length, 87 (85–88) $\mu$ ; oral diameter, 18 $\mu$ ; aboral diameter, 15 (15–16) $\mu$ .



Fig. 53. *Tintinnus tubulosus* OSTENFELD 630 $\times$

*Occurrence*:—Very rare in Akkeshi Bay in August and September in water temperatures of 11.0–20.2°C.

*Distribution*:—The species has been found from the Atlantic, the Mediterranean, and the East Indies.

*Variation*:—This is an old species having various simple tubular forms of moderate sizes. In general, specimens examined in the present investigation are comparatively small and slender.

*Comparison*:—The species differs from *T. lusus-undae* Entz in its smaller dimensions and the absence of flaring oral margin and from *T. exiguus* Hada in having no oral brim.

*Remarks*:—This is a widely distributed species especially common in European waters.

48. *Tintinnus rectus* WAILES

Fig. 54

*Tintinnus lusus-undae* var. *rectus*: WAILES, 1929, pp. 2, figs. 23.*Tintinnus lusus-undae*: WAILES, 1929, pl. 2, fig. 22.*Tintinnus rectus*: KOFOID & CAMPBELL, 1929, pl. 338, fig. 645; HADA, 1932b, p. 57, fig. 23.

*Description*:—Lorica rather stout, 4.2–6.7 oral diameters in length; oral end slightly flaring, with about 40 short triangular teeth; shaft scarcely dilated in the median portion; aboral opening 0.74–0.84 oral diameters, its marginal eversion almost invisible. Length, 250 (182–304)  $\mu$ ; oral diameter, 44 (40–45)  $\mu$ ; aboral diameter, 36 (32–37)  $\mu$ .

*Occurrence*:—Common during July and August and rare in June and September in Akkeshi Bay in water temperatures of 7.8–20.2°C.

*Distribution*:—The species occurs in the Straits of Georgia in Canada, the California Current and off the east coast of Kamchatka in the Oyashiwo Current. All localities are in the North Pacific.

*Variation*:—The species is variable in length. The number of oral teeth is different between specimens from Asiatic coasts of the Pacific and those from the American part; 40–50 in the former, but only 22–26 in the latter.

*Comparison*:—The species differs from *T. turris* Kofoid & Campbell in the larger and stouter form and from *T. rugosus* Kofoid & Campbell in the lack of a rugose structure on the surface.

*Remarks*:—The species is one of the commonest Tintinnoinea in summer plankton of Akkeshi Bay. Its distribution so far as is now known is restricted up to the northern part of the Pacific.

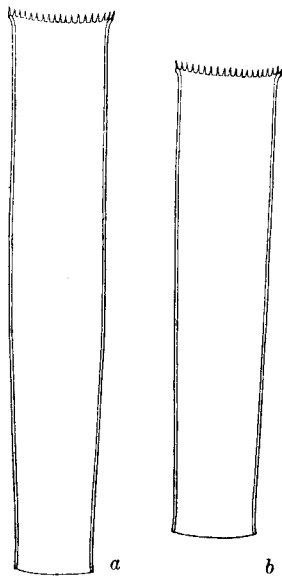


Fig. 54. *Tintinnus rectus*  
WAILES 300 $\times$

49. *Tintinnus turris* KOFOID & CAMPBELL

Fig. 55

*Tintinnus turris*: KOFOID & CAMPBELL, 1929, p. 342, fig. 642.



Fig. 55. *Tintinnus turris* KOFOID & CAMPBELL 700×

*Distribution*:—Lorica tubular, 5.3–5.5 oral diameters in length; oral margin somewhat flaring, denticulated with 26–30 sharp everted teeth; shaft slightly tapering towards a narrow aboral region; aboral end spreading outwardly, 0.63–0.70 oral diameters in transdiameter, without a brim. Length, 104 (95–110)  $\mu$ ; oral diameter, 20 (18–20)  $\mu$ ; oral diameter, 13 (12–14)  $\mu$ ; length of a tooth, 4  $\mu$ .

*Occurrence*:—Many specimens were once examined in a vertical haul of 10 m taken on August 1, 1933 in water temperatures of 11.0–15.3°C according to depth off the Biological Station.

