



HOKKAIDO UNIVERSITY

Title	Studies on the Tintinnoinea from the Western Tropical Pacific (With 3 Tables and 100 Textfigures)
Author(s)	HADA, Yosine
Citation	北海道帝國大學理學部紀要 = JOURNAL OF THE FACULTY OF SCIENCE HOKKAIDO IMPERIAL UNIVERSITY Series . Zoology, 6(2): 87-190
Issue Date	1938-08
URL	http://hdl.handle.net/2115/27012
Rights	
Type	bulletin
Additional Information	



Instructions for use

Studies on the Tintinnoinea from the Western Tropical Pacific¹⁾

By

Yosine Hada

Akkeshi Marine Biological Station of the Hokkaido
Imperial University, Akkeshi, Hokkaido

(With 3 Tables and 100 Textfigures)

Introduction

The present report is the fourth describing investigation on the Tintinnoinea found in the plankton of the western Pacific. It has been based upon collections from the tropical regions including the western part of the South Sea Islands under Japanese Mandate and the East Indies comprising the South China, Java, Celebes, and Sulu Seas and also the localized area of the Indian Ocean connected with the Strait of Sunda.

Regarding the Tintinnoinea from the western tropical Pacific several records have been previously published by Cleve (1901), Schmidt (1901), Brandt (1906-07), and Marshall (1934). The first author reported the plankton obtained from the Malay Archipelago, the second from the Gulf of Siam, the third from the western coast of Borneo and New Pomerania, and the last from the Great Barrier Reef.

The plankton materials described in this examination were taken by horizontal and vertical hauls of a plankton net made of No. 25 silk bolting cloth. Those from the South Sea Islands were collected from the Palao Islands and the island of Yap in the West Caroline Islands and near the islands of Saipan and Tinian in the Mariana

1) Contributions from the Akkeshi Marine Biological Station, No. 22.

Islands by the author himself during his stay in those vicinities from the end of September, 1930 to the beginning of March, 1931 for the purpose of collecting plankton, Foraminifera, and corals. Collections were made at 14 scattered stations in the lagoons of the Palao Islands surrounding Babelthuap, Korrör, and Malakal Islands etc. At the station in Malakal Harbour plankton collections were carried out twice or three times in a month during the author's stay on Korrör Island (October, 1930–February, 1931). From the outside of the barrier of the Palao Islands five bottles of plankton were obtained in the region off the Malakal Passage. Surface water temperatures were variable from 28.1°C to 30.6°C at the time of collections in the Palao Islands. The materials from Yap were taken from eight points in the lagoon near the anchorage on January 8–14, 1931 in the mean surface temperature of 29°C. Near Saipan and Tinian which are located close together the collections were made respectively four times on the 22nd–24th and twice on the 25th of September, 1930 in surface temperatures of 27.4–28.3°C. The plankton materials of the East Indies were taken also by the writer himself while on board the research boat of the Government of Formosa, *Shonan-Marü*, which cleared from Takao, Formosa on July 13, 1933 for Nhatrang, Annam, then after making oceanographical observations and fishery researches in the above mentioned seas, returned to Takao on September 28. The materials were taken at 56 stations distributed as follows: 16 in the South China Sea, 31 in the Java Sea, 5 in the Indian Ocean, and 2 in the Celebes and Sulu Seas. The surface temperatures varied between 27.4°C and 29.8°C in these seas of the East Indies at the time of collections.

Of 101 forms consisting of 88 species and 13 varieties which have been recorded in this paper, seven species and three varieties seem to be new to science. All of them except seven cosmopolitan forms are warm water inhabitants occurring generally in tropical and subtropical waters. Specimens from the West Caroline Islands comprise the greatest number with 73 forms. Neritic and oceanic ones are included in them in nearly equal ratio, the former group usually occurring in lagoons, the latter generally appearing in the open sea outside the coral reefs. Twenty-five species and four varieties were secured in the materials from the Mariana Islands. Most of them are eupelagic, because the plankton materials were collected off the fringing reefs of Saipan and Tinian. The forms detected from

the South China Sea are 26 in number, among which those from the northern deep part are almost all oceanic plankters, while those from the southern shallow area are mostly coast dwellers. Thirty-one were observed in the collections from the Java Sea and 16 kinds from the Indian Ocean off the Strait of Sunda. Most of them are members of neritic plankton, though this region of the Indian Ocean where materials were taken is open and very deep. This is probably due to the fact that the flow of the Java Sea was pouring into the Indian Ocean through the Strait of Sunda when this research was made. From the Celebes Sea only two species and from the Sulu Sea six were examined.

The author wishes to express his heartfelt gratitude to Prof. T. Uchida of the Hokkaido Imperial University, Director of the Akkeshi Marine Biological Station, for his kind help during the preparation of this study, and also to Prof. S. Hatai of the Tohoku Imperial University and Mr. T. Kumata of the Nissan Fisheries Institute for their kindness in giving opportunities for making these collections. For the materials the author is considerably indebted to some members of the Fisheries Department of the Government of the South Sea Islands, the Fisheries Experiment Station of the Government of Formosa, and the Nissan Fisheries Institute. Here, the author's cordial thanks are extended to them.

Systematic Part

Family Tintinnididae KOFOID & CAMPBELL, 1929

Genus *Tintinnidium* KENT, 1882

Tintinnidium: KENT, 1882, p. 604; BRANDT, 1907, p. 439; KOFOID & CAMPBELL, 1929, p. 9; HADA, 1937, p. 151.

A single species which has been reported in this paper is designated as the type species of this genus.

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

Fig. 1

Tintinnidium mucicola: HADA, 1937, p. 151, fig. 6.

Length 100-190 μ ; oral diameter 30-50 μ ; greatest transdiameter of the lorica 50-160 μ .

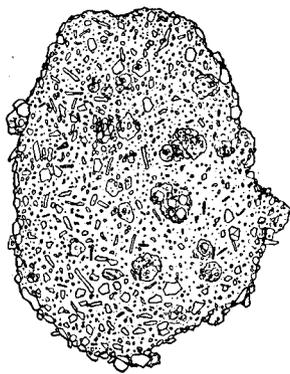


Fig. 1. *Tintinnidium mucicola* (CLAPARÈDE & LACHMANN) 250×

Occurrence:—Palao Islands, very rare.

Remarks:—This species which has been mostly known from European waters, is now first recorded from the tropical region. Occurring even in tropical coastal plankton, this species seems to be cosmopolitan in neritic waters of the world. Most of the specimens examined from Akkeshi Bay (1937) were elongate and tubular, but those of the Palao Islands are remarkably variable in size and form, and large ovate individuals as shown in fig. 1 were often observed.

Genus *Leprotintinnus* JÖRGENSEN, 1899

Leprotintinnus: JÖRGENSEN, 1899, p. 10; 1927, p. 8; LAACKMANN (pt.), 1909, p. 398; KOFOID & CAMPBELL, 1929, p. 16; HADA, 1937, p. 152.

The following two species, of which one is of a simple tubular form, but the other is provided with a characteristic large aboral flare, have been found in materials obtained from the East Indies.

Key to species

1. Lorica simple tubular, without an aboral flare*L. simplex* SCHMIDT
2. Lorica with a distinct aboral flare
.....*L. nordqvisti* (BRANDT) KOFOID & CAMPBELL

2. *Leprotintinnus simplex* SCHMIDT

Fig. 2

Leprotintinnus simplex: SCHMIDT, 1901; KOFOID & CAMPBELL, 1929, p. 18, fig. 10.

Lorica tubular, 5.8 oral diameters in length, gradually tapering (2°) to the aboral end without a flare or a constriction; sides more or less curved; aboral diameter 0.86 oral diameter; wall comparatively thin, with sparse foreign particles laid spirally on the surface. Length 205 μ ; oral diameter 33 μ .

Occurrence:—Off Semarang, Java, rare.

Distribution:—Gulf of Siam (Schmidt, 1901).

Comparison:—The species differs from *L. neriticus* (Campbell) in being smaller in dimensions, from *L. nordqvisti* (Brandt) in bearing no aboral flare, and from *L. pellucidus* (Cleve) in the absence of a posterior constriction.

Remarks:—This species was only rarely detected in a collection taken at a single station off Semarang in the Java Sea. It is allied to *L. neriticus* in outline, but can be clearly distinguished from the latter by its smaller size.



Fig. 2. *Leprotintinnus simplex* SCHMIDT 230×

3. *Leprotintinnus nordqvisti* (BRANDT) KOFOID & CAMPBELL

Fig. 3

Tintinnopsis nordqvisti: BRANDT, 1906, p. 4, pl. 24, figs. 1-4; 1907, p. 166.

Leprotintinnus nordqvisti: KOFOID & CAMPBELL, 1929, p. 17, fig. 13; MARSHALL, 1934, p. 634; HADA, 1935, p. 244.

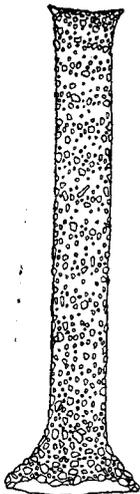


Fig. 3. *Leprotintinnus nordqvisti* (BRANT) 300×

Lorica consisting of a tubular shaft and an inverted funnel-shaped aboral flare, 4.3-10.5 oral diameters in length; oral rim irregular, usually slightly flaring (30° - 85°); shaft more or less tapering (15°), expanding near the posterior region to form a distinct aboral conical flare (50° - 110°); aboral aperture large, 1.2-2.3 oral diameters; aboral margin very ragged; wall showing a faint spiral structure, made of rather scarce particles aggregated more thickly on the surface of the aboral flare than on that of the shaft. Length 245 (150-352) μ ; oral diameter 35 (30-38) μ ; aboral diameter 61 (40-80) μ .

Occurrence:—Off Nhatrang, Annam, very rare; Singapore, frequent; central portion of the sea between Borneo and Sumatra, rare; western area of the Java Sea, frequent; Strait of Sunda, Indian Ocean connected with the strait, rare.

Distribution:—Mouth of the Tocantins River in Brazil, west coast of Borneo (Brandt, 1907); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from the other species of *Leprotintinnus* in having a conspicuous great aboral flare.

Remarks:—The species is rather widely variable in length. A marked deviation is observed in the size and form of the aboral flare. The spiral organization and the oral expansion are seen in most of specimens examined in the present research.

Family Codonellidae KENT, 1882

Genus *Tintinnopsis* STEIN

Tintinnopsis: STEIN, 1867; KENT, 1882, p. 617; DADAY (pt.), 1887, p. 544; BRANT (pt.), 1907, p. 126; JÖRGENSEN, 1924, p. 65; 1927, p. 5; KOFOID & CAMPBELL, 1929, p. 19; HADA, 1937, p. 155.

Fourteen species described in this paper mostly occurred in plankton collected from the lagoons of the West Caroline Islands and from the sea surrounded by Borneo, Sumatra, and Java.

Key to species

- A. Lorica anteriorly cylindrical.
- a. Aboral region conical.
1. Lorica bullet-shaped; aboral end pointed*T. beroidea* STEIN
 2. Lorica minute; aboral region usually conical, but rarely rounded
.....*T. nana* LOHMANN
 3. Lorica stout; aboral region widely conical
.....*T. brasiliensis* KOFOID & CAMPBELL
 4. Lorica large, slightly constricted near its middle length
.....*T. elongata* var. *yappensis* n. var.
 5. Lorica bullet-shaped, with a hyaline apical spine
.....*T. platensis* CUNHA & FONSECA
 6. Lorica slender; aboral region convex conical.....
.....*T. gracilis* KOFOID & CAMPBELL
- b. Aboral region rounded.
7. Lorica without a posterior expansion, wall coarsely agglomerated
.....*T. karajacensis* BRANDT
 8. Lorica capsular; wall rather thin, without spiral structure.....
.....*T. karajacensis* var. *rotundata* JÖRGENSEN
 9. Lorica with a slight oral flare and an aboral globose part.....
.....*T. directa* HADA
 10. Lorica consisting of a short subcylindrical collar and an ovate bowl...
.....*T. nucula* (FOL) BRANDT

- c. Aboral opening present.
11. Lorica elongate, distally tapering.....*T. radix* (IMHOF) BRANDT
 12. Lorica posteriorly inflated with a stout aboral horn.....
.....*T. aperta* var. *tocantinensis* KOFOID & CAMPBELL
- B. Lorica with a flaring collar and a bowl.
13. Bowl rotund, widened near its middle.....*T. schotti* BRANDT
 14. Bowl elongate, dilated in the posterior region.....*T. loricata* BRANDT

4. *Tintinnopsis beroidea* STEIN

Fig. 4

Tintinnopsis beroidea: HADA, 1937, p. 156, fig. 9.

Length 53 (42-78) μ ; oral diameter 30 (27-34) μ .

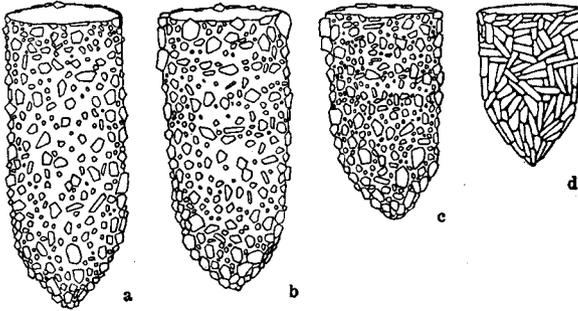


Fig. 4. *Tintinnopsis beroidea* STEIN 500 \times

a-c from the Palao Islands

d from Yap

Localities:—Lagoons of the Palao Islands, common; Yap, rare; Java Sea, very rare.

Remarks:—There have been found elongate specimens (figs. 4 a, b) from the Palao Islands. They sometimes show a weakly developed spiral structure in the upper part of the lorica as those examined from Akkeshi Bay, Hokkaido.

5. *Tintinnopsis nana* LOHMANN

Fig. 5

Tintinnopsis nana: LOHMANN, 1908, p. 292, pl. 17, fig. 12; 1911, p. 29, pl. 1, fig. 5; FELDHAUS, 1920, p. 42; KOFOID & CAMPBELL, 1929, p. 41, fig. 15; HOFKER, 1931, p. 340, fig. 19.

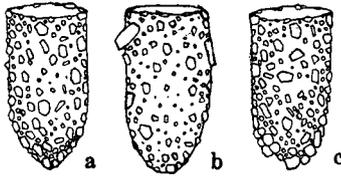


Fig. 5. *Tintinnopsis nana*
LOHMANN 750×

Tintinnopsis karajacensis var. *minutus*:
WAILES, 1929, pl. 2, figs. 7, 8.

Tintinnopsis minuta: KOFOID & CAMP-
BELL, 1926, p. 40, fig. 16.

Lorica very small, 1.7–2.0 oral diameters
in length; oral rim ragged; bowl usually
cylindrical, occasionally formed irregularly;
aboral end conical or rounded. Length 30–
35 μ ; oral diameter 16–18 μ .

Occurrence:—Palao Islands, very rare.

Distribution:—Kiel Bay (Lohmann, 1908); North Sea (Feld-
haus, 1920; Hofker, 1931); Zuider Zee (Hofker, 1931); Straits of
Georgia, British Columbia (Wailes, 1929).

Comparison:—The species differs from *T. beroidea* Stein in the
smaller size and the shape of the aboral region.

Remarks:—This species is the smallest in *Tintinnopsis*. The
aboral end of the specimens examined in this work is variously
shaped: it is rounded in some cases as *T. minuta* recorded by Wailes
(1929) from the Strait of Georgia, but conical in others as originally
described by Lohmann (1908) from Kiel Bay. According to Hofker
(1931) small forms as contracting specimens of *T. beroidea* and *T.*
karajacensis have been incorporated into this species.

6. *Tintinnopsis brasiliensis* KOFOID & CAMPBELL

Fig. 6

Tintinnopsis sp.: BRANDT, 1906, pl. 16, fig. 8;
1907, p. 159.

Tintinnopsis brasiliensis: KOFOID & CAMPBELL,
1929, p. 29, fig. 30.

Lorica stout, 1.2–1.4 oral diameters in length; oral
margin ragged; bowl sometimes more or less flaring
orally; aboral region abruptly narrowing (90°) to a
blunt aboral end; wall coarsely agglomerated. Length
42–48 μ ; oral diameter 30–35 μ .

Occurrence:—The Palao Islands, Yap,
Strait of Sunda, very rare.

Distribution:—Northern coast of Brazil (Brandt, 1907).

Comparison:—The species differs from *T. beroidea* Stein in its
stouter proportions and the more abruptly narrowed aboral region.

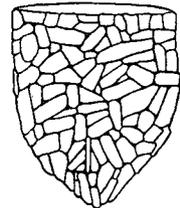


Fig. 6. *Tintinnopsis*
brasiliensis KOFOID
& CAMPBELL 500×
from Yap

Remarks:—The specimens observed in the present investigation are generally smaller and stouter than those found by Brandt (1906–07) in the collections of the Plankton Expedition from the mouth of the Tocantins River. This species is apparently stouter in form than *T. beroidea*.

7. *Tintinnopsis elongata* var. *yappensis* n. var.

Fig. 7

Lorica fusiform, 1.8–2.1 oral diameters in length; oral rim roughened; oral region slightly flaring from the result of a promedian constriction; bowl narrowed in the portion of the anterior 0.33–0.37 of the lorica, its shortest transdiameter 0.87–0.90 of an oral diameter; aboral region conical (55° – 65°) in the posterior 0.42 of the lorica; aboral end usually subacute; wall rather coarsely agglomerated. Length 83 (75–92) μ ; oral diameter 41 (40–43) μ .

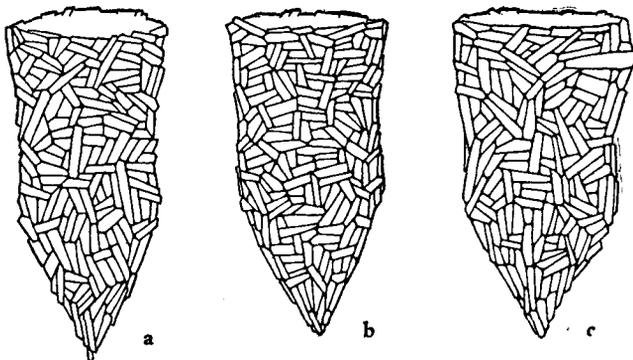


Fig. 7. *Tintinnopsis elongata* var. *yappensis* n. var. 500 \times

Occurrence:—Yap, rare.

Comparison:—This form differs from the typical one of *T. elongata* Daday in its smaller size and the presence of a promedian constriction.