*Distribution*:—The species is described from Nome Bay, Alaska.

*Variation*:—No remarkable variation in specimens from Akkeshi Bay. They are a little shorter and have more oral teeth than those from Alaska.

*Remarks*:—This species seems to be a cold water form, and occasionally enters Akkeshi Bay with the cold current, Oyashiwo.

#### Genus *Salpingella* JÖRGENSEN, 1924

Lorica elongate, generally slender, trumpet-shaped, with a short collar provided with a circular or polygonal oral rim; bowl forming a tubular shaft in the anterior main part which becomes gradually tapering posteriorly, having a number of raised spiral fins in the lower region; aboral end typically opening; wall hyaline, composed of a single layer.

Type species—*Salpingella acuminata* (CLAPARÈDE & LACHMANN) JÖRGENSEN.

The type species oldest and commonest in *Salpingella*, was examined in this work.

#### 50. *Salpingella acuminata* (CLAPARÈDE & LACHMANN) JÖRGENSEN

Fig. 56

*Tintinnus acuminatus*: CLAPARÈDE & LACHMANN, 1858, p. 199, pl. 8, fig. 4; KENT, 1882, p. 606, pl. 31, fig. 14; DADAY (pt.), 1887, p. 532; JÖRGENSEN, 1899,

p. 8, pl. 1, fig. 1; BRANDT, 1906, pl. 66, figs. 2-4, pl. 67, figs. 1, 9; 1907, p. 388; OKAMURA, 1907, p. 140, pl. 6, fig. 68; WAILES, 1929, pl. 2, figs. 27, 28.

*Tintinnus Möbii*: BRANDT, 1896, p. 50.

*Salpingella acuminata*: JÖRGENSEN, 1924 (pt.), p. 13; KOFOID & CAMPBELL, 1929, p. 350, fig. 682; PAULSEN, 1931, p. 95.

*Description*:—Lorica elongated trumpet-shaped, its length 6-7 oral diameters; collar forming a low funnel of  $100^\circ$ , its basal transdiameter 0.43-0.47 oral diameters; bowl cylindrical in the anterior two-thirds, slightly bulged in the posterior one-third, then gradually tapering to a truncated aboral end; fins six in number, spiraled, 0.31-0.35 of the total length, arising from a little above the aboral aperture. Length, 240-272  $\mu$ ; oral diameter, 37-40  $\mu$ ; transdiameter of the neck, 17  $\mu$ ; length of a fin, 70-80  $\mu$ .

*Occurrence*:—A single specimen was once discovered among surface plankton obtained on January 16, 1933 from Akkeshi Bay in a surface temperature of  $-1^\circ\text{C}$  and several in a vertical haul of 100 m taken on August 2, 1936 off the Bay in water temperatures of  $5.7-13.8^\circ\text{C}$  from bottom to surface.

*Distribution*:—The species is widely distributed in cold and warm seas of the Pacific, Atlantic, and Mediterranean.

*Variation*:—Variation in length of the lorica is not so remarkable in specimens examined here as in the collection of the Plankton Expedition studied by Brandt (1907). Fins of the posterior region are constant (6) in number in these specimens, but variable from six to nine according to Brandt's report (1907).

*Remarks*:—Being a eupelagic species, this is rather rare in Akkeshi Bay, but common off the Bay.