Remarks:—This form closely resembles *T. elongata* in general contour except a slightly constricted region of the lorica, but it is smaller in size than the typical form, of which specimens were examined from Naples by Daday (1887) and from Akkeshi Bay by the present author (1937).

8. *Tintinnopsis platensis* CUNHA & FONSECA

Fig. 8

Tintinnopsis platensis: CUNHA & FONSECA, 1917; KOFOID & CAMPBELL, 1929, p. 45, fig. 89.



Fig. 8. *Tintinnopsis platensis* CUNHA & FONSECA 600X

Lorica bullet-shaped, 3-4 oral diameters in length without an aboral spine; oral margin ragged; bowl usually cylindrical, sometimes slightly constricted in its middle; aboral region forming an inverted cone of 80°-95°, with a long, somewhat irregularly curved, hyaline spine having a pointed tip, its length 0.37-0.45 of the length of the bowl; wall composed of rather minute foreign particles. Length 110 (98-142) μ ; oral diameter 33 (31-35) μ ; length of the aboral spine 45 (33-48) μ .

Occurrence:—Palao Islands, very rare; Yap, abundant; Saipan, very rare.

Distribution:—Atlantic Coast of South America (Cunha & Fonseca, 1917).

Comparison:—The species differs from all other species of *Tintinnopsis* in having a hyaline aboral spine.

Remarks:—It seems that aboral spines, characteristic of this species, are perhaps spicules of other organisms which are used by this species, but not secreted by itself.

Examples of other groups of the Protozoa showing such a special selection of the material of the wall are known in the species of the arenaceous Foraminifera: e.g., the test of *Psammosphera parva* Flint is often penetrated by a sponge spicule.

9. *Tintinnopsis gracilis* KOFOID & CAMPBELL

Fig. 9

Tintinnopsis karajacensis var. a: BRANDT, 1906, pl. 19, figs. 1, 2; 1907, p. 163.

Tintinnopsis gracilis: KOFOID & CAMPBELL, 1929, p. 36, fig. 37; MARSHALL, 1934, p. 636; HADA, 1935, p. 244.

Lorica finger-shaped, 3.3-4.0 oral diameters in length; oral margin usually comparatively smooth; bowl tubular, sometimes slightly swollen in the posterior one-third of the bowl; aboral region convex conical (40°-75°) with a blunt distal

end; wall coarsely agglomerated without a spiral structure. Length 113 (105-125) μ ; oral diameter 31 (23-34) μ .

Occurrence:—Singapore, common; west of Borneo, very rare; western area of the Java Sea, very rare.

Distribution:—Western coast of Borneo (Brandt, 1907); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *T. karajacensis* Brandt in the conical aboral region instead of the round.

Remarks:—This is probably a tropical species. The outline of the lorica is often irregular owing to a coarse agglomeration of the wall.



Fig. 9. *Tintinnopsis gracilis* KOFOID & CAMPBELL 330 \times

10. *Tintinnopsis karajacensis* BRANDT

Fig. 10

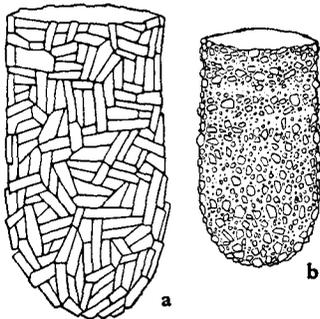


Fig. 10. *Tintinnopsis karajacensis* BRANDT 500 \times

a from Yap
b from the Java Sea

Tintinnopsis karajacensis: BRANDT, 1896, p. 57, pl. 3, fig. 5; 1906, pl. 19, figs. 5, 7, 10-12, pl. 26, fig. 3; 1907, p. 162; LAACKMANN, 1906, p. 21, pl. 1, figs. 12-14; HELDHAUS, 1920, pp. 30, 39; JÖRGENSEN, 1927, p. 7; KOFOID & CAMPBELL (pt.), 1929, p. 37, fig. 38; HADA, 1932, p. 558, text-fig. 6.

Lorica capsular, 2 oral diameters in length; oral margin roughened; bowl cylindrical in the main part, rounded in the aboral end; wall coarsely agglomerated, often with a spiral structure in the anterior region of the lorica. Length 60-80 μ ; oral diameter 30-40 μ .

Occurrence:—Yap, Java Sea, exceedingly rare.

Distribution:—Coastal waters of North Europe (Laackmann, 1906; Brandt, 1906; Feldhaus, 1920), Iceland, Barents Sea (Feldhaus, 1920), and Greenland (Brandt, 1896); Mutsu Bay (Hada, 1932).

Comparison:—This species differs from *T. directa* Hada in the absence of the oral flare and the posterior inflation.

Remarks:—This species consisting of a tubular bowl and a round aboral region has been reported from rather cold waters until now, but in this research a few specimens have been found from tropical waters. The species is probably a cosmopolitan inhabitant. The allied, *T. rotundata* Jörgensen and *T. tenuis* Hada, are perhaps respectively the warm water and the cold water varieties of this species.

11. *Tintinnopsis karajacensis* var. *rotundata* JÖRGENSEN

Fig. 11

Tintinnopsis beroidea: DADAY, 1887, p. 547, pl. 19, figs. 2, 14.

Tintinnopsis beroidea var. *rotundata*: JÖRGENSEN, 1889, pp. 5, 24.

Tintinnopsis rotundata: KOFOID & CAMPBELL, 1929, p. 46, fig. 73; MARSHALL, 1934, p. 635; HADA, 1935, p. 244.

Lorica 1.5-2.1 oral diameters in length; oral margin usually ragged; bowl cylindrical; aboral region rounded; wall comparatively thin, spiral structure invisible. Length 40-60 μ ; aboral diameter 25-28 μ .

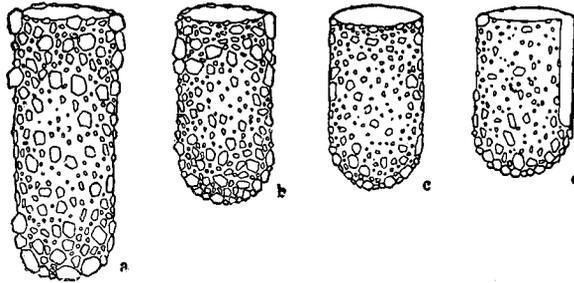


Fig. 11. *Tintinnopsis karajacensis* var. *rotundata* JÖRGENSEN 500 \times

a-d from the Palao Islands

a abnormally elongated specimen

Occurrence:—Palao Islands, common; Yap, very rare; Tinian, rare; off Nhatrang, very rare; south-western part of the Java Sea, Indian Ocean connected with the Strait of Sunda, very rare.

Distribution:—Mediterranean (Daday, 1887; Entz, 1909); Great Barrier Reef (Marshall, 1934).

Comparison:—The variety differs from the typical form of *T. karajacensis* Brandt in the possession of the thin wall without spiral structure.

Remarks:—This variety usually occurs in warm waters and shows a slight variation in dimensions. A few abnormally elongated specimens (fig. 11a) which were 68–72 μ long and similar to the typical form, were found in collections from the lagoons of the Palao Islands. These can be distinguished from the typical form by the smaller aperture and the thin wall having no spiral structure. In general, the wall of individuals collected inside the coral reefs and near coasts is composed of coarse foreign particles, but that of individuals from the open seas is neatly agglomerated with fine materials. Agglomerated particles usually attach densely to the surface of the wall of the oral border and the aboral region of the lorica.

12. *Tintinnopsis directa* HADA

Fig. 12

Tintinnopsis karajacensis var. b: BRANDT (pt.), 1906, pl. 19, figs. 9, 19, pl. 26, fig. 9; 1907, p. 163.

Tintinnopsis sp.: OKAMURA, 1907, p. 139, pl. 6, fig. 64.

Tintinnopsis patula: KOFOID & CAMPBELL (pt.), 1929, p. 43.

Tintinnopsis directa: HADA, 1932, p. 557, fig. 4.

Lorica elongated, campanulate, consisting of a low oral flare (55°–90°), a subcylindrical median part, and a globose posterior region, 2.3–2.7 greatest transdiameters of the bowl in length; oral rim formed irregularly, 1.05–1.37 greatest transdiameters of the bowl in oral diameter; median part slightly tapering, narrowest at its distal portion, its shortest diameter 0.75–0.97 greatest diameters of the bowl; aboral end hemispherical; wall coarse in appearance. Length 88 (80–95) μ ; oral diameter 40 (35–48) μ ; greatest transdiameter of the bowl 34 (32–35) μ .

Occurrence:—Palao Islands, very rare; Yap, common.

Distribution:—Mouth of the Tocantins, Bombay, west coast of Borneo (Brandt, 1907); Kurosiwo (Okamura, 1907); Mutsu Bay (Hada, 1932).

Comparison:—The species differs from *T. everta* Kofoid & Campbell and *T. cyathus* Daday in having a distinct globose posterior region.

Remarks:—This species is widely distributed in coastal waters of tropical and temperate regions. The lorica of individuals obtained

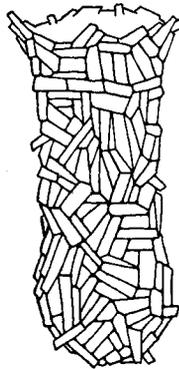


Fig. 12. *Tintinnopsis directa* HADA 500 \times
from Yap

from the lagoon of Yap Island had no spiral structure and was roughened on the oral margin on account of special agglomerated particles of the wall. In this species the greatest transdiameter of the bowl is taken as the standard of proportions because of a variation of the oral diameter.

13. *Tintinnopsis nucula* (FOL) BRANDT

Fig. 13

Codonella nucula: FOL, 1884.

Tintinnopsis nucula: BRANDT (pt.), 1906, pl. 16, figs. 10, 12; 1907, p. 158; KOFOID & CAMPBELL, 1929, p. 41, fig. 47.

Tintinnopsis ventricosa: BRANDT (pt.), 1906, pl. 17, fig. 11; 1907, p. 154.

Tintinnopsis conglobata: HADA, 1932, p. 555, text-fig. 2.

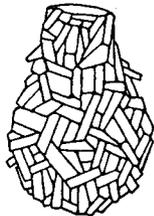


Fig. 13. *Tintinnopsis nucula* (FOL) 500×

Lorica flask-shaped, consisting of a short tubular collar and an ovate bowl, its length 3 oral diameters; collar low, subcylindrical, 0.31 of the total length; bowl ovoid or ellipsoid, 1.8 oral diameters in greatest diameter; oral rim rough; aboral end rounded; wall coarsely agglomerated, no spiral structure. Length 55 μ ; oral diameter 18 μ ; length of the collar 17 μ ; greatest diameter of the bowl 33 μ .

Occurrence:—Lagoon of Yap, remarkably rare.

Distribution:—Bombay, Kiel Bay, mouth of the Tocantins (Brandt, 1907); Mutsu Bay (Hada, 1932).

Comparison:—The species differs from *T. compressa* Daday in the lack of a suboral constriction and from *T. lata* Meunier in the presence of a differentiated collar.

Remarks:—This is a neritic species occurring in warm waters. In this species two different forms are comprised: one is comparatively stout and has a round bowl like specimens described as *T. conglobata* by the present author from Mutsu Bay (1932), while the other is tall and its bowl is ellipsoid. The individuals from Yap Island belong to the former group.

14. *Tintinnopsis radix* (IMHOF) BRANDT

Fig. 14

Tintinnopsis radix: HADA, 1937, p. 166, fig. 18.

Length 140–496 μ ; oral diameter 32–43 μ .

Occurrence:—The Palao Islands, rare; South-west coast of Formosa, west of Borneo, very rare; Singapore, common; southern part of the Java Sea, Strait of Sunda, common.

Distribution:—Cosmopolitan species occurring in neritic waters of the tropical and temperate zones.

Remarks:—This species is exceedingly variable in length. Specimens found from lagoons of the Palao Islands were generally short; 140–200 μ long, but those of the Malay Archipelago were longer; 225–496 μ in length.

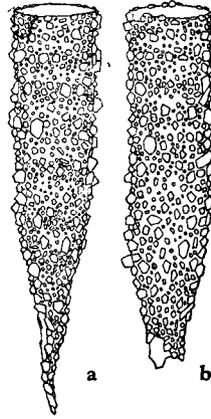


Fig. 14. *Tintinnopsis radix* (IMHOF) 330 \times from the Palao Islands

15. *Tintinnopsis aperta* var. *tocantinensis* KOFOID & CAMPBELL

Fig. 15



Fig. 15. *Tintinnopsis aperta* var. *tocantinensis* KOFOID & CAMPBELL 400 \times

Tintinnopsis aperta var. a: BRANDT, 1906, pl. 25, figs. 2, 7; 1907, p. 177.

Tintinnopsis tocantinensis: KOFOID & CAMPBELL, 1929, p. 48, fig. 46; HADA, 1932, p. 559, text-fig. 8; MARSHALL, 1934, p. 638; HADA, 1935, p. 244.

Lorica generally tubular, 4.1 oral diameters in length; oral margin rough; bowl cylindrical in the anterior two-thirds, posteriorly dilated, its greatest diameter 1.3 oral diameters, distally tapering to an aboral horn opening laterally; wall composed of coarse particles, spiral structure invisible. Length 95 μ ; oral diameter 18 μ .

Occurrence:—Nhatrang, Annam, very rare.

Distribution:—Mouth of Tocantins (Brandt, 1907); Mutsu Bay (Hada, 1932); Great Barrier Reef (Marshall, 1934).

Remarks:—Being different from the typical form of *T. aperta* Brandt only in the small size and in the possession of a somewhat short and stout aboral horn, this form has been identified as a variety of the species.

16. *Tintinnopsis schotti* BRANDT

Fig. 16

Tintinnopsis dadayi var. *a schotti*: BRANDT, 1906, p. 18, pl. 22, fig. 2; 1907, p. 145.

Tintinnopsis schotti: KOFOID & CAMPBELL, 1929, p. 46, fig. 56; HADA, 1935, p. 244.

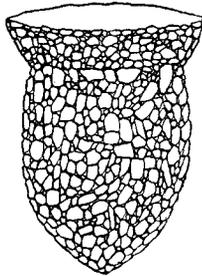


Fig. 16 *Tintinnopsis schotti* BRANDT 440×

Lorica bell-shaped, constricted in the suboral 0.2-0.25 of the total length, 1.15-1.41 oral diameters in length; oral rim irregular; collar widely flaring to form an inverted truncated low cone of 45°-75° with convex sides, its shortest basal diameter 0.68-0.78 of an oral diameter; bowl cup-shaped, usually broadest a little below its middle, 0.75-0.85 of an oral diameter in greatest diameter; aboral region broadly convex conical (90°-120°) to a blunt distal end; wall coarsely agglomerated, thickened to make an inward projection at the nuchal constriction, no spiral structure. Length 100 (96-120) μ; oral diameter 84 (82-85) μ; nuchal diameter 61 (58-65) μ; greatest diameter of the bowl 65 (62-70) μ.

Occurrence:—Coastal area of the western half of the Java sea, abundant.

Distribution:—West of Borneo (Brandt, 1907).

Comparison:—The species differs from *T. orientalis* Kofoid & Campbell in having a more flaring low collar and a more distinct nuchal constriction and from *T. loricata* Brandt in possessing a stouter bowl.

Remarks:—This species is a tropical water inhabitant known from the restricted region of the East Indies.

17. *Tintinnopsis loricata* BRANDT

Fig. 17

Tintinnopsis dadayi var. *b loricata*: BRANDT, 1906, pl. 19, fig. 4, pl. 20, fig. 11; 1907, p. 145.

Tintinnopsis loricata: KOFOID & CAMPBELL, 1929, p. 39, fig. 60.

Lorica elongate bag-shaped, 1.88 oral diameters in length, consisting of a flaring collar and a tall bowl; oral margin roughened; collar dish-like, 0.2 of the total length in height, its basal diameter 0.7 of an oral diameter; bowl gradually expanding (12°), broadest in the position of the posterior 0.2 of the lorica, its

greatest diameter 0.76 oral diameter; aboral region broadly convex conical (137°) to a bluntly pointed end; wall composed of coarse foreign particles without a spiral structure. Length $160\ \mu$; oral diameter $85\ \mu$.

Occurrence:—Singapore, very rare.

Distribution:—West coast of Borneo (Brandt, 1907).

Comparison:—The species differs from *T. schotti* Brandt in the elongate bowl inflated in its posterior part, but the bowl of the latter is widened near its middle.

Remarks:—The specimen examined by the writer was not so ragged on the oral rim as those shown by Brandt (1906) in Pl. 19, fig. 4 and Pl. 20, fig. 7. The distribution of the species is limited, as far as known at present, to only the sea between Borneo and Sumatra.

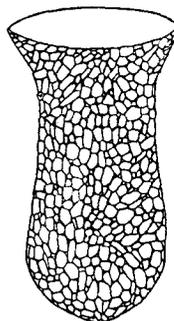


Fig. 17. *Tintinnopsis loricata* BRANDT 250 \times

Genus *Codonella* HAECKEL, 1873

Codonella: HAECKEL (pt.), 1873; BRANDT (pt.), 1907, p. 73; JÖRGENSEN, 1924, p. 90; KOFOID & CAMPBELL, 1929, p. 51.

Lorica usually pot-shaped, apparently divided by a nuchal constriction and an inner shelf into a collar and a bowl; oral rim entire, regularly or irregularly serrated; collar generally forming a short truncated convex cone, sometimes with an elevated suboral ring; bowl rounded or ovate; aboral end round, conical, or flat, with or without a stout aboral horn; wall single-layered with an irregularly reticulated structure, sometimes carrying foreign particles on the surface.

Type species—*Codonella galea* HAECKEL.

This genus is represented by many eupelagic species, but only two species have been examined in the present investigation, because collections were mostly made in neritic waters.

Key to species

1. Lorica bag-like, with a slight elevation at the aboral end; reticulation minute, regular.....*C. inflata* KOFOID & CAMPBELL
2. Lorica elongate, with a stout conical aboral horn; reticulation rather coarse.....*C. rapa* KOFOID & CAMPBELL

18. *Codonella inflata* KOFOID & CAMPBELL

Fig. 18

Codonella nationalis var. d: BRANDT, 1906, pl. 5, fig. 5; 1907, p. 94.
Codonella inflata: KOFOID & CAMPBELL, 1929, p. 61, fig. 108.

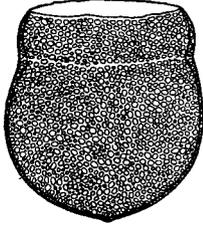


Fig. 18. *Codonella inflata*
 KOFOID & CAMPBELL 500X

Lorica bag-like, 1.4 oral diameters in length; collar distinct from the bowl by a slight nuchal constriction, with a somewhat serrated oral rim, dilated at its middle, 0.27 of the total length in height; bowl rotund, its greatest diameter 1.3 oral diameters; aboral region broadly rounded, showing a trace of elevation at its center; wall thickened on the nuchal constricted border to separate the lorica internally into two distinct parts, reticulation of the surface comparatively regular. Length $55\ \mu$; oral diameter $40\ \mu$.

Occurrence:—Outside of the barrier of the Palao Islands, very rare.

Distribution:—Off Somaliland (Brandt, 1907).

Comparison:—The species differs from *C. acerca* Jörgensen in the possession of a short and more bulging collar and from *C. nationalis* Brandt in the inflated collar and the present of an inclination to become pointed at the aboral end.

Remarks:—The specimens secured in this research are small sized in comparison with ones ($80\text{--}85\ \mu$ in length) observed by Brandt (1907) in the material from the coast of Somaliland in the Indian Ocean.

19. *Codonella rapa* KOFOID & CAMPBELL

Fig. 19

Codonella amphorella var. b: BRANDT, 1906, pl. 7, fig. 4; 1907, p. 100.
Codonella rapa: KOFOID & CAMPBELL (pt.), 1929, p. 65, fig. 130.

Lorica elongate, consisting of a low inflated collar and an ovate bowl with a stout aboral horn, its length 1.8 oral diameters; oral margin minutely serrated or uneven; collar more or less flaring, dish-shaped, 0.2 of the total length in height; nuchal constriction well-developed, 0.8 of an oral diameter; bowl stout ovoidal, broadest above its middle, 1.1 oral diameters in greatest

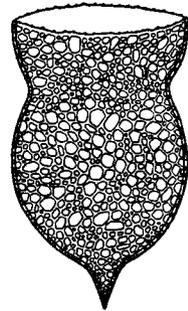


Fig. 19. *Codonella rapa*
 KOFOID & CAMPBELL 500X

diameter; aboral horn forming a short inverted cone of 40°, its length 0.2 of the total length; wall with polygonal secondary structure varying in shape. Length 76 μ ; oral diameter 43 μ .

Occurrence:—Palao Islands, Saipan, exceedingly rare.

Distribution:—New Pomerania (Brandt, 1907); Peruvian Stream, Galapagos Eddy, South Equatorial Stream, of the Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *C. amphorella* Biedermann in having a roughened oral rim and a stouter apical horn and from *C. recta* Kofoid & Campbell in possessing a more flaring collar and a distinct nuchal constriction.

Remarks:—This species seems to be generally distributed in tropical Pacific waters.

Family Codonellopsidae KOFOID & CAMPBELL, 1929

Genus *Stenosemella* JÖRGENSEN, 1924

Stenosemella: JÖRGENSEN, 1924, p. 95; 1927, p. 8; KOFOID & CAMPBELL, 1929, p. 67; HADA, 1937, p. 177.

A cosmopolitan and a tropical species have been found in this study as reported below.

Key to species

1. Lorica ovate; fenestration absent on the collar.....
.....*S. nivalis* (MEUNIER) KOFOID & CAMPBELL
2. Lorica ellipsoid; apparent fenestration present on the collar.....
.....*S. parvicollis* (MARSHALL) HADA

20. *Stenosemella nivalis* (MEUNIER) KOFOID & CAMPBELL

Fig. 20

Stenosemella nivalis: HADA, 1937, p. 178, fig. 26.

Length 36 (35-39) μ ; oral diameter 18 (16-21) μ ; greatest diameter of the bowl 32 (30-33) μ .

Occurrence:—Lagoons of the Palao Islands, Yap, rare.

Distribution:—Cosmopolitically distributed in neritic waters.

Remarks:—The specimens found in the materials taken from the West Caroline Islands differ from those of Japanese waters, such as

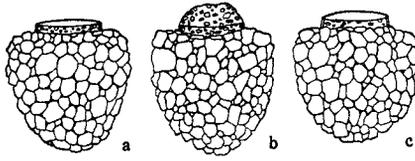


Fig. 20. *Stenosemella nivalis* (MEUNIER)
500× from the Palao Islands

Mutsu and Akkeshi Bays, in the following respects. 1. The lorica is comparatively small and globose. 2. The aboral region is broadly rounded. 3. The shoulder is more squarish. 4. Every specimen has minute particles attached to the surface of the collar.

There have been observed examples of division and conjugation of this organism in collections from the lagoon of Yap.

21. *Stenosemella parvicollis* (MARSHALL) HADA

Fig. 21

Codonellopsis parvicollis: MARSHALL, 1934, p. 640, text-fig. 13.

Stenosemella parvicollis: HADA, 1935, p. 244.

Lorica ovate; 2.2-2.5 oral diameters in length; collar 0.08-0.10 of the total length, provided with a row of 8-9 arched fenestrae; bowl ellipsoid, 1.7-1.9 oral diameters in greatest diameter; aboral end rounded; wall of the bowl coarsely agglomerated. Length 48-60 μ ; oral diameter 19-25 μ ; length of the collar 4-6 μ ; greatest diameter of the bowl 34-47 μ .

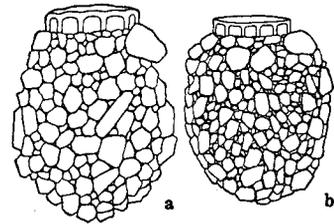


Fig. 21. *Stenosemella parvicollis* (MARSHALL) 500×
a from the Palao Islands
b from the Java Sea

Occurrence:—Lagoons of the Palao Islands, common; at two stations where collections were made in the west part of the Java Sea, abundant.

Distribution:—Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from the other species of *Stenosemella* in having large fenestrae on the collar and from most species of *Codonellopsis* in possessing a short collar consisting of a row of arched fenestrae without a spiral structure.

Remarks:—This species was originally described from the Great Barrier Reef by Marshall (1934) as a species of *Codonellopsis*, but it has been recognized by the present author (1935) to belong to the genus *Stenosemella* because of the possession of the short collar without spiral structure. In this research local variation is observed in size: the specimens obtained from lagoons of the Palao Islands were 57-60 μ in length and 24-25 μ in oral diameter, but those col-

lected from the Java Sea were 48–50 μ in length and 19–20 μ in oral diameter. The number of fenestrae on the collar is rather constant being usually nine or occasionally eight, but Marshall reported that they ranged from five to nine.

Genus *Codonellopsis* JÖRGENSEN, 1924

Codonellopsis: JÖRGENSEN, 1924, p. 98; KOFOID & CAMPBELL, 1929, p. 73; HADA, p. 179.

Five neritic and two oceanic species of this genus have been described in the present report. Of these seven species, three are probably new to science. Discrimination between neritic and eupelagic forms may be indicated by differences of the structure of the bowl, which is deficient in agglomerated materials in the latter.

Key to species

- A. Wall of the bowl composed of agglomerated particles.
- a. A few fenestrae on the collar.
 1. Bowl ovate, aborally conical with a blunt end *C. morchella* (CLEVE) JÖRGENSEN
 2. Lorica stout; bowl spherical.....*C. curta* n. sp.
 3. Lorica elongate; bowl ellipsoid.....*C. americana* KOFOID & CAMPBELL
 4. Lorica tall; bowl globose*C. stativa* n. sp.
 5. Lorica fusiform; bowl posteriorly tapering to a pointed terminal
..... *C. fusiformis* n. sp.
 - b. Numerous fenestrae in spiral rows on the collar.
 6. Bowl rotund.....*C. ostenfeldi* (SCHMIDT) KOFOID & CAMPBELL
- B. Wall of the bowl almost without foreign particles.
7. Lorica stout; bowl rounded.....*C. robusta* KOFOID & CAMPBELL
 8. Lorica provided with an aboral horn....*C. parva* KOFOID & CAMPBELL

22. *Codonella morchella* (CLEVE) JÖRGENSEN

Fig. 22

Codonella morchella: CLEVE, 1900; 1901, p. 10; OKAMURA, 1907, p. 137, pl. 6, figs. 54a, b.

Codonella (?) *morchella*: BRANDT (pt.), 1906, pl. 13, figs. 2, 3, pl. 14, fig. 3; 1907, p. 124.

Codonella (?) *morchella* var. *erythraënsis*: BRANDT, 1906, pl. 14, fig. 4.

Codonellopsis morchella: JÖRGENSEN, 1924, p. 100, fig. 111; KOFOID & CAMPBELL, 1929, p. 83, fig. 165.

Codonellopsis indica: KOFOID & CAMPBELL, 1929, p. 80, fig. 158; MARSHALL, 1934, p. 639, text-fig. 12; HADA, 1935, p. 244.

Codonellopsis erythrænsis: KOFOID & CAMPBELL, 1929, p. 79, fig. 151.

Codonellopsis orientalis: HADA, 1932, p. 563, text-fig. 15.

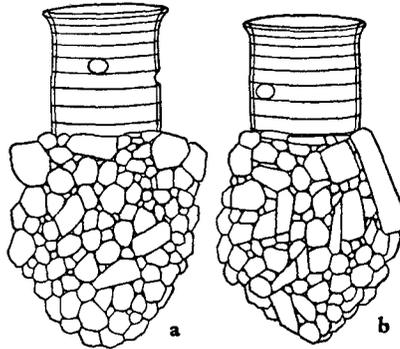


Fig. 22. *Codonellopsis morchella* (CLEVE)
500 \times from the Palao Islands

Lorica 2.2-3.2 oral diameters in length; collar with a somewhat flaring rim, slightly bulging near its middle, usually lower than the bowl, its height 0.22-0.34 of the total length, composed of 4-11 spiral turns with a few elliptical fenestrae; bowl generally ovate, 1.5-1.7 oral diameters in greatest diameter; aboral region convex conical; aboral end usually round or rarely bluntly pointed; wall of the bowl thick, coarsely agglomerated. Length 65-95 μ ; oral diameter 29-32 μ ; length of the collar 14-32 μ , greatest diameter of the bowl 43-65 μ .

Occurrence:—Lagoons of the Palao Islands, frequent; southwest of Formosa, very rare; Java Sea, Strait of Sunda, common.

Distribution:—Occurs in neritic plankton of tropical and temperate regions of the world (Cleve, 1900, 1901; Brandt, 1907; Okamura, 1907; Jörgensen, 1924; Hada, 1932; Marshall, 1934).

Comparison:—The species differs from *C. americana* Kofoid & Campbell in its shorter lorica and ovate bowl instead of an ellipsoid one and from *C. schabi* (Brandt) in its low bowl.

Remarks:—Cleve's original figure of this species is very simple and his description is also short. It seems impossible, in fact, to find specimens having a collar like his figure. Kofoid & Campbell (1929) and the present author (1923), therefore, considered that this species was almost negligible on account of a doubtful existence of specimens answering to Cleve's figure, but in this investigation the author includes various forms under this specific name according to Brandt (1907) and Jörgensen (1924). They possess a cylindrical collar and a coarsely agglomerated ovate bowl and are similar to Cleve's figure in outline.

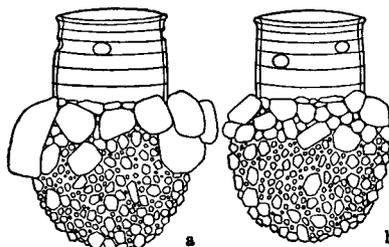
This species is variable in size. The specimens (88-95 μ long) collected in lagoons of the Palao Islands were generally larger than those (length below 88 μ) secured in materials taken from the seas of the East Indies.

23. *Codonellopsis curta* n. sp.

Fig. 23

Codonella morchella: DONS, 1921, p. 76, fig. 25?

Lorica stout, flask-shaped, consisting of a short collar and a spherical bowl, 2.0-2.2 oral diameters in length; oral margin slightly flaring; collar stout, sub-cylindrical, 0.31-0.41 of the total length in height, spiral turns 5-9 in number with a few elliptical fenestrae on median ones; bowl globose, its breadth 1.40-1.46 oral diameters; aboral end hemispherical; wall of the bowl agglomerated with coarse particles on the shoulder border and fine ones in the posterior region. Length 63 (60-66) μ ; oral diameter 30 (29-30) μ ; length of the collar 23 (19-27) μ ; greatest diameter of the bowl 43 (42-44) μ .

Fig. 23. *Codonellopsis curta* n. sp. 500 \times

Occurrence:—Outside the barrier of the Palao Islands, very rare; Saipan, Tinian, abundant.

Comparison:—The species differs from *C. morchella* (Cleve) in marked outline and the roundly ended bowl and from *C. frigida* Hada in the thick and coarse wall of the bowl.

Remarks:—Dons's figure (1921) drawn from the specimen captured near Auckland Island is more or less allied to this new species in general contour, but it is questionable that it belongs to this species, because his drawing is imperfect for identification.

24. *Codonellopsis americana* KOFOID & CAMPBELL

Fig. 24

Codonellopsis americana: KOFOID & CAMPBELL, 1929, p. 75, fig. 159.

Lorica elongated, 3.2-3.4 oral diameters in length; oral rim abruptly flaring, everted; collar slightly shorter than the bowl, 0.41-0.45 of the total length in length, very slightly dilated in its middle, with 11-15 spiral turns and a few transversely oval fenestrae on some median ones; bowl ellipsoidal, 1.45-1.56 oral diameters in greatest diameter; aboral region rounded; wall generally agglomerated with comparatively small particles. Length 106 (102-110) μ ; oral diameter 32 (32-34) μ ; length of the collar 44 (42-48) μ ; greatest diameter of the bowl 48 (45-50) μ .

Occurrence:—Lagoons of the Palao Islands, rare.

Distribution:—California Current (Kofoid & Campbell, 1929).

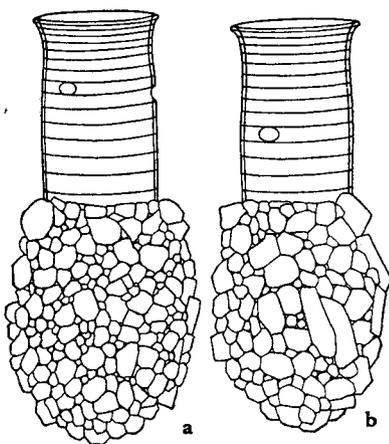


Fig. 24. *Codonellopsis americana*
KOFROID & CAMPBELL 500 \times

Comparison:—The species differs from *C. morchella* Cleve in the ellipsoidal bowl instead of the ovate.

Remarks:—Specimens of this species often occur in company with those of the similar species, *C. morchella*, in plankton of the Palao Islands, but the latter is immediately distinguishable from the former by the shorter collar and the conical aboral region which is rounded in this species.

25. *Codonellopsis stativa* n. sp.

Fig. 25

Lorica tall top-shaped, 2.16–3.28 oral diameters in length; collar with a distinct oral eversion, elongated, somewhat longer than the bowl, 0.52–0.58 of the total length in height, slightly inflated below its middle, composed of 15–21 annular turns widening gradually downwards; bowl comparatively small, ovoid, broadest at its anterior one-third, 1.50–1.57 oral diameters in greatest transdiameter; aboral end usually round or sometimes more or less convex conical; wall of the bowl rather coarse. Length 102 (95–115) μ ; oral diameter 32 (30–35) μ ; length of the collar 55 (50–60) μ ; greatest transdiameter of the bowl 48 (45–51) μ .

Occurrence:—Palao Islands, rare.

Comparison:—The species differs from *C. americana* Kofoid & Campbell and *C. morchella* (Cleve) in the relative length of the collar to the bowl and from *C. brevicaudata* (Brandt) in the absence of the aboral horn.

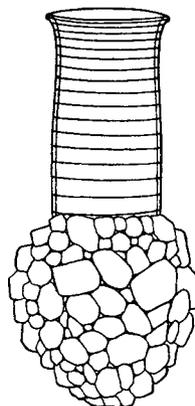


Fig. 25. *Codonellopsis stativa* n. sp. 500 \times

26. *Codonellopsis fusiformis* n. sp.

Fig. 26

Lorica fusiform, 3.1–3.5 oral diameters in length; collar subcylindrical with a moderate oral flare and a slight submedian bulge, 0.35–0.40 of the total length,

spiraled with 7-9 turns on which a few ovate fenestrae appear near the middle of the collar; bowl stout fusiform, broadest a little above its middle, 1.27-1.34 oral diameters in greatest diameter; aboral region conical (65° - 85°) to a subacute aboral end; wall usually neatly agglomerated with elongate polygonal flakes. Length 107 (93-115) μ ; oral diameter 33 (32-34) μ ; length of the collar 39 (35-43) μ ; greatest diameter of the bowl 68 (63-73) μ .

Occurrence:—Yap, common.

Comparison:—The species differs from the allied species of *D. morchella* (Cleve) in the tapering aboral region with a pointed end.

Remarks:—The agglomerated material consisting of thin flakes in specimens of Yap Island seems to be not an important characteristic of this species, because most of species of the Tintinnoinea with the agglomerated wall in the collections of Yap Island usually possess such flakes. If this species should be found from other localities in the future, it is probable that the wall will be composed of some other foreign particles different from this case.

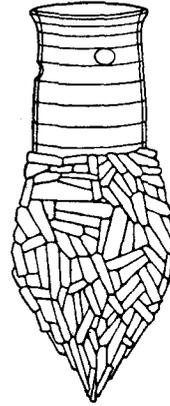


Fig. 26. *Codonellopsis fusiformis* n. sp. 500 \times

27. *Codonellopsis ostenfeldi* (SCHMIDT) KOFOID & CAMPBELL

Fig. 27

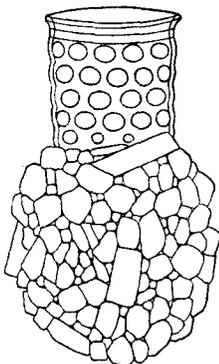


Fig. 27. *Codonellopsis ostenfeldi* (SCHMIDT) 500 \times

Codonella ostenfeldi: SCHMIDT, 1901; BRANDT, 1906, pl. 14, figs. 1, 2, pl. 15, fig. 2, pl. 20, fig. 10; 1907, p. 122; OKAMURA, 1907, p. 137, pl. 6, figs. 3a, b.

Codonella fenestrata: CLEVE, 1901, pp. 9, 53, pl. 7, fig. 15.

Codonellopsis ostenfeldi: KOFOID & CAMPBELL, 1929, p. 84, fig. 160; MARSHALL, 1934, p. 638; HADA, 1935, p. 245.