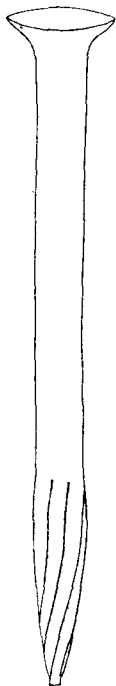


Fig. 56. *Salpingella acuminata* (CLAPARÈDE & LACHMANN)  
370 $\times$

## Literature

- BRANDT, K. 1896 Zoologische Ergebnisse der von der Gesellschaft für Erdkunde zu Berlin unter Leitung Dr. von Drygalski's ausgesandten Grönlandexpedition nach Dr. Vanföffen's Sammlungen bearbeitet. IV. Die Tintinnen. Bibliotheca Zoologica, Bd. 8, pp. 45-72, pl. 3.
- 1906 Die Tintinnodeen der Plankton-Expedition. Tafelklärungen nebst kurzer Diagnose der neuen Arten. Ergebn. Plankton-Exped. Humboldt-Stift, Bd. 3, L. a, 33 p., 70 pls.
- 1907 *Idem*. Systematischer Theil. *Ibid.*, 488 p.
- CAMPBELL, A. S. 1926 The Cytology of *Tintinnopsis nucula* (FOL) LAACKMANN with an Account of its Neuromotor Apparatus, Division, and a new Intranuclear Parasite. Univ. California Publ. Zool., vol. 29, pp. 179-236, pls. 12-15, 7 textfigs.
- CLAPARÈDE, É. & J. LACHMANN 1858-1859 Études sur les infusoires et les rhizopodes. Mem. Inst. Genevois, Tomes 5, 6, pp. 1-482, pls. 1-24, Tome 7, pp. 1-291, pls. 1-13.
- CLEVE, P. T. 1899 Plankton collected by the Swedish Expedition to Spitzbergen in 1898. Kgl. Svenska Vet.-Akad. Handl., Bd. 32, No. 3, pp. 1-51, pls. 1-4.
- 1900a The Plankton of the North Sea, the English Channel, and the Skagerak in 1898. *Ibid.*, Bd. 32, No. 8, pp. 1-53, 11 textfigs.
- 1900b *Idem* in 1899. *Ibid.*, Bd. 34, No. 2, pp. 1-77.
- 1902 The Plankton of the North Sea and the Skagerak in 1900. *Ibid.*, Bd. 35, No. 7, pp. 1-49, 1 textfig.
- 1903 Plankton-researches in 1901 and 1902. *Ibid.*, Bd. 36, No. 8, pp. 1-53, 2 textfigs.
- VON DADAY, E. 1887 Monographie der Familie der Tintinnodeen. Mitt. Zool. Sta. Neapel, Bd. 7, pp. 473-591, pls. 18-21.
- ENTZ, G. Sr. 1884 Ueber Infusorien des Golfes von Neapel. Mitt. Zool. Sta. Neapel, Bd. 5, pp. 289-444, pls. 20-25.
- ENTZ, G. Jr. 1909 Studien über Organisation und Biologie der Tintinniden. Arch. Prot., Bd. 15, pp. 93-226, pls. 8-21, 2 textfigs.
- HADA, Y. 1932a Descriptions of two new neritic Tintinnoinea, *Tintinnopsis japonica* and *Tps. kofoidi* with a brief Note on a Unicellular Organism parasitic on the Latter. Proc. Imp. Acad., vol. 8, no. 5, pp. 209-212, 3 textfigs.
- 1932b The Tintinnoinea from the Sea of Okhotsk and its Neighborhood. Jour. Fac. Sci. Hokkaido Imp. Univ., ser. 4, vol. 2, no. 1, pp. 37-59, 23 textfigs.
- 1932c Report of the Biological Survey of Mutsu Bay. 26. The pelagic Ciliata, Suborder Tintinnoinea. Sci. Rep. Tohoku Imp. Univ., 4th ser., Biol., vol. 7, no. 4, pp. 553-573, 26 textfigs.
- 1935 On the Pelagic Ciliata, Tintinnoinea, from the East Indies with Considerations on the Character of the Plankton in the Seas. (Japanese, with English synopsis) Bull. Japanese Soc. Sci. Fish., vol. 4, no. 4, pp. 242-252, 3 textfigs.
- HAMBURGER, CL. & VON BUDDENBROCK 1911 Nordische Ciliata mit Ausschluss der Tintinnoidea. Nordisches Plankton, XIII, pp. 1-152, 185 textfigs.
- HOFKER, J. 1931 Studien über Tintinnoidea. Arch. Prot., Bd. 75, pp. 315-402, 89 textfigs.
- IMHOF, O. E. 1886 Ueber mikroskopische pelagische Thiere aus den Lagunen von Venedig. Zool. Anz., Bd. 9, pp. 101-104.