Lorica flask-shaped, 2.7-3.0 oral diameters in length; oral margin entire, slightly flaring; collar subcylindrical, 0.40-0.43 of the total length in height, with 2-4 spiral turns in its anterior 0.15 and 5-6 annular rows of elliptical fenestrae lying transversely on the lower part; bowl globose, its greatest trans-diameter 1.6 oral diameters; aboral end broadly rounded; wall agglomerated with coarse foreign

particles. Length 95–112 μ ; oral diameter 35–38 μ ; length of the collar 38–50 μ ; greatest transdiameter of the bowl 55–62 μ .

Occurrence:—Palao Islands, common; between Borneo and Sumatra, very rare; Java Sea, Strait of Sunda, frequent.

Distribution:—Kurosiwo (Okamura, 1907); Gulf of Siam (Schmidt, 1901); Malay Archipelago (Cleve, 1901; Brandt, 1907); Great Barrier Reef Marshall, 1934); Arabia and Red Seas (Cleve, 1903 after Brandt, 1907); off Zanzibar (Brandt, 1907).

Comparison:—The species differs from the other species of *Codonellopsis* in having spiral rows of numerous fenestrae on the collar.

Remarks:—From the former records, this species is widely distributed in warm waters of the Indo-Pacific.

28. *Codonellopsis robusta* KOFOID & CAMPBELL

Fig. 28

Codonellopsis robusta: KOFOID & CAMPBELL, 1929, p. 87, fig. 152.

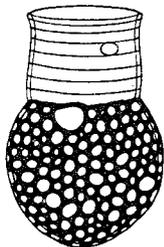


Fig. 28. *Codonellopsis robusta* KOFOID & CAMPBELL 500 \times

Lorica stout top-shaped, 2.0–2.2 oral diameters in length; oral rim weakly flaring; collar with a slight submedian bulge, 0.32–0.37 of the total length in height, annulated with 6–7 spiral turns on which a very few fenestrae lie near the middle of the collar; bowl rounded, 1.3 oral diameters in breadth; aboral end typically hemispherical; wall uniform in thickness throughout the bowl, variously sized oblong or irregular areas on the surface. Length 62 (60–63) μ ; oral diameter 30 (28–30) μ ; length of the collar 21 (20–22) μ ; greatest transdiameter of the bowl 40 μ .

Occurrence:—Outside the barrier of the Palao Islands, rare.

Distribution:—California Current (Kofoid & Campbell, 1929).

Comparison:—The species differs from *C. frigida* Hada in the structure of the wall of the bowl.

Remarks:—The specimens observed in the present investigation are generally smaller in size than those of the Albatross collections examined by Kofoid & Campbell (1929). This species resembles *C. frigida*, but is distinct from the latter in the above mentioned respect, moreover, from their distribution it seems to be reasonable that they are separated from each other.

29. *Codonellopsis parva* KOFOID & CAMPBELL

Fig. 29

Codonella orthocera var. d: BRANDT, 1906, pl. 4, fig. 14, pl. 11, figs. 1a-c; 1907, p. 112.

Codonella orthocera var. e: BRANDT, 1906, pl. 4, fig. 15, pl. 7, fig. 6a, pl. 10, figs. 5, 5a, b; 1907, p. 112.

Codonellopsis parva: KOFOID & CAMPBELL, 1929, p. 86, fig. 170.

Lorica consisting of a subcylindrical collar and a stout bowl with an aboral horn, 3.1-3.4 oral diameters in length; oral rim abruptly flaring; collar nearly cylindrical, 0.33-0.38 of the total length in height, having 13-16 spiral turns; bowl with a short cylindrical anterior part which is 0.055-0.068 of the total length, globular in the posterior main region, its greatest transdiameter 1.34 oral diameters; aboral horn 0.20-0.25 of the total length, tapering to a blunt tip; wall of the bowl composed of a reticulate structure; surface rather smooth, almost without agglomerated materials. Length 158-180 μ ; oral diameter 50-52 μ ; length of the collar 52-60 μ ; greatest transdiameter of the bowl 68-70 μ ; length of the aboral horn 30-38 μ .

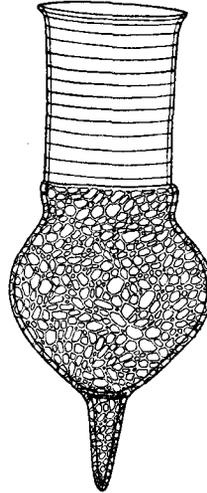


Fig. 29. *Codonellopsis parva* KOFOID & CAMPBELL 400 \times

Occurrence:—Palao Islands, very rare.

Distribution:—Equatorial Counter Current, South Equatorial Stream, Panamic Area, and Galapagos Eddy in the Pacific (Kofoid & Campbell, 1929); Gulf and Atlantic Streams, Sargasso Sea (Brandt, 1907).

Comparison:—The species differs from *C. pura* Brandt in being longer and having a distinct cylindrical region at the upper part of the bowl.

Remarks:—This species is probably eupelagic, so the reticulate structure of the bowl is free from foreign particles. *C. speciosa* is similar to this species in general contour except the possession of the comparatively elongate collar; the feature is probably restricted to this species, though that can not be stated conclusively on account of the scarcity of specimens in this research.

Family Coxliellidae KOFOID & CAMPBELL, 1929

Genus *Coxliella* BRANDT, 1907

Coxliella: BRANDT (pt.), 1907, p. 259; LAACKMANN, 1909, p. 454; JÖRGESEN, 1924, p. 71; 1927, p. 11; KOFOID & CAMPBELL, 1929, p. 95; HADA, 1937, p. 181.

This genus is divided into two subgenera, *Coxliella* Kofoid & Campbell and *Protocoxliella* Jörgensen, from the structure of the wall. The former is composed of entirely separated laminae with a distinct secondary structure, and the latter is made up of imperfectly separated ones without highly developed secondary structure. In this research two species belonging to each subgenus have been studied as follows.

Key to species

1. Lorica bullet-shaped, with completely separated laminae
..... *C. longa* (BRANDT) LAACKMANN
2. Lorica conical, with partially separated laminae.....
..... *C. mariana* n. sp.

30. *Coxliella longa* (BRANDT) LAACKMANN

Fig. 30

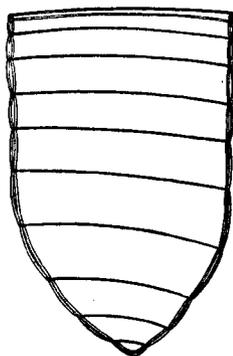


Fig. 30. *Coxliella longa*
(BRANDT) 350×

Cyttarocyclus ? *ampla* var. *c longa*: BRANDT, 1906, pl. 28, fig. 3.

Cyttarocyclus ? *laciniosa* var. *longa*: BRANDT, 1907, p. 272.

Coxliella laciniosa var. *longa*: LAACKMANN, 1909, p. 456.

Coxliella longa: KOFOID & CAMPBELL, 1929, p. 101, fig. 196.

Lorica stout bullet-shaped, 1.5-1.8 oral diameters in length, nearly cylindrical in its anterior two-thirds, then conical (80°-90°) in its posterior one-third; oral rim irregular; aboral end often more or less curved, bluntly or acutely pointed; 10-27 annulated lines seen in front view; wall composed of completely separated lamellae having a fine reticulation. Length 120-150 μ; oral diameter 75-85 μ.

Occurrence:—Lagoons of the Palao Islands, very rare.

Distribution:—New Pomerania (Brandt, 1907).

Comparison:—The species differs from *C. ampla* (Jørgensen) in bearing perfectly separated laminae and from *C. laciniosa* (Brandt) in being cylindrical in the upper main part and having no well-developed aboral horn.

Remarks:—The specimens examined in this work are slightly different from Brandt's figure (1906, Pl. 28, fig. 3) drawn from an individual taken near New Pomerania in being stouter and in the lack of a distinct oral serration, and they are variable in the number of spiral turns and in the shape of the distal end which is usually pointed, bluntly conical, or slightly rounded.

31. *Coxiella mariana* n. sp.

Fig. 31

Lorica small, convex conical in general contour changing from 20° to 100°, 1.2-1.4 oral diameters in length; oral margin smooth; aboral end somewhat tapering to a pointed terminal; wall with 8 spiral turns, partially separated, hyaline, reticulated structure invisible. Length 60-65 μ ; oral diameter 45-50 μ .

Occurrence:—Tinian, very rare.

Comparison:—The new species differs from *C. ampla* (Jørgensen) in the more conical lorica, from *C. laciniosa* in incompletely separated lamellae, and from *C. longa* (Brandt) in being smaller and conical.

Remarks:—This new species is considered to belong to the subgenus *Protocoxiella* Jørgensen, because the wall shows a weak development of separation.

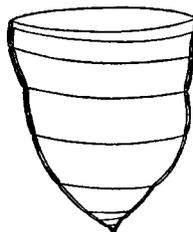


Fig. 31. *Coxiella mariana* n. sp. 500 \times

Genus *Helicostomella* JØRGENSEN, 1924

Helicostomella: JØRGENSEN, 1924, p. 24; KOFOID & CAMPBELL, 1929, p. 104; HADA, 1937, p. 183.

A single characteristically small-sized species is reported in this paper.

32. *Helicostomella longa* (BRANDT) KOFOID & CAMPBELL

Fig. 32

Tintinnus mediterraneus var. *longa*: BRANDT, 1906, pl. 65, figs. 6-8; OKAMURA, 1907, p. 140, pl. 6, fig. 66.



Fig. 32. *Helicostomella longa* (BRANDT) 500×

Tintinnus patagonicus: BRANDT, 1907, p. 401.

Helicostomella longa: KOFOID & CAMPBELL, 1929, p. 106, fig. 206.

Lorica small, bullet-shaped, its length 2.2-3.5 oral diameters, expanding very slightly near the middle; oral rim without dentation; anterior subcylindrical part 0.40-0.56 of the total length, with 2-9 annular lines; aboral region conical (38°-41°); aboral end usually pointed, sometimes provided with a poorly marked aboral horn; wall hyaline. Length 53 (40-63) μ ; oral diameter 18 (17-18) μ .

Occurrence:—Palao Islands, rare; Yap, common.

Distribution:—Off the coast of Patagonia (Brandt, 1907); Kuro-siwo off Tosa (Okamura, 1907).

Comparison:—The species differs from the other species of *Helicostomella* in smaller size and stouter form.

Remarks:—Most species of *Helicostomella* are generally elongate and slender, but only this species is especially small and short, hence it is easily distinguishable from the other species.

Family Cyttarocylidae KOFOID & CAMPBELL

Genus *Cyttarocylis* FOL, 1881

Cyttarocylis: FOL, 1881, p. 22; DADAY (pt.), 1887, p. 574; BRANDT (pt.), 1907, p. 181; LAACKMANN, 1909, p. 443; JÖRGENSEN, 1924, p. 77; KOFOID & CAMPBELL, 1929, p. 109.

Lorica baggy or subconical, consisting of a collar and a bowl; oral margin entire or denticulate; collar usually forming a low truncated funnel with an inner shelf and a nuchal constriction; bowl rotund or convex conical; aboral end rounded, pointed, slightly elevated, or with a short horn; wall composed of separated laminae with a distinct reticulation of numerous polygons varying in size.

Type species—*Cyttarocylis cassis* (HAECKEL) FOL.

Two warm water species of a wide distribution in tropical and subtropical regions have been found in materials obtained from the West Caroline Islands.

Key to species

1. Lorica stout, baggy *C. brandti* KOFOID & CAMPBELL
2. Lorica elongate, conical *C. acutiformis* KOFOID & CAMPBELL

33. *Cyttarocyliis brandti* KOFOID & CAMPBELL

Fig. 33

Cyttarocyliis plagiostoma: BRANDT (pt.), 1906, pl. 35, fig. 7, pl. 36, fig. 6; 1907, p. 198.

Cyttarocyliis plagiostoma var. a: BRANDT, 1906, pl. 36, figs. 1, 1a, 4, 4a, 8; 1907, p. 199; LAACKMANN, 1909, p. 447.

Cyttarocyliis brandti: KOFOID & CAMPBELL, 1929, p. 111, fig. 215.

Cyttarocyliis longa: KOFOID & CAMPBELL, 1929, p. 113, fig. 217.

Lorica inverted helmet-shaped, 0.9 oral diameter in length; oral margin irregularly serrated; collar low, abruptly flaring (72° - 85°), 0.1 of the total length in height, its basal diameter 0.85-0.87 of an oral diameter; bowl bag-like, broadest near the distinct nuchal conjunction; aboral region broadly convex conical (135° - 142°) with a slight elevation at the aboral end; wall irregularly reticulated, polygons usually becoming smaller towards the distal end. Length 95-108 μ ; oral diameter 108-120 μ .

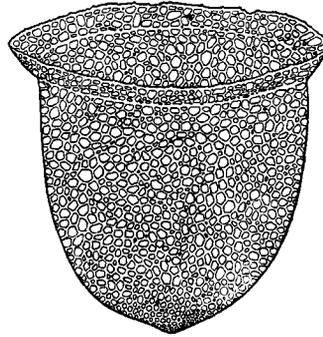


Fig. 33. *Cyttarocyliis brandti*
KOFOID & CAMPBELL 350 \times

Occurrence:—Outside the barrier of the Palao Islands, very rare.

Distribution:—Widely distributed in warm waters of the Pacific, Atlantic, and Indian Oceans (Brandt, 1907; Laackmann, 1909; Kofoid & Campbell, 1929).

Comparison:—The species differs from *C. eucecryphalus* (Haeckel) in having an aboral elevation and from *C. plagiostoma* (Daday) in the more baggy bowl and the rounded aboral end instead of pointed.

Remarks:—This form has been separated by Kofoid & Campbell (1929) into two species, *C. brandti* and *C. longa*, from a relative degree of bagginess of the lorica and the shape of the aboral end. Notwithstanding a careful comparison with Brandt's figures (1906, Pl. 35, fig. 7 and Pl. 36, fig. 1) on which Kofoid & Campbell's description of these species was based, it was impossible to observe distinct differences between them, and moreover, the bowl and the aboral end are very changeable in shape. Therefore, they have been included under the single species, *C. brandti*, in this paper.

34. *Cyttarocyliis acutiformis* KOFOID & CAMPBELL

Fig. 34

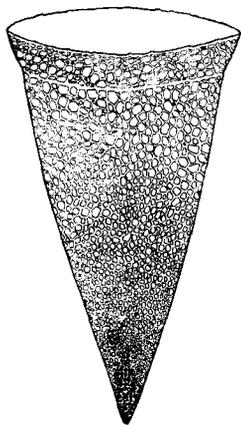


Fig. 34. *Cyttarocyliis acutiformis* KOFOID & CAMPBELL 230×

Cyttarocyliis cassis var. c: BRANDT, 1906, pl. 35, fig. 6.

Cyttarocyliis var. d: BRANDT, 1906, pl. 35, figs. 1, 1a, 2, 2a; 1907, p. 197; LAACKMANN, 1909, p. 447.

Cyttarocyliis acutiformis: KOFOID & CAMPBELL, 1929, p. 111, fig. 221.

Lorica forming a tall inverted cone, 1.75 oral diameters in length; oral margin irregularly dentate; collar low funnel-shaped (48°), convex outwardly, 0.11 of the total length in height, its basal diameter 0.84 oral diameter; bowl conical, slightly convex; aboral end bluntly pointed; wall reticulated with comparatively minute polygons which are larger near the nuchal constriction. Length 223 μ ; oral diameter 127 μ .

Occurrence:—Palao Islands, very rare.

Distribution:—California, Pervian, and South Equatorial Streams of the Pacific, Panamic Area in the Pacific (Kofoid & Campbell, 1929); New Pomerania (Brandt, 1907); Gulf, Brazil, and North and South Equatorial Streams of the Atlantic, Sargasso Sea (Brandt, 1907; Laackmann, 1909); off Madagascar (Brandt, 1907).

Comparison:—The species differs from *C. magna* Brandt in size and the lack of an aboral horn and from *C. cassis* (Haeckel) in being slender and showing less inflation of the bowl.

Remarks:—The distribution of this species is nearly the same as that of *C. brandti*.

Genus *Poroecus* CLEVE, 1902

Poroecus: CLEVE, 1902; JÖRGENSEN 1924, p. 31; KOFOID & CAMPBELL, 1929, p. 116.

Lorica capsular; oral margin entire or roughened; bowl usually cylindrical; aboral region rounded or convex conical, with or without an aboral horn; wall composed of two lamellae which are often almost fused, secondary reticulated structure sometimes visible, coccoliths generally attached to the surface.

Type species—*Poroecus apiculatus* (CLEVE) CLEVE.

This genus is a small group including several rare species. In this research two forms have been studied: each is very rare in the seas where collections were made.

Key to species

1. Lorica elongate, with an aboral horn.....*P. apiculatus* (CLEVE) CLEVE
2. Lorica rotund; aboral end hemispherical.....*P. rotundatus* HADA

35. *Poroecus apiculatus* (CLEVE) CLEVE

Fig. 35

Porella apiculata: CLEVE, 1900.

Poroecus apiculatus: CLEVE, 1902; JÖRGENSEN, 1924, p. 31, fig. 36; KOFOID & CAMPBELL, 1929, p. 118, fig. 225.

Cyttarocylis apiculatus: BRANDT, 1906, pl. 32, figs. 3-5; 1907, p. 203.

Lorica tall goblet-shaped, 3.2 oral diameters in length; oral margin almost entire; bowl subcylindrical, slightly tapering (5°); aboral region abruptly narrowing (68°) with a tubular horn, of which the length is 0.42 of the total length; wall bearing coccoliths fixed thicker on the surface of the posterior part than on that of the anterior. Length 95μ ; oral diameter 30μ ; aboral horn 40μ .

Occurrence:—Palao Islands, remarkably rare.

Distribution:—South Atlantic (Cleve, 1900); Sargasso Sea (Brandt, 1907); Bay of Cadiz, Spain, Adriatic Sea (Jørgensen, 1924); South Indian Ocean (Cleve, 1901); South Equatorial Stream (Kofoid & Campbell, 1929).

Comparison:—The species differs from the other species of *Poroecus* in having an elongate aboral horn.

Remarks:—A single specimen shown in fig. 35 was detected in this work. It is different from prior descriptions of this species in the presence of an aboral opening which seems to be broken by accident. If an aboral opening is always observed in any individual, the form would probably be an independent species from *P. apiculata*.

This species is variable in the structure of the lorica: the specimens reported by Brandt (1906-7) as this species from the Sargasso

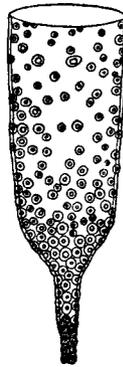


Fig. 35. *Poroecus apiculatus* (CLEVE) 500×

Sea did not bear coccoliths on the surface and secondary reticulated structure was apparently seen, and ones of the South Equatorial Stream of the Pacific examined by Kofoid & Campbell (1929) exhibited an irregular oral margin.

36. *Poroecus rotundatus* HADA

Fig. 36

Poroecus rotundatus: HADA, 1935, pp. 242, 245, fig. 2.



Fig. 36. *Poroecus rotundatus* HADA 500 ×

Lorica stout capsular, 1.1 oral diameters in length, more or less cylindrical in the upper half, rounded in the lower; wall with variously sized coccoliths on the surface. Length 40 μ ; oral diameter 36 μ .

Occurrence:—Macassar Strait, exceedingly rare.

Comparison:—The species differs from the other published species of *Poroecus* in rotund outline.

Genus *Favella* JÖRGENSEN, 1924

Favella: JÖRGENSEN (pt.), 1924, p. 25; 1927, p. 10; KOFOID & CAMPBELL, 1929, p. 147; HADA, 1937, p. 186.

Two species and one new variety have been described in this paper. They were found in the collections of the West Caroline and Mariana Islands and indicated a fine reticulation.

Key to species

- A. Lorica without an aboral horn.
 - 1. Oral rim entire*F. azorica* (CLEVE) JÖRGENSEN
- B. Lorica with an aboral horn.
 - 2. Oral rim irregular.....*F. campanula* (SCHMIDT) KOFOID & CAMPBELL
 - 3. Oral margin regularly denticulated...*F. campanula* var. *palaoensis* n. var.

37. *Favella azorica* (CLEVE) JÖRGENSEN

Fig. 37

Undella azorica: CLEVE, 1900.

Favella azorica: JÖRGENSEN (pt.), 1924, p. 26, fig. 28; KOFOID & CAMPBELL, 1929, p. 151, fig. 284; MARSHALL, 1934, p. 642, text-fig. 15.

Favella azorica var. *campanula*:
JÖRGENSEN, 1924, p. 27, fig. 30.

Lorica inverted bell-shaped, 1.4-1.8 suboral diameters in length; oral margin entire with a slight brim; oral annular band usually single, single-layered; bowl cylindrical in the anterior half of the lorica, posteriorly convex conical (80° - 85°) to a rounded end; wall hyaline, distinctly separated in the dilated band below the suboral annular ring and in the aboral end, but scarcely in the other part. Length 83 (68-100) μ ; oral diameter 52 (48-58) μ .

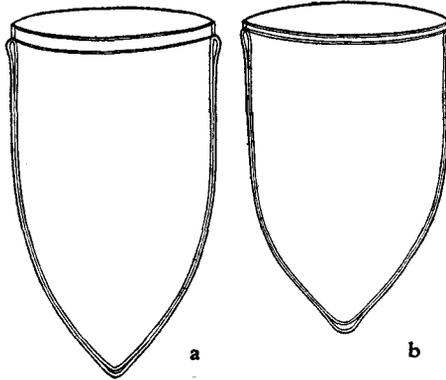


Fig. 37. *Favella azorica* (CLEVE) 500 \times

Occurrence:—Palao Islands, rare; Saipan, Tinian, very rare.

Distribution:—Azores (Cleve, 1900); Mediterranean (Jörgensen, 1924); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *F. campanula* (Schmidt) in the lack of an aboral horn and from *F. composita* Jörgensen in possessing fewer annular rings.

Remarks:—The species is surely a tropical inhabitant from its known localities and also is widely distributed in the areas of the West Caroline and Mariana Islands.

38. *Favella campanula* (SCHMIDT) KOFOID & CAMPBELL

Fig. 38

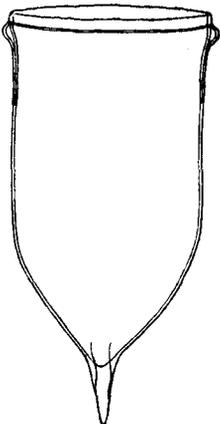


Fig. 38. *Favella campanula* (SCHMIDT) 400 \times

Undella campanula: SCHMIDT, 1901.

Favella campanula: KOFOID & CAMPBELL, 1929, p. 151, fig. 281.

Lorica campanulate, 2.1 oral diameters in length; oral rim more or less irregular; bowl with a raised band just below the suboral ring, cylindrical in its upper 0.65; aboral region convex conical (80°) to a stout horn; aboral horn having a few vertical striae on the surface, tapering (20°) to a bluntly pointed tip, its length 0.15 of the total length; wall almost hyaline with a hardly visible reticulation, apparently separated in the suboral inflated part and scarcely in the following 0.15 of the total length. Length 143 μ ; oral diameter 68 μ .

Occurrence:—Yap, remarkably rare.

Distribution:—Gulf of Siam (Schmidt, 1901).

Comparison:—The species differs from *F. azorica* (Cleve) in the presence of an aboral horn.

39. *Favella campanula* var. *palaoensis* n. var.

Fig. 39

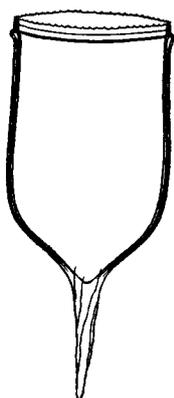


Fig. 39. *Favella campanula* var. *palaoensis* n. var. 250×

Lorica goblet-shaped, 2.2-2.6 oral diameters in length; consisting of a suboral annulated part, a campanulate bowl, and an aboral horn; oral rim regularly serrated with numerous minute teeth; suboral part with one or two annular bands; bowl slightly expanding on its anterior margin, nearly cylindrical in its upper half, somewhat inflated and broadest at the portion of the posterior one-third, then aborally convex conical (85°-100°); aboral horn made of a tall cone with several marked oblique ridges, 0.19-0.24 of the total length, pointed at tip; wall entirely separated, with a very fine reticulation. Length 172-210 μ ; oral diameter 75-80 μ .

Occurrence:—Palao Islands, rare.

Comparison:—The new variety differs from the typical form of *F. campanula* (Schmidt) in having a regular dentation and from *F. franciscana* Kofoid & Campbell in the stout bowl and fine reticulation of the wall.

Family Ptychocylidae KOFOID & CAMPBELL, 1929

Genus *Epiplocylis* JÖRGENSEN, 1924

Epiplocylis: JÖRGENSEN (pt.), 1924; p. 54; KOFOID & CAMPBELL (pt.), 1929, p. 172.

Lorica tall or low goblet-shaped; oral margin entire with a thin wall; suboral region often somewhat inflated; bowl globose, conical, or cylindrical, usually convex conical in the aboral region provided with a tapering horn with an acute tip; wall composed of separated lamellae with a fine primary structure, thickened in the suboral dilated part, posteriorly covered with an uneven coarse reticulation

of the outer lamella, small ovate fenestrae often appearing in its meshes.

Type species—*Epiplocylis acuminata* (DADAY) JÖRGENSEN.

In the present investigation the group of Jörgensen's (1924) and Kofoid & Campbell's (1929) *Epiplocylis* having an oral gutter and a partially separated wall is divided into two genera, this genus and a new genus *Epiplocyloides*. Four species and three varieties have been secured in the materials.

The species of this genus are mostly oceanic plankters occurring in warm water regions.

Key to species

- A. Primary structure of the wall fine.
- a. Suboral dilation slight; coarse reticulation on the aboral region.
 1. Lorica stout, subcylindrical in the bowl.....*E. undella* (OSTENFELD & SCHMIDT) JÖRGENSEN
 2. Lorica globose in outline..*E. undella* var. *constricta* KOFOID & CAMPBELL
 3. Lorica elongate, nearly cylindrical in the bowl.....*E. undella* var. *blanda* JÖRGENSEN
 - b. Suboral inflation distinct; coarse reticulation covering the bowl except the suboral region.
 4. Lorica low, conical.....*E. calyx* (BRANDT) JÖRGENSEN
 5. Lorica tall, conical.....*E. calyx* var. *labiosa* KOFOID & CAMPBELL
 6. Lorica subcylindrical in the bowl, rounded in the aboral region.....*E. lata* KOFOID & CAMPBELL
- B. Primary structure of the wall rather coarse in the anterior half of the lorica.
7. Lorica ovate, without a conspicuous suboral dilation.....*E. deflexa* KOFOID & CAMPBELL

40. *Epiplocylis undella* (OSTENFELD & SCHMIDT) JÖRGENSEN

Fig. 40

Cyrtarocylis undella: OSTENFELD & SCHMIDT, 1901.

Ptychocylis undella: BRANDT, 1906, pl. 60, figs. 6, 6a; 1907, 292; OKAMURA, 1907, p. 139, pl. 6, fig. 51; 1912, p. 33, pl. 5, fig. 97.

Ptychocylis undella var. a: BRANDT, 1906, pl. 59, fig. 1; 1907, p. 294.

Ptychocylis undella var. n *sargassensis*: BRANDT, 1906, pl. 60, figs. 5, pl. 61, fig. 7; 1907, p. 298.

Epiplocylis undella: JÖRGENSEN, 1924, p. 54, fig. 61; KOFOID & CAMPBELL, 1929, p. 185, fig. 345; MARSHALL, 1934, p. 645, text-fig. 18.

Epiplocylis atlantica: KOFOID & CAMPBELL, 1929, p. 176, fig. 340.

Epiplocylis sargassensis: KOFOID & CAMPBELL, 1929, p. 185, fig. 331.

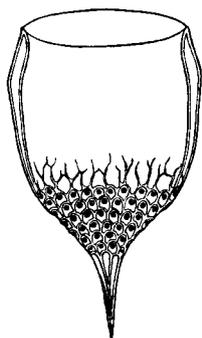


Fig. 40. *Epiplocylis undella* (OSTENFELD & SCHMIDT) 400×
from the South China Sea

Epiplocylis blanda: HADA, 1935, p. 245.

Epiplocylis constricta: HADA, 1935, p. 245.

Lorica goblet-shaped, 1.7-1.9 oral diameters in length; bowl subcylindrical in its upper half, slightly dilated near the portion of its anterior one-third, convex conical (60° - 90°) in the aboral region; aboral horn forming an inverted tall cone of 10° - 20° with a pointed tip, of which the length is 0.20-0.32 of the total length; coarse reticulation appearing in the narrowing aboral region, having ovate fenestrae in most of its meshes. Length 100-128 μ ; oral diameter 55-75 μ ; length of the aboral horn 25-36 μ .

Occurrence:—Outside the barrier of the Palao Islands, rare; South China Sea, very rare; Sulu Sea, rare.

Distribution:—Red Sea (Ostenfeld & Schmidt, 1901); Mediterranean (Brandt, 1907; Jørgensen, 1924); warm water regions of the Atlantic (Brandt, 1907); Kurosiwo (Okamura, 1907, 1912); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *E. deflexa* Kofoid & Campbell in the structure of the upper clear zone.

Remarks:—Remarkably varying in shape, proportion, and caudal elongation, this species has four varieties besides the type form. Among them the rotund ovate and the tall cylindrical ones are respectively named var. *constricta* Kofoid & Campbell and *blanda* Jørgensen; both are reported in this paper. The low conical form is var. *exquisita* Kofoid & Campbell corresponding to Brandt's *E. undella* varieties e and f, and the rest, var. *impensa*, including Kofoid & Campbell's *E. lineata* is similar to the main form in size, but different in being more conical. The last one agrees with Brandt's *E. undella* varieties i, k, and l.

Specimens in the present collections, which are comparatively tall, are fairly difficult to distinguish from var. *blanda*.

41. *Epiplocylis undella* var. *constricta* KOFOID & CAMPBELL

Fig. 41

Ptychocylis undella var. e: BRANDT, 1906, pl. 56, fig. 2; 1907, p. 295.

Epiplocylis constricta: KOFOID & CAMPBELL, 1929, p. 177, fig. 333. MARSHALL, 1934, p. 643.

Epiplocylis pacifica: KOFOID & CAMPBELL, 1929, p. 184, fig. 335.

Lorica 1.6-1.8 oral diameters in length; bowl rounded, inflated in the suboral region, broadest at the anterior 0.20-0.24 of the total length, its greatest transdiameter 1.1-1.2 oral diameters; aboral region convex conical (90°); aboral horn tapering (15°-17°) to a pointed tip, 0.21-0.25 of the total length; wall coarsely reticulated in the aboral 0.35 of the bowl. Length 95-100 μ; oral diameter 56-57 μ; length of the aboral horn 20-25 μ.

Occurrence:—Palao Islands, Tinian, very rare.

Distribution:—New Pomerania (Brandt, 1907); Great Barrier Reef (Marshall, 1934); warm waters of the East Pacific (Kofoid & Campbell, 1929).

Remarks:—Though Kofoid & Campbell's *E. pacifica* is different from the present variety in a little larger size and a somewhat wider reticulated zone, it is probably merged into this variety judging from the close resemblance of the general outline. This has been known to be widely scattered only in warm waters of the Pacific.

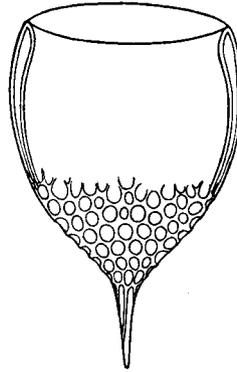


Fig. 41. *Epiplocylis undella* var. *constricta* KOFOID & CAMPBELL 500× from the Palao Islands

42. *Epiplocylis undella* var. *blanda* JÖRGENSEN

Fig. 42

Tintinnus mucronatus: ZACHARIAS, 1906, p. 555, fig. 17.

Ptychocylis undella var. b: BRANDT, 1906, pl. 61, fig. 3; 1907, p. 294.

Ptychocylis undella var. m: BRANDT, 1906, pl. 59, fig. 5, pl. 61, fig. 8; 1907, p. 298.

Ptychocylis undella var. o: BRANDT, 1906, pl. 60, fig. 3; 1907, p. 299.

Epiplocylis undella var. *blanda*: JÖRGENSEN, 1924, p. 55, fig. 62.

Epiplocylis blanda: KOFOID & CAMPBELL, 1929, p. 176, fig. 341; MARSHALL, 1934, p. 644, text-fig. 19.

Epiplocylis mucronata: KOFOID & CAMPBELL, 1929, p. 183, fig. 346.

Epiplocylis obtusa: KOFOID & CAMPBELL, 1929, p. 183, fig. 339.

Lorica elongate, 2 oral diameters in length; bowl nearly cylindrical except a reticulated convex conical (85°) aboral region; aboral horn 0.23 of the total length, tapering (15°-20°) to a distal point. Length 130 μ; oral diameter 69 μ; length of the aboral horn 30 μ.

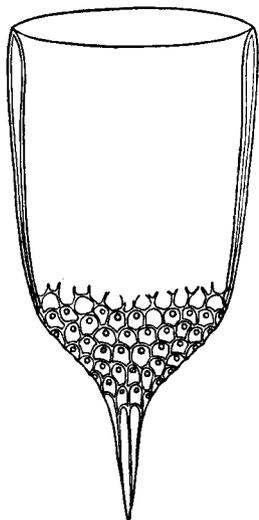


Fig. 42. *Epiplocylis undella* var. *blanda*
JÖRGENSEN 500×

Occurrence:—Tinian, very rare.

Distribution:—Mediterranean (Zacharias, 1906; Brandt, 1907; Jörgensen, 1924); Sargasso Sea, North Equatorial Stream of the Atlantic (Brandt, 1907); New Pomerania (Brandt, 1907); Great Barrier Reef (Marshall, 1934).

Comparison:—The variety differs from the typical form of *E. undella* (Ostenfeld & Schmidt) in having a longer and more cylindrical bowl.

Remarks:—In the present materials from the South Sea Islands and the East Indies, this variety was not observed in company with the typical form as in Jörgensen's (1924) examination of the collections from the Mediterranean.

43. *Epiplocylis calyx* (BRANDT) JÖRGENSEN

Fig. 43

Ptychocylis calyx: BRANDT, 1906, p. 8, pl. 58, figs. 7, 12; 1907, p. 292; LAACKMANN, 1909, p. 458.

Ptychocylis calyx var. a: BRANDT, 1906, pl. 58, figs. 14, 14a; 1907, p. 292; LAACKMANN, 1909, p. 458.

Epiplocylis calyx: JÖRGENSEN, 1924, p. 54; KOFOID & CAMPBELL, 1929, p. 177, fig. 328.

Lorica conical cup-shaped, 1.3 oral diameters in length; suboral region slightly inflated through the remarkably thickened wall; bowl convex conical, abruptly narrowing in the aboral region; aboral horn tapering (16°), 0.27 of the total length; reticulated zone wide, covering over the lower 0.8 of the bowl. Length 82μ ; oral diameter 62μ ; length of the aboral horn 23μ .

Occurrence:—Saipan, very rare.

Distribution:—Sargasso Sea, North and South Equatorial Streams of the Atlantic (Brandt, 1907); Guinea Stream (Laackmann, 1909).

Comparison:—The species differs from *E. lata* Kofoid & Campbell in conical outline.

Remarks:—This species has been reported only from tropical waters of the Atlantic, so this record is the first from the Pacific. *E. labiosa* Kofoid and *E. exigua* Kofoid & Campbell seem to be elongate varieties of this species. Moreover, the latter form is different from the main form in having a gradually narrowing bowl with a wide zone lacking a coarse reticulation.

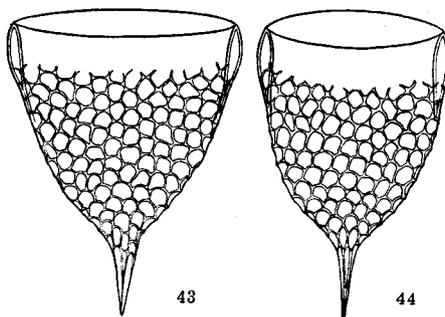


Fig. 43. *Epiplocylis calyx* (BRANDT) 500×
Fig. 44. *Epiplocylis calyx* var. *labiosa*
KOFOID & CAMPBELL 500×

44. *Epiplocylis calyx* var. *labiosa* KOFOID & CAMPBELL

Fig. 44

Ptychocylis calyx var. b: BRANDT, 1906, pl. 58, figs. 13, 13a; 1907, p. 292.

Ptychocylis calyx: LAACKMANN (pt.), 1909, p. 458.

Epiplocylis labiosa: KOFOID & CAMPBELL, 1929, p. 182, fig. 338.

Epiplocylis exigua: MARSHALL, 1934, p. 643, text-fig. 17.