- JÖRGENSEN, E. 1899 Ueber die Tintinnodeen der norwegischen Westküste. Bergens Mus. Aarbog, 1899, no. 2, pp. 1-48, pls. 1-3.
- 1900 Protophyten und Protozoën im Plankton aus der norwegischen Westküste. Ibid., 1899, no. 6, pp. 1-112 + LXXXIII, pls. 1-5.
- 1901 Protistenplankton aus dem Nordmeere in den Jahren 1897-1900. Ibid., 1900, no. 6, pp. 1-37, pls. 1-3.
- 1924 Mediterranean Tintinnidae. Rept. Danish Oceanog. Exped. 1908-10 to the Mediterranean and Adjacent Seas, vol. 2, Biology, pp. 1-110, 114 textfigs.
- 1927 Ciliata: Tintinnidae. Die Tierwelt der Nord- und Ostsee, Lief. 8, Teil II. c, pp. 1-26, 33 textfigs.
- KAHL, A. 1930 Urtiere oder Protozoa. I. Wimpertiere oder Ciliata (Infusoria). Eine Bearbeitung der freilebenden und ectocommensalen Infusorien der Erde, unter Ausschluss der marinen Tintinnidae. 1. Allgemeiner Teil und Postomata. Die Tierwelt Deutschlands und der angrenzenden Meeresteile. Teil 18, pp. 1-180, 25 text figs.
- 1933 Ciliata libera et ectocommensalia. Die Tierwelt der Nord- und Ostsee, Lief. 23, Teil II. c., pp. 29-146, 26 textfigs.
- KENT, W. S. 1881-1882 A Manual of the Infusoria. 3 vols., X 913 p., 51 pls.
- KOFOID, C. A. & A. S. CAMPBELL 1929 A Conspectus of the Marine and Fresh-water Ciliata belonging to the Suborder Tintinnoinea, with Descriptions of New Species principally from the Agassiz Expedition to the Eastern Tropical Pacific 1904-1905. Univ. California Publ. Zool., vol. 34, pp. 1-403, 697 textfigs.
- LAACKMANN, H. 1906 Ungeschlechtliche und geschlechtliche Fortpflanzung der Tintinnen. Wiss. Meeresunters., N. F., Bd. 10, pp. 15-38, pls. 1-3.
- 1913 Adriatische Tintinnodeen. Sitz. Kais. Akad. Wiss. Wien, Mathem.-naturw. Klasse, Bd. 122, pp. 1-45, pls. 1-6, 2 textfigs.
- LOHMANN, H. 1908 Untersuchungen zur Feststellung des vollständigen Gehaltes des Meeres an Plankton. Wiss. Meeresunters., N. F., Bd. 10, pp. 129-370, pls. 9-17, 22 textfigs.
- MARSHALL, S. M. 1934 The Silicoflagellata and Tintinnoinea. Great Barrier Reef Expedition 1928-29, Sci. Rep., vol. 6, no. 15, pp. 623-664, 43 textfigs.
- MERESCHKOWSKY, S. 1879 Studien über Protozoen des nördlichen Russland. Arch. Mikr. Anat., Bd. 16, pp. 153-248, pls. 10, 11.
- MERKLE, H. 1909 Untersuchungen an Tintinnodeen der Ost- und Nordsee. Wiss. Meeresunters., N. F. Bd. 11, pp. 139-186, pls. 2, 3, 3 textfigs.
- MEUNIER, A. 1910 Microplankton des mers de Barents et de Kara. Duc d'ORLÉANS. Compagne arctique de 1907, XVIII 355 p., 37 pls.
- OKAMURA, K. 1907 An annotated List of Plankton Microorganisms of the Japanese Coast. Annot. Zool. Japonenses, 1906-1908, vol. 6, pp. 125-151, pls. 3-6.
- OSTENFELD, C. H. 1910 Marine Plankton from the East-Greenland Sea collected during the "Danmark Expedition" 1906-1908. II. Protozoa. Medd. Grönland, Bd. 43, pp. 289-299, 7 textfigs.
- PAULSEN, O. 1931 Études sur le Microplancton de la mer d'Alboran. Inst. Espanol Ocean., Trabajos, pp. 1-108, 61 textfigs.
- WAILLES, G. H. 1929 Tintinnidae, from the Strait of Georgia, B. C. Mus. Art Not., vol. 6, no. 3, pp. 124-129, pls. 2, 3.