Lorica elongate, 1.7 oral diameters in length; bowl broadest at the point of the suboral 0.1 of the total length, its greatest diameter 1.1 oral diameters, convex conical in the aboral region; aboral horn slender, 0.26 of the lorica, conical (15°); coarse reticulation appearing in the lower 0.75 of the bowl; wall thickened in the upper 0.27 of the total length. Length 74μ ; oral diameter 45μ ; length of the aboral horn 19μ .

Occurrence:—Tinian, very rare.

Distribution:—South Equatorial Stream of the Atlantic (Brandt, 1907); Guinea Stream (Laackmann, 1909).

Comparison:—The variety differs from the typical form of *E. calyx* (Brandt) in its slender proportions.

Remarks:—A single specimen was found in collections from Tinian Island; it was smaller than the Atlantic ones reported by Brandt (1907) and Laackmann (1909).

45. *Epiplocylis lata* KOFOID & CAMPBELL

Fig. 45

Epiplocylis lata: KOFOID & CAMPBELL, 1929, p. 182, fig. 336; HADA, 1935, p. 245.



Fig. 45. *Epiplocylis lata*
KOFOID & CAMPBELL
500×

Lorica rotund, 1.56-1.67 oral diameters in length; suboral region dilated, free from a coarse reticulation, its width one-fourth of the height of the bowl, its greatest diameter 1.14-1.19 oral diameters; bowl sub-cylindrical or slightly tapering in the upper main part, rounded in the aboral region; aboral horn comparatively stout, conical (18° - 20°) to a pointed terminal, 0.18-0.28 of the total length; wall abruptly thickened in the non-reticulated suboral zone. Length 64-70 μ ; oral diameter 41-44 μ ; length of the aboral horn 12-20 μ .

Occurrence:—South-west of Formosa, rare.

Distribution:—Widely distributed in warm water regions of the East Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *E. calyx* (Brandt) and its varieties in being more cylindrical in the bowl and more roundly convex conical in the aboral region.

Remarks:—This species is more or less variable in the length of the aboral horn. The specimens from the south-west coast of Formosa are generally smaller than those detected by Kofoid & Campbell (1929) from tropical or subtropical waters of the East Pacific.

46. *Epiplocylis deflexa* KOFOID & CAMPBELL

Fig. 46

Ptychocylis undella var. d: BRANDT, 1906, pl. 59, fig. 3; 1907, p. 295.

Epiplocylis deflexa: KOFOID & CAMPBELL, 1929, p. 178, fig. 334; MARSHALL, 1934, p. 645, text-fig. 20; HADA, 1935, p. 245.

Lorica globose, 1.7 oral diameters in length; bowl broadest in its anterior one-third of which the greatest diameter is 1.2 oral diameters, then gradually narrowing to a widely convex conical aboral region; aboral horn, stout, 1.8 of the total length, conical (26° - 30°) to a pointed tip; wall thicker in the suboral region, composed of a coarser primary structure, which a coarsely reticulated zone in the lower half of the bowl, fenestration visible in meshes of a coarse reticulation. Length 90-92 μ ; oral diameter 55 μ ; length of the aboral horn 17 μ .

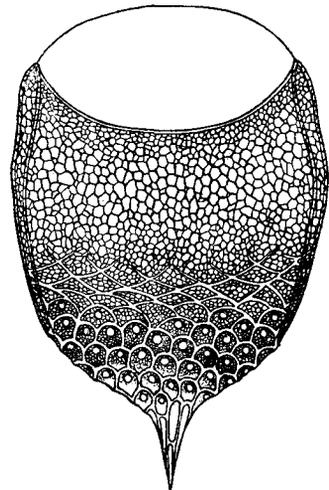


Fig. 46. *Epiplocylis deflexa*
KOFOID & CAMPBELL 600×

Occurrence:—Northern part of the South China Sea, rare.

Distribution:—New Pomerania (Brandt, 1907); Great Barrier Reef (Marshall, 1934); warm waters of the East Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *E. undella* var. *constricta* Kofoid & Campbell in the conspicuously observable coarse primary structure of the wall.

Remarks:—The main characteristic of this species is that it is coarser and distinct in the primary structure of the wall. This has been known only from the tropical Pacific until now.

Genus *Epiplocyloides* n. gen.

Lorica acorn-shaped, with double oral rims, inner one entire, erect, little higher than the flaring outer; shallow oral gutter formed between them; bowl conical or cylindrical in the upper main part, convex conical or broadly rounded in the aboral region having always a short aboral horn; wall separated in the oral border, with a fine primary structure, surface covered with a coarsely anastomosed reticulation and linear striae.

Type species—*Epiplocyloides reticulata* (OSTENFELD & SCHMIDT)

This new genus differs from *Epiplocyloides* Jörgensen in having inner and outer oral rims and an almost fused wall except the part of the oral gutter. It differs from *Rhabdonella* Brandt in bearing an anastomosed reticulation on the surface instead of vertical or spiral striae. This genus has been included in the genus *Epiplocyloides* owing to similarities in outline and reticulation by some authors (Jörgensen, 1924; Kofoid & Campbell, 1929; Marshall, 1934; Hada, 1935), but seems to be distinct because of differences of the construction of the oral region and the constitution of the wall as above described. The species of this genus are allied to those of *Rhabdonella* having a weakly developed wall in the form of the oral border, they are, however, easily discriminated from the latter on account of the difference of the characteristic ornamentation on the surface of the lorica.

In this new genus must be included the following forms: *E. reticulata* (Ostenfeld & Schmidt), *E. reticulata* var. *acuta* (Kofoid & Campbell), *E. reticulata* var. *curta* (Kofoid & Campbell), *E. raluensis* (Brandt), *E. freymadli* (Brandt)?, and *E. nervosa* (Cleve).

The first species designated as the type species and its variety, *acuta*, are reported in this paper. It is questionable that Brandt's figure of *E. freymadli* (1906) was drawn from a specimen of *E. reticulata* in an abnormal condition, for its suboral constriction seems to be due to contraction caused by fixation. Therefore, the existence of *E. freymadli* is probably uncertain. The last species, *E. nervosa*, oldest among them, is different from the others in the conical lorica without an aboral horn and in having a net-work consisting of lengthwise and crosswise striae on the surface of the lorica. The species is special in form and similar to simple forms of *Rhabdonella*. For the same reason Kofoid & Campbell (1929) divided the genus *Epiplocypris* into the subgenera, *Epiplocypris* and *Epicancellula*, and included only *E. nervosa* in the latter. All species of this genus are distributed in tropical or subtropical waters.

47. *Epiplocyloides reticulata* (OSTENFELD & SCHMIDT)

Fig. 47

Cyttarocypris reticulata: OSTENFELD & SCHMIDT, 1901.

Ptychocypris reticulata: BRANDT, 1906, pl. 58, figs. 1, 4; 1907, p. 287; LAACKMANN, 1909, p. 457.

Epiplocypris reticulata: JÖRGENSEN, 1924, p. 54; KOFOID & CAMPBELL, 1929, p. 184.

Epiplocypris brandti: KOFOID & CAMPBELL, 1929, p. 177, fig. 324.

Epiplocypris healdi: KOFOID & CAMPBELL, 1929, p. 180, fig. 321; MARSHALL, p. 643, text-fig. 16; HADA, 1935, p. 245.

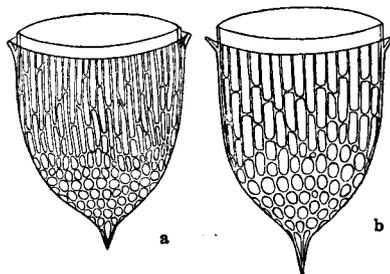


Fig. 47. *Epiplocyloides reticulata* (OSTENFELD & SCHMIDT) 500×

a from the Palao Islands

b from the Java Sea

Lorica acorn-like, 1.36-1.75 inner oral diameters in length; outer oral rim flaring (50°-67°), 1.2 inner oral diameters; bowl subcylindrical in its anterior half, broadly rounded or convex conical (90°-115°) in the aboral region; aboral horn forming an inverted cone of 18°-48°, stout, 0.09-0.18 of the total length; reticulation usually covering the surface of the aboral region, sometimes stretching out beyond the middle of the lorica. Length 60-72 μ; inner oral diameter 40-44 μ; outer oral diameter 48-52 μ; length of the aboral horn 6-11 μ.

Occurrence:—Palao Islands, common; coast of Cochin China, rare; Singapore, rare; west coast of Borneo, abundant; Java Sea, Strait of Sunda region, common.

Distribution:—Red Sea (Ostenfeld & Schmidt, 1901); widely distributed in oceanic and coastal waters of the Pacific (Brandt, 1907; Kofoid & Campbell, 1929; Marshall, 1934) and the Atlantic (Brandt, 1907; Laackmann, 1909).

Comparison:—The species differs from *E. ralumensis* (Brandt) in the presence of linear striae on the surface of the upper part of the lorica.

Remarks:—This species is exceedingly variable in an elongation of the lorica, the shape of the aboral region, and the area of reticulation of the surface. The reticulation of the original figure given by Ostenfeld & Schmidt (1901) was probably sketched imperfectly, because such a case of reticulation has not been observed. In this examination specimens agreeing with Kofoid & Campbell's (1929) *E. brandti* which is stout in outline and covered with a wide reticulated area, were detected in company with ones of the form of Kofoid & Campbell's *E. healdi* which is longer than the former and has a narrow reticulated zone in the aboral region. It is difficult to separate them into two groups because of the gradual changes of the contour and the reticulated area of the surface of the lorica among them. In general, specimens of the stouter form were more frequently found in collections of the Palao Islands as compared with those of the elongate, but the former were fewer than the latter in materials from the East Indies. Kofoid & Campbell's *E. curta* is probably an elongate variety of this species, because it is only different from the typical form in being slender in proportion.

48. *Epiplocyloides reticulata* var. *acuta* (KOFOID & CAMPBELL)

Fig. 48

Epiplocyloides acuta: KOFOID & CAMPBELL, 1929, p. 175, fig. 322.

Lorica generally conical, 1.6 inner oral diameters in length; aboral region convex conical (55° - 75°), provided with a stout, sharply tapering aboral horn of 18° - 20° , of which the length is 0.16 of the total length; reticulation of the surface inconspicuous, covering the posterior half of the bowl. Length 66-68 μ ; inner oral diameter 41 μ ; outer oral diameter 50 μ ; length of the aboral horn 10-11 μ .

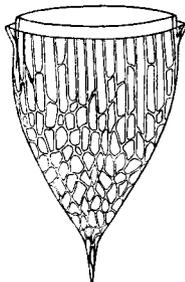


Fig. 48. *Epiplocyloides reticulata* var. *acuta*
(KOFOID & CAMPBELL) 500×

Occurrence:—Java Sea, very rare.

Distribution:—Known everywhere from warm waters of the East Pacific (Kofoid & Campbell, 1929).

Comparison:—The variety differs from the typical form of *E. reticulata* (Ostenfeld & Schmidt) in the gradually narrowing aboral region.

Remarks:—Specimens of this variety were very rarely found as compared with those of the typical form in the Java Sea, and distinguished from the latter in the conical contour and faint reticulation.

Family Petalotrichidae KOFOID & CAMPBELL, 1929

Genus *Craterella* KOFOID & CAMPBELL, 1929

Craterella: KOFOID & CAMPBELL, 1929, p. 194.

Lorica cup-shaped, with outer and inner collars separated by a shallow trough; oral margin entire; bowl subconical or globular; aboral end round, conical, pointing, or with a pore; wall single-layered, usually hyaline.

Type species—*Craterella urceolata* (OSTENFELD) KOFOID & CAMPBELL.

Two species, *C. retusa* Hada and *C. aperta* Marshall, were secured during this research.

Key to species

1. Lorica convex conical; aboral end rounded.....*C. retusa* HADA
2. Lorica anteriorly cylindrical; aboral end with a pore...*C. aperta* MARSHALL

49. *Craterella retusa* HADA

Fig. 49

Craterella retusa: HADA, 1935, pp. 242, 245, fig. 3.

Lorica minute, stout ovate, nearly equal to the inner oral diameter in length; inner collar sloping (48° – 55°) to the base of a trough, higher than the outer, distance between the two rims 0.10–0.14 of the total length, outer collar abruptly

flaring (80° - 85°), 1.23 inner oral diameters in outer oral diameter; bowl cup-shaped; aboral region hemispherical or convex conical with a rounded end; wall hyaline. Length 32-33 μ ; inner oral diameter 30 μ .

Occurrence:—Outside of the Palao Islands, exceedingly rare; Java Sea, very rare.

Comparison:—The species differs from *C. torulata* (Jørgensen) in the widely expanding outer rim and the rounded aboral end and from *C. urceolata* (Ostenfeld) in being smaller and stouter.

Remarks:—This species is somewhat variable in the following respects: specimens (fig. 49) from the Palao Islands were conical in outline from the possession of a low inner collar and a somewhat conical aboral region, but those (Hada, 1935, fig. 3) from the Java Sea were globose in general contour, having a high inner collar and a broadly rounded end.



Fig. 49. *Craterella retusa*
HADA 500 \times from
the Palao Islands

50. *Craterella aperta* MARSHALL

Fig. 50

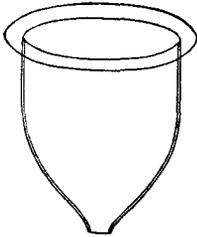


Fig. 50. *Craterella aperta*
MARSHALL 500 \times

Craterella aperta: MARSHALL, 1934, p. 645, text-fig. 21.

Lorica goblet-shaped, 1.20-1.31 inner oral diameters in length; outer rim abruptly flaring to make a wide expansion, its diameter 1.23-1.26 oral diameters; bowl cylindrical in the anterior half, convex conical (75° - 90°) in the aboral region; aboral end slightly elevated, transversely cut off; wall hyaline. Length 50-55 μ ; oral diameter 42-43 μ ; aboral diameter 6-8 μ .

Occurrence:—Palao Islands, rare; Tinian, very rare.

Distribution:—Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from all the other species of *Craterella* in the presence of an aboral aperture.

Remarks:—This species is characteristic in having an aboral pore which is not seen in the other species of *Craterella*. The oral trough was hardly visible in the present examination, though it is conspicuously recognizable in Marshall's figure (1934, text-fig. 21).

Genus *Metacylis* JÖRGENSEN, 1924

Metacylis: JÖRGENSEN, 1924, p. 97; KOFOID & CAMPBELL, 1929, p. 197.

Lorica generally small, ovate or elongate capsular, consisting of a short annulated collar and a bowl; oral margin usually entire; aboral region rounded or conical to a blunt or pointed end; wall usually single-layered and hyaline, occasionally separated and with a fine prismatic structure.

Type species—*Metacylis mediterranea* (MERESCHKOWSKY) JÖRGENSEN.

Two species and one variety have been secured in this research from the South Sea Islands.

Key to species

- A. Collar low and cylindrical.
 1. Bowl ovate.....*M. mereschkowskii* KOFOID & CAMPBELL
- B. Collar generally narrowing to a oral margin.
 2. Lorica globose.....*M. corbula* KOFOID & CAMPBELL
 3. Lorica convex conical with a subacute end; collar zigzag in outline.....
*M. corbula* var *perspicax* n. var.

51. *Metacylis mereschkowskii* KOFOID & CAMPBELL

Fig. 51

Metacylis mediterranea var. *pontica*: JÖRGENSEN, 1924, p. 97, fig. 109 b.

Metacylis mereschkowskii: KOFOID & CAMPBELL, 1929, p. 200, fig. 377.

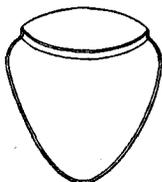


Fig. 51. *Metacylis mereschkowskii* KOFOID & CAMPBELL 500×

Lorica vase-shaped, 1.06-1.21 oral diameters in length, consisting of a low collar and an ovoid bowl; oral margin entire, with a slight brim; collar very short, usually with a single annular ring at base, its length 0.06 of the total length; shoulder rounded, smoothly sloping outwards; bowl 1.13-1.27 oral diameters in greatest transdiameter, convex conical in the aboral region to a rounded end; wall hyaline. Length 37-42 μ ; oral diameter 33-37 μ ; length of the collar 2.0-2.5 μ ; greatest diameter of the bowl 40-43 μ .

Occurrence:—Palao Islands, very rare; Saipan, Tinian common.

Distribution:—Black and Mediterranean Seas, western coasts of Europe, near Florida, China Sea (Jörgensen, 1924).

Comparison:—The species differs from *M. pontica* (Mereschkowsky) in the wide and low collar and from *M. jørgenseni* (Cleve) in the rounded aboral end.

Remarks:—This species probably has a local variation. The specimens from the South Sea Islands are smaller in dimensions and lower in the height of the collar with a single turn instead of two in comparison with those examined by Jørgensen (1924) from European waters as *M. mediterranean* var. *pontica*. Moreover, the wall of the bowl is completely separated in his figure (fig. 109 b), while that of the writer's specimens is single-layered.

52. *Metacylis corbula* KOFOID & CAMPBELL

Fig. 52

Metacylis corbula: KOFOID & CAMPBELL, 1929, p. 199, fig. 376; MARSHALL, 1934, p. 646, text-fig. 22.

Lorica subspherical, its length nearly equal to the oral diameter; collar forming a truncated convex cone with 3-5 annular rings situated at uniform intervals, slightly distinguished from the bowl by a faint constriction, 0.14-0.30 of the total length, its basal diameter 1.1-1.3 oral diameters; bowl hemispherical or ovate, broadest at the point of the anterior 0.4 of the lorica, 1.16-1.24 oral diameters in greatest transdiameter; aboral end rounded, more or less becoming conical; wall translucent. Length 35-41 μ ; oral diameter 33-40 μ ; greatest diameter 41-44 μ .

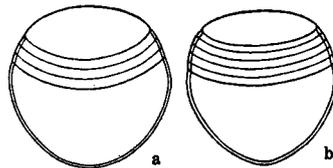


Fig. 52. *Metacylis corbula* KOFOID & CAMPBELL 500 \times

Occurrence:—Lagoons of the Palao Islands, rare.

Distribution:—Bay of Panama (Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from all species of *Metacylis* by its globose contour.

Remarks:—The specimens obtained from the Palao Islands are closely similar to Marshall's figure (1934, text-fig. 22) in outline, but somewhat different from Kofoid & Campbell's original one (1929, fig. 376) in stouter dimensions, proportions and in having a conical oral margin which is erect in the upper part of the latter.

53. *Metacylis corbula* var. *perspicax* n. var.

Fig. 53



Fig. 53. *Metacylis corbula*
var. *perspicax* n. var.
600×

Lorica bowl-like, 0.95 oral diameter in length; oral aperture large; collar low, 0.22 of the total length in height, conical (60°) upwards, ringed with three angular bands of which the diameter of the largest posterior one is 1.18 oral diameters; junction between collar and bowl barely visible as a slight constriction; bowl broadest just below the nuchal constriction, its greatest transdiameter almost equal to the diameter of the lowest band; aboral region broadly convex conical (130°) to a subacute aboral end; wall hyaline. Length 35 μ ; oral diameter 37 μ ; greatest diameter 42 μ .

Occurrence:—Palao Islands, exceedingly rare.

Comparison:—The variety differs from the typical form of *M. corbula* Kofoid & Campbell in the uneven collar and the conical aboral end.

Remarks:—A zigzag appearance of the collar owing to elevated annular rings has already been shown in Marshall's figure (1934, text-fig. 22) of *M. corbula*, and the typical form of the species is inclined to become conical in the aboral region. It may therefore be that this is an abnormal form of *M. corbula*.

Genus *Petalotricha* KENT, 1882

Petalotricha: KENT, 1882, p. 627; DADAY, 1887, p. 572; BRANDT, 1907, p. 337; LAACKMANN, 1909, p. 466; JÖRGENSEN, 1924, p. 88; KOFOID & CAMPBELL, 1929, p. 202.

Lorica bag-shaped or conical; with an oral shelf spreading out and a low flaring collar; oral margin entire or serrated; collar divided by a nuchal constriction and an inner nuchal ledge from the main part; bowl globose or baggy; aboral end rounded, conical, or with a trace of pointing; wall usually single-layered, generally with two kinds of fenestrae, of which the suboral oblong ones form a single row and subnuchal spherical or elliptical ones are scattered in a zone.

Type species—*Petalotricha ampulla* (FOL) KENT.

In the present investigation only one species, *P. pacifica* Kofoid & Campbell, has been met with.

54. *Petalotricha pacifica* KOFOID & CAMPBELL

Fig. 54

Petalotricha capsa var. b: BRANDT, 1906, pl. 62, fig. 16; 1907, p. 343.

Petalotricha pacifica: KOFOID & CAMPBELL, 1929, p. 205, fig. 385.

Lorica stout bag-like, 0.84 oral diameter in length; oral margin irregularly serrated; oral shelf flaring (48°), with four waves; collar 0.2 of the total length in height including a shelf, forming a low funnel (40°); nuchal constriction distinct, 0.94 oral diameter; a single row of elliptical spots appearing at the conjunction of the collar and the oral shelf; bowl shallow cup-shaped, with numerous small circular fenestrae in its anterior region; aboral end broadly rounded; wall composed of a single layer. Length 92μ ; oral diameter 110μ .

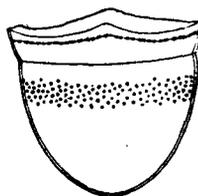


Fig. 54. *Petalotricha pacifica* KOFOID & CAMPBELL 250 \times

Occurrence:—Tinian, very rare.

Distribution:—New Pomerania (Brandt, 1907); California and South Equatorial Streams in the Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *P. capsa* Brandt in its stouter proportions.

Remarks:—The specimen obtained near Tinian Island was different from the figure given by Brandt (1906) in Pl. 62, fig. 16 from one taken near New Pomerania in the absence of a slight elevation at the aboral end, more distinct nuchal constriction and in having a zone comprised of numerous fenestrae, but it closely resembles the latter in general contour and dimensions.

Family Rhabdonellidae KOFOID & CAMPBELL, 1929

Genus *Protorhabdonella* JÖRGENSEN, 1924

Protorhabdonella: JÖRGENSEN, 1924, p. 57; 1929, p. 206; HADA, 1937, p. 207.

Species of this genus belong to warm water forms. Three of five known species are reported in this paper.

Key to species

- A. Lorica stout, conical.
1. Wall separated in the upper part of the lorica, with a few longitudinal striae.....*P. simplex* (CLEVE) JÖRGENSEN
 2. Wall entirely single-layered, with numerous striae
..... *P. curta* (CLEVE) JÖRGENSEN
- B. Lorica slender, elongate.
3. Wall separated in the oral border, with many longitudinal striae.....
..... *P. striatura* KOFOID & CAMPBELL

55. *Protorhabdonella simplex* (CLEVE) JÖRGENSEN

Fig. 55

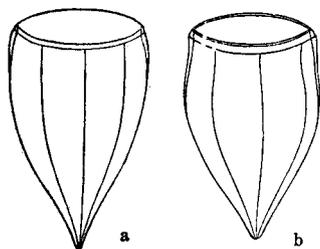
Cyttarocylis simplex: CLEVE, 1900; 1901, p. 10.*Rhabdonella amor* var. *simplex*: BRANDT (pt.), 1907, p. 331; LAACKMANN, 1909, p. 463, pl. 48, fig. 13, pl. 49, fig. 15.*Protorhabdonella simplex*: JÖRGENSEN, 1929, p. 57, fig. 64; KOFOID & CAMPBELL, 1929, p. 208, fig. 395; MARSHALL, 1934, p. 646; HADA, 1935, p. 246.

Fig. 55. *Protorhabdonella simplex* (CLEVE) 500×
from the Palao Islands

Lorica elongated coniform, 1.76 oral diameters in length; oral margin erect or sloping to an oral rim from a slightly elevated suboral ring; bowl more or less dilated to the broadest portion, its greatest diameter 1.1 oral diameters, then convex conical and distally tapering to a blunt or acute aboral point; wall hyaline, composed of separated lamellae in the anterior part above the broadest portion and of a single-layered lamella in the posterior conical region, provided with 6-7 longitudinal striae extending from the suboral ring to the aboral end. Length 54-58 μ ; oral diameter 30-33 μ .

Occurrence:—Palao Islands, very rare; off Takao, rare; southern part of the South China Sea, very rare; Java Sea, Strait of Sunda, common.

Distribution:—Warm water regions of the Atlantic (Cleve, 1900; Laackmann, 1909); Mediterranean (Jörgensen, 1924); Peruvian Current (Jörgensen, 1924; Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934); Indian Ocean (Cleve, 1901; Jörgensen, 1924).

Comparison:—The species differs from *P. curta* (Cleve) in having the partially separated wall and few striae.

Remarks:—This is a widely distributed species in warm waters of the world.

56. *Protorhabdonella curta* (CLEVE) JÖRGENSEN

Fig. 56

Protorhabdonella curta: HADA, 1937, p. 207, fig. 50.

Length 40–48 μ ; oral diameter 25–28 μ .

Occurrence:—Palao Islands, commom.

Remarks:—This species occurs even in waters of fairly low temperatures, such as off Akkeshi Bay (Hada, 1937).

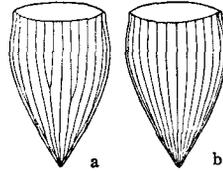


Fig. 56. *Protorhabdonella curta* (CLEVE) 500 \times

57. *Protorhabdonella striatura* KOFOID & CAMPBELL

Fig. 57

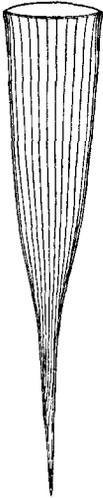


Fig. 57. *Protorhabdonella striatura* KOFOID & CAMPBELL 500 \times

Protorhabdonella striatura: KOFOID & CAMPBELL, 1929, p. 208, fig. 392.

Lorica elongated, chalice-shaped, 4.8 oral diameters in length; bowl gradually tapering (7°) in the anterior 0.3 of the lorica, more abruptly (23°) in the aboral region; pedicel slender, about 0.3 of the total length, conical (7°) to a pointed tip; wall composed of a single-layer except the oral 0.08 of the lorica; surface ornamented with numerous vertical striae. Length 130 μ ; oral diameter 27 μ .

Occurrence:—Tinian, exceedingly rare.

Distribution:—Atlantic (Cleve, 1901 after Kofoid & Campbell, 1929); Peruvian Current, Galapagos Eddy, South Equatorial Drift of the Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *P. mira* Kofoid & Campbell in the slender pedicel and great number of striae.

Genus *Rhabdonella* BRANDT, 1907

Rhabdonella: BRANDT (pt.), 1907, p. 313; LAACKMANN (pt.), 1909, p. 460; JÖRGENSEN (pt.), 1924, p. 58; KOFOID & CAMPBELL, p. 209.

Lorica conical or elongate chalice-shaped; oral border with a gutter between the inner and outer rims, the former usually erect and

the latter flaring, a little lower than the former; bowl gradually tapering in the anterior part, abruptly narrowing in the aboral region, usually having a slender pedicel pointed or perforated at its tip; wall separated in the bowl, composed of a fine prismatic structure, with a number of longitudinal or more or less spiral ribs which often branch on the surface and with minute fenestrae between ribs in many cases.

Type species—*Rhabdonella spiralis* (FOL) BRANDT.

This genus belongs to the warm water group of the Tintinnoinea and is represented by the following five species in this collection. The identification of the species is fairly difficult because of wide variations in size, contour, and structure.

Key to species

- A. Lorica chalice-shaped, with a pedicel.
- a. Lorica elongate; wall of the bowl completely separated.
 1. Lorica slender, consisting of a long bowl and pedicel.....
.....*R. spiralis* (FOL) BRANDT
 2. Lorica conical, with a shorter pedicel.....*R. elegans* JÖRGENSEN
 - b. Lorica stout; wall single-layered except a gutter region.
 3. Lorica short, with a stout conical pedicel
.....*R. poculum* (OSTENFELD & SCHMIDT) KOFOID & CAMPBELL
- B. Lorica conical; wall single-layered except a gutter border.
4. Aboral end pointed; ribs few in number.....*R. amor* (CLEVE) BRANDT
 5. Lorica small, bluntly ending*R. parvula* n. sp.

58. *Rhabdonella spiralis* (FOL) BRANDT

Fig. 58

Tintinnus spiralis: FOL, 1881, p. 247, pl. 17, fig. 4.

Undella spiralis: DADAY (pt.) 1887, p. 565, pl. 18, fig. 8.

Tintinnus striatus: BIEDERMANN, 1893, p. 29, pl. 3, figs. 13a, b.

(*Ptychocylis*) *Rhabdonella spiralis*: BRANDT, 1906, pl. 52, figs. 4, 7-10; 1907, p. 323.

(*Ptychocylis*) *Rhabdonella spiralis* var. *indopacifica*; BRANDT, 1906, pl. 52, fig. 1, pl. 53, figs. 8, 9; 1907, p. 326.

(*Ptychocylis*) *Rhabdonella spiralis* var. *striata*: BRANDT (pt.), 1906, pl. 52, figs. 5, 6, 6a; 1907, p. 326.

Rhabdonella spiralis var. *indopacifica*: LAACKMANN, 1909, p. 462.

Rhabdonella spiralis: LAACKMANN, 1913, p. 35, pl. 6, figs. 69-82; JÖRGENSEN, 1924, p. 60, fig. 68; KOFOID & CAMPBELL, 1929, p. 219, fig. 414; MARSHALL, 1934, p. 646, text-fig. 23; HADA, 1935, p. 246.

Rhabdonella striata: KOFOID & CAMPBELL, p. 219, fig. 411.

Rhabdonella conica: KOFOID & CAMPBELL, 1929, p. 214, fig. 418; HADA, 1935, p. 246.

Lorica elongate, slender, 5-9 inner oral diameters in length; inner rim erect, outer one widely flaring (55° - 70°), 1.2-1.3 inner oral diameters bowl gradually tapering (2° - 11°) in its anterior main part, abruptly narrowing (18° - 37°) posteriorly to a prolonged pedicel which is slender, 0.35-0.52 of the total length, and pointed or perforated at the terminal; wall perfectly separated almost through the lorica except the distal part of the pedicel of an imperfect separation, fenestration on the bowl always visible. Length 264-460 μ ; inner oral diameter 51-53 μ ; outer oral diameter 60-65 μ ; length of the pedicel 96-240 μ .

Occurrence:—South China Sea, rare; Java Sea, common; Strait of Sunda and off that in Indian Ocean, rare; Celebes and Sulu Seas, very rare.

Distribution:—Has a wide distribution in warm water regions of the Mediterranean (Fol, 1881; Daday, 1887; Laackmann, 1913; Jörgensen, 1924), the Atlantic (Brandt, 1907), the Pacific (Brandt, 1907; Kofoid & Campbell, 1929; Marshall, 1934), and the Indian Ocean (Brandt, 1907; Laackmann, 1909).

Comparison:—The species differs from *R. elegans* Jörgensen in greater size, slender contour, and an elongation of the bowl.

Remarks:—The species was first described by Fol (1881), and then it was again recorded by Biedermann (1893) under the different specific name, *striata*. Afterwards, Brandt (1907) divided it into several varieties, and Kofoid & Campbell (1929) raised them to the rank of species. The identification of the species is, therefore, considerably confused at present.

The species shows marked variations in dimensions, proportions, outline, and caudal elongation. From collections of the East Indies two distinguishable forms were observed; the short one is 264-320 μ long and has a pointed tip, usually appearing in neritic plankton and being very similar to Biedermann's *Tintinnus striatus* (1893,

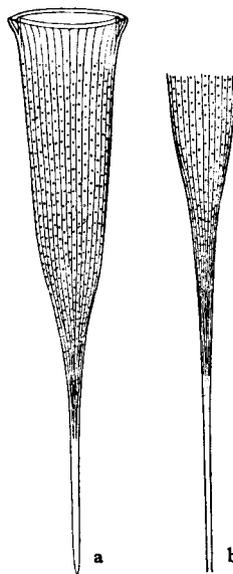


Fig. 58. *Rhabdonella spiralis* (FOL) 250 \times

a from the Java Sea
b aboral region of an elongated specimen collected from the South China Sea

pl. 3, fig. 13 a), Brandt's var. *indopacifica* (1906, pl. 52, fig. 1), Jörgensen's species including var. *elongate* (1924, figs. 68, 69) and Marshall's specimen (1934, fig. 23), while the other elongate one is 432–460 μ long and provided with a long, slender pedicel perforated at the terminal, often occurring in open waters of the South China and Sulu Seas and agreeing with Kofoid & Campbell's *R. conica* (1929). It is considered that they are probably to be united into this species, because several intermediate forms were recorded by Brandt (1906–07) under names, *R. spiralis* and *R. spiralis* var. *indopacifica*.

59. *Rhabdonella elegans* JÖRGENSEN

Fig. 59

Undella spiralis: DADAY (pt.), 1887, p. 565.

(*Ptychocylis*) *Rhabdonella spiralis* var. *striata*: BRANDT (pt.), 1906, pl. 52, figs. 2, 10; 1907, p. 326.

(*Ptychocylis*) *Rhabdonella amor* var. *cuspidata*: BRANDT, 1906, pl. 54, figs. 3, 10, 11; 1907, p. 331.

(*Ptychocylis*) *Rhabdonella amor* var. *valdestriata*: BRANDT, 1906, pl. 54, figs. 1, 8, 9, 16–18, pl. 68, fig. 7; 1907, p. 332.

Rhabdonella elegans: JÖRGENSEN, 1924, p. 59, fig. 67; KOFOID & CAMPBELL, 1929, p. 215, fig. 401.

Rhabdonella brandti: KOFOID & CAMPBELL, p. 213, fig. 400; MARSHALL, 1934, p. 649, text-fig. 24; HADA, 1935, p. 246.

Rhabdonella inflata: KOFOID & CAMPBELL, 1929, p. 217, fig. 403.

Rhabdonella quantula: KOFOID & CAMPBELL, 1929, p. 218, fig. 402; MARSHALL, 1934, p. 649, text-fig. 25.

Rhabdonella valdestriata: KOFOID & CAMPBELL, 1929, p. 220, fig. 410.

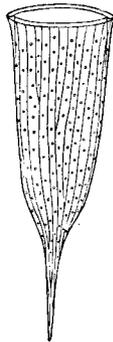


Fig. 59. *Rhabdonella elegans* JÖRGENSEN
250 \times from the
Java Sea

Lorica chalice-shaped, 3.0–4.8 inner oral diameters in length; outer oral rim somewhat flaring, 1.14–1.23 inner oral diameters; bowl slightly conical (9° – 15°) in its anterior part, then abruptly narrowing (34° – 55°) in the aboral region; pedicel often elongated, 0.30–0.47 of the total length, gradually tapering (3° – 10°) to a pointed tip; wall usually apparently separated in the bowl but weakly in the pedicel, having many longitudinal ribs (about 25) on the surface and numerous small fenestrae between them. Length 140–205 μ ; inner oral diameter 35–48 μ ; outer oral diameter 40–60 μ ; length of the pedicel 55–94 μ .

Occurrence:—Palao Islands, common; Tinian, Saipan, very rare; northern part of the South China Sea, common; Java Sea, Strait of Sunda, common; Celebes Sea, very rare; Sulu Sea, common.

Distribution:—Known from warm waters of the world (Daday, 1887; Brandt, 1907; Jörgensen, 1924; Marshall, 1934). The Karajak Fjord of Greenland reported by Brandt (1907) is a questionable locality for this species.

Comparison:—The species differs from *R. spiralis* (Fol) in the small lorica and the short conical bowl.

Remarks:—This species is exceedingly variable in size, form, and number of ribs, especially in the shape of the aboral region and in the elongation of a pedicel. The four species, *brandti*, *valdestriata*, *inflata*, and *quantula* of Kofoid & Campbell (1929), all belong to this species: the latter two have an inconspicuous distal pore, which is not of the usual construction in *Rhabdonella*. They can not be distinguished, because their differences seem to be individual variations. In the present investigation specimens of Kofoid & Campbell's *brandti* type with a stout pedicel were most frequently found, and those of *quantula* type consisting of a conical bowl and a slender pedicel were rarely detected from outside the barrier of the Palao Islands and the south-west of Formosa. There were observed stout conical specimens like Jörgensen's fig. 67 (1924) and those provided with a pore at a distal end of a pedicel.

60. *Rhabdonella poculum* (OSTENFELD & SCHMIDT) KOFOID & CAMPBELL

Fig. 60

Cyrtarocylis poculum: OSTENFELD & SCHMIDT, 1901.

(*Ptychocylis*) *Rhabdonella amor* var. *poculum*: BRANDT, 1907, p. 329.

Rhabdonella poculum: KOFOID & CAMPBELL, 1929, p. 218, fig. 405; HADA, 1935, p. 246.

Rhabdonella amor: MARSHALL, 1934, p. 649, text-figs. 26, 26a-b.

Lorica stout, goblet-shaped, 1.8-2.2 inner oral diameters in length; inner oral rim erect or somewhat curved inwards, outer one flaring. 1.15-1.26 inner oral diameters; bowl subcylindrical in its main part; aboral region abruptly narrowing (70° - 95°) to a stout pedicel forming a cone of 20° - 45° ; wall single-layered except a border of an oral gutter, ornamented with numerous vertical striae which sometimes branch. Length 80-96 μ ; inner oral diameter 38-44 μ ; outer oral diameter 44-51 μ .

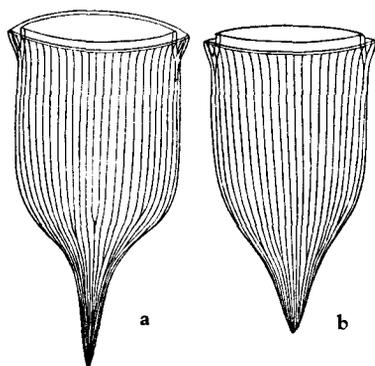


Fig. 60. *Rhabdonella poculum*
(OSTENFELD & SCHMIDT) 500×
a from the Palao Islands
b from the Java Sea

Occurrence:—Palao Islands, rare; northern part of the South China Sea, Strait of Sunda, common; Sulu Sea, very rare.

Distribution:—Red Sea (Ostenfeld & Schmidt, 1901); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *R. amor* (Cleve) in having a differentiated pedicel and numerous striae.

Remarks:—Specimens found from the Palao Islands generally resemble ones reported by Ostenfeld & Schmidt (1901) from the Red Sea in size and outline, especially in the possession of

a distinct pedicel, which was tall and sharply tapering (20°). Specimens of the South China and Java Seas were rather small in dimensions and more gradually narrowed (70° – 90°) than in those of the Palao Islands (95°), and their pedicel was short and wide conical (34° – 45°) as Marshall's text-fig. 26 of *R. amor* (1934), which probably belongs to this species judging from numerous striae on the surface of the lorica.

61. *Rhabdonella amor* (CLEVE) BRANDT

Fig. 61

Cyttarocylis amor: CLEVE, 1900; 1901, p. 10.

(*Ptychocylis*) *Rhabdonella amor*: BRANDT, 1906, pl. 54, figs. 4–6, 12–15; 1907, p. 327.

Rhabdonella amor var. *simplex*: BRANDT (pt.), 1907, p. 331.

Rhabdonella amor: LAACKMANN, 1909, p. 463; JÖRGENSEN, 1924, p. 58, fig. 66; KOFOID & CAMPBELL, 1929, p. 212, fig. 398; HADA, 1935, p. 246.

Lorica conical, 2.0–2.3 inner oral diameters in length; outer rim little lower than the inner, 1.10–1.22 inner oral diameters; bowl gradually narrowing to the acute aboral end; aboral region forming an inverted cone of 40° – 48° ; wall separated in the upper

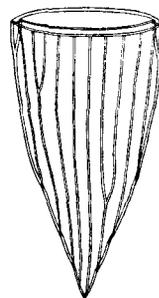


Fig. 61. *Rhabdonella amor* (CLEVE) 450×
from the Palao Islands

0.1 of the lorica, bearing about 20 vertical ribs which sometimes branch. Length 75-90 μ ; inner oral diameter 37-40 μ .

Occurrence:—Palao Islands, common; Tinian, rare; south-west of Formosa, very rare.

Distribution:—Has a wide distribution in the Atlantic (Cleve, 1900; Brandt, 1907; Laackmann, 1909), the Indian Ocean (Cleve, 1901; Brandt, 1907; Laackmann, 1909), and the Mediterranean (Entz, Jr., 1909; Jörgensen, 1924).

Comparison:—The species differs from *R. indica* Laackmann in being larger and having fewer ribs, and from *P. poculum* (Ostenfeld & Schmidt) in the absence of a conspicuous aboral horn and the small number of striae.

Remarks:—This species was first reported by Brandt (1907) from the Karajak Fjord in Greenland, but afterwards from several localities in tropical and temperate zones. He showed small pores on the lorica in his figures (1906, Pl. 54, figs. 4, 6, 13, 15), but specimens with such fenestrae have not been found in the present collections. This species is said to be variable in form and number of ribs, but in the present materials the lorica was uniformly shaped and the number of ribs was rather small and fairly constant.

62. *Rhabdonella parvula* n. sp.

Fig. 62

Lorica very small, subconical, 1.74 inner oral diameters in length; outer oral rim more or less flaring (35°), its diameter 1.17 inner oral diameters; bowl most inflated at the portion of the suboral 0.25 of the total length, in greatest diameter 1.3 inner oral diameters, convex conical in the posterior half with a blunt end; wall single-layered except in the region of the oral gutter, almost hyaline, with numerous longitudinal striae running on the entire surface of the lorica. Length 40 μ ; inner oral diameter 23 μ .

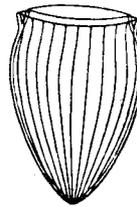


Fig. 62. *Rhabdonella parvula* n. sp. 600 \times

Occurrence:—Palao Islands, remarkably rare.

Comparison:—The new species differs from *R. amor* (Cleve) and *R. indica* Laackmann in being smaller and more dilated and from *Protorhabdonella curta* (Cleve) in having a distinctly developed oral gutter.

Remarks:—This is the most primitive species in *Rhabdonella* showing a simple form and a weakly differentiated oral gutter, and also is related to *Protorhabdonella* because of the close resemblance to *P. curta* in size and form.

Genus *Rhabdonellopsis* KOFOID & CAMPBELL, 1929

Rhabdonellopsis: KOFOID & CAMPBELL, 1929, p. 221.

Lorica elongated chalice-shaped, consisting of a conical bowl and a long pedicel with a knob and an apical lance; oral border with a gutter between the inner and outer rims; wall almost like the elongated species of *Rhabdonella* in structure.

Type species—*Rhabdonellopsis apophysata* (CLEVE) KOFOID & CAMPBELL.

This genus is only different from the forms of *Rhabdonella* in having a slender pedicel and a distinct knob on the pedicel. A unique species mentioned above as the type species was examined in collections from the South Sea Islands and the East Indies.

63. *Rhabdonellopsis apophysata* (CLEVE) KOFOID & CAMPBELL

Fig. 63

Cyttarocylis hebe var. *apophysata*: CLEVE, 1900.

Tintinnus triton: ZACHARIAS: 1906, p. 519, fig. 8.

(*Ptychocylis*) *Rhabdonella apophysata*: BRANDT, 1906, pl. 51, figs. 5-7; 1907 p. 333.

(*Ptychocylis*) *Rhabdonella apophysata* var. b: BRANDT, 1906, pl. 51, figs. 1, 1a, 2; 1907, p. 336.

Rhabdonella apophysata: JÖRGENSEN, 1924, p. 64, figs. 71a-c.

Rhabdonella apophysata var. b: LAACKMANN, 1909, p. 466.

Rhabdonellopsis apophysata: KOFOID & CAMPBELL, 1929, p. 221, fig. 420; HADA, 1935, p. 246.

Rhabdonellopsis intermedia: KOFOID & CAMPBELL, 1929, p. 223, fig. 424; MARSHALL, 1934, p. 650, text-fig. 28.

Rhabdonellopsis longicaulis: KOFOID & CAMPBELL, 1929, p. 223, fig. 419.

Lorica elongated, consisting of a slightly conical bowl and a slender pedicel with a knob and an apical lance, its length 5.7-8.0 inner oral diameters; outer oral rim as high as an inner, widely flaring one (50°-67°), its diameter 1.2-1.3 inner oral diameters; bowl more or less narrowing (7°-10°) in its upper main part to a convex conical aboral region of 17°-26°; pedicel elongate, as long as the bowl, gradually tapering (1.5°-3.5°) and abruptly expanding to form a conical knob of 25°-40° with

a blunt skirt at its distal end; lance short, conical (4° - 10°), with a perforated terminal; wall finely prismatic, with 10-14 somewhat spiral longitudinal ribs extending from the outer oral margin to the skirt of the knob on the surface. Length 266-384 μ ; inner oral diameter 42-48 μ ; outer oral diameter 55-58 μ ; length of the apical lance 16-25 μ .

Occurrence:—Outside the barrier of the Palao Islands, common; Saipan, Tinian, rare; south-west of Formosa, rare.

Distribution:—Widely distributed in warm water currents of the Atlantic (Cleve, 1900; Brandt, 1907; Laackmann, 1909; Jörgensen, 1924) and the Pacific (Brandt, 1907; Kofoid & Campbell, 1929; Marshall, 1934). Also known from the Mediterranean (Zacharias, 1906), the Red Sea (Brandt, 1907), and off the east coast of Africa (Brandt, 1907; Laackmann, 1909).

Comparison:—The species differs from *R. composita* (Brandt) in finer structure and having more conspicuous ribs.

Remarks:—The species is a eupelagic plankter occurring in tropical regions. Kofoid & Campbell (1929) included six species in *Rhabdonellopsis*. Of those six species the following four, *apophysata*, *triton*, *intermedia*, and *logicaulis*, in all probability should be merged into a single species which is considerably variable in size, because the length of the lorica is not generally an important specific character in most species of the Tintinnoinea bearing an elongate lorica, and the fenestration of the bowl seems to be changeable in individuals as in species of *Rhabdonella*: Marshall (1934), in fact, sometimes observed fenestrae in specimens taken from the outer barrier of the Great Barrier Reef. The specimens examined in this research had few comparatively straight ribs and lacked fenestration in all cases.

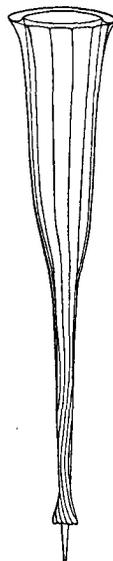


Fig. 63. *Rhabdonellopsis apophysata* (CLEVE) 250 \times

Family Xystonellidae KOFOID & CAMPBELL, 1929

Genus *Xystonella* BRANDT, 1907

Xystonella: BRANDT (pt.), 1907, p. 235; LAACKMANN, 1909, p. 448; JÖRGENSEN, 1924, p. 32; KOFOID & CAMPBELL, 1929, p. 234.

Lorica elongate chalice-shaped; oral margin forming a channel between double rims, the inner entire, usually erect, the outer entire or denticulate, flaring; bowl subcylindrical or more or less conical, aborally abruptly narrowing to a slender pedicel with or without a knob and a lance; wall trilamellate, showing a regular polygonal reticulation.

Type species—*Xystonella treforti* (DADAY) LAACKMANN.

In the present study the type species only has been treated.

64. *Xystonella treforti* (DADAY) LAACKMANN

Fig. 64

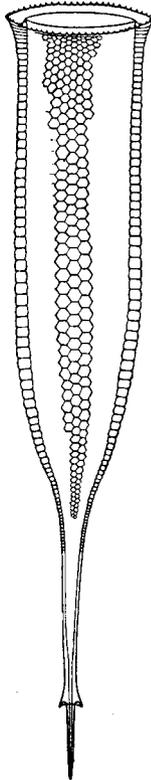


Fig. 64. *Xystonella treforti* (DADAY) 250×

Cyttarocypris treforti: DADAY, 1887, p. 579, pl. 21, fig. 1.

Cyttarocypris quadridens: KOFOID, 1905, p. 290, pl. 27, figs. 8-11, pl. 28, fig. 18.

Cyttarocypris (*Xystonella*) *treforti*: BRANDT (pt.), 1906, pl. 47, figs. 2, 3, 6, 7, 9, pl. 48, fig. 1; 1907, p. 240.

Xystonella treforti: LAACKMANN, 1909, p. 449; JÖRGENSEN, 1924, p. 32, fig. 37; KOFOID & CAMPBELL, 1929, p. 238, fig. 452; MARSHALL, 1934, p. 651.

Lorica elongate chalice-shaped, 4.60-5.65 outer oral diameters in length; outer oral margin flaring (33°-45°), minutely dentate, 1.20-1.25 inner oral diameters; bowl subcylindrical or conical (5°), sometimes very slightly bulging below its middle, convex conical in the aboral region (30°-40°); pedicel tapering (6°-9°), provided with a knob and an apical lance, about 0.25 of the total length without a lance; knob conical, skirted with an acute edge; lance 0.07-0.10 of the total length, pointed at its tip; reticulation of the wall regularly hexagonal, most coarse near the middle of the bowl. Length 325-424 μ ; outer oral diameter 75 μ .

Occurrence:—Palao Islands, very rare.

Distribution:—Widely distributed in warm water regions of the Atlantic (Brandt, 1907; Laackmann, 1909; Jörgensen, 1924), the Pacific (Kofoid, 1905; Brandt, 1907; Kofoid & Campbell, 1929; Marshall, 1934), and the Indian

Ocean (Brandt, 1907; Laackmann, 1909; Jörgensen, 1924). Also reported from the Mediterranean (Daday, 1887, Entz, Jr. 1909; Jörgensen, 1924) and the Red Sea (Brandt, 1907).

Comparison:—The species differs from *X. minuscula* Kofoid & Campbell in having an elongate bowl instead of a short conical one.

Remarks:—This is one of the common species widely occurring among oceanic plankton of tropical and subtropical waters of the world.

Genus *Xystonellopsis* JÖRGENSEN, 1924

Xystonellopsis: JÖRGENSEN, 1924, p. 50; KOFOID & CAMPBELL, 1929, p. 238.

Lorica usually elongate, consisting of a cylindrical or subcylindrical bowl, a short or long pedicel with or without a knob and a skirt, and an apical lance; cavity generally stretching to a distal end of the lance; oral margin usually entire, thin-walled; longitudinal or spiral striae, ridges, or fins sometimes present on the pedicel; wall trilamellate, middle layer composed of a distinct or fine prismatic structure.

Type species—*Xystonellopsis paradoxa* (CLEVE) JÖRGENSEN.

In this genus many oceanic species of warm waters are included. In the present paper have been described five species which were collected from the open seas of the South Islands. When the prismatic structure of the wall is very fine, the wall is generally almost translucent.

Key to species

- A. Pedicel stout, with duplicate skirts, a short conical lance, and plate-like fins.
 - 1. Lorica stout with a wide raised suboral band.....
..... *X. paradoxa* (CLEVE) JÖRGENSEN
- B. Pedicel elongate, with a small knob and a slender lance.
 - 2. Suboral region with a single dilated band.....
..... *X. cymatica* (BRANDT) JÖRGENSEN
 - 3. Lorica elongate with two expanding rings on a wide suboral band.....
..... *X. dicymatica* (BRANDT) KOFOID & CAMPBELL
 - 4. Bowl cylindrical, almost uniform in thickness; pedicel with ridges.....
..... *X. heros* (CLEVE) KOFOID & CAMPBELL
- C. Pedicel inconspicuous with a lance and fins, without a knob.
 - 5. Suboral region inflated to make a wide band.....
..... *X. brandti* (LAACKMANN) JÖRGENSEN
 - 6. Wall uniform in thickness throughout the bowl.....
..... *X. dahli* (BRANDT) KOFOID & CAMPBELL

65. *Xystonellopsis paradoxa* (CLEVE) JÖRGENSEN

Fig. 65

Undella paradoxa: CLEVE, 1900.*(Cyttarocylis?) Xystonella paradoxa*: BRANDT, 1906, pl. 48, figs. 3-6; 1907, p. 256.*Xystonella paradoxa*: LAACKMANN, 1906, p. 453, pl. 49, fig. 8.*Xystonellopsis paradoxa*: JÖRGENSEN, 1924, p. 52, fig. 59; KOFOID & CAMPBELL, 1929, p. 249, fig. 464.

Fig. 65. *Xystonellopsis paradoxa* (CLEVE)
230×

Lorica stout, consisting of a subcylindrical bowl and a duplicate knob with a marked lance, 4.85-5.00 oral diameters in length; oral margin entire; bowl with a wide raised suboral band, somewhat conical (3° - 8°) in its middle; aboral region convex conical to an aboral constriction, provided with several more or less spiral plate-like ridges which are usually stretched out to an upper ring of the knob and 0.17 of the total length in length; knob great, with double edged rings, distance between them 0.06-0.08 of the total length, upper ring 0.67 and the lower 0.57 of an oral diameter; lance stout, 0.13-0.15 of the total length, conical (25° - 30°) with a pointed tip; wall thickened in the suboral band and the knob. Length 197-200 μ ; oral diameter 40 μ .

Occurrence:—Outside the barrier of the Palao Islands, rare.

Distribution:—Warm water currents of the Atlantic (Cleve, 1900; Brandt, 1907; Laackmann, 1909); California Current (Kofoid & Campbell, 1929); near Madagascar (Brandt, 1907); Mediterranean (Entz, Jr., 1909; Jörgensen, 1924).

Comparison:—The species differs from the other species of *Xystonellopsis* in possessing a duplicate knob.

Remarks:—*X. conicauda* described by Kofoid & Campbell (1929) from the South Equatorial Stream of the Pacific seems to be a variety of this characteristic species, because the former is different from the latter only in elongate contour and in having a short apical lance which is wide conical.

66. *Xystonellopsis cymatica* (BRANDT) JÖRGENSEN

Fig. 66

Cyttarocylis (Xystonella) cymatica: BRANDT, 1906, p. 6, pl. 44, figs. 3, 4; 1907, p. 251.

Cyttarocylis (Xystonella) cymatica var. a: BRANDT, 1906, pl. 44, fig. 5, pl. 45, fig. 2; 1907, p. 251.

Xystonella cymatica: LAACKMANN, 1909, p. 452, pl. 49, fig. 5.

Xystonellopsis cymatica: JÖRGENSEN, 1924, p. 51, fig. 57; KOFOID & CAMPBELL, 1929, p. 245, fig. 458.

Lorica comparatively stout, chalice-shaped, 4.6 oral diameters in length; oral rim smooth; bowl with a single elevated suboral band, gradually tapering (8°) in its subcylindrical middle part, then abruptly narrowing (33°) in the aboral region; pedicel rather stout, 0.25 of the total length without a lance; knob small, with a slightly widened angular margin, its width 0.24 oral diameter; apical lance slender, tapering (4°) to a pointed terminal; wall thickest in the suboral band, rapidly thinning to the oral margin and gradually to the aboral end, reticulated with minute hexagons being larger below the suboral dilated band. Length 233μ ; oral diameter 50μ .

Occurrence:—Outside the coral reefs of the Palao Islands, exceedingly rare.

Distribution:—Mediterranean (Brandt, 1907; Jörgensen, 1924); North and South Equatorial Streams, Sargasso Sea (Brandt, 1907; Laackmann, 1909), European coasts in the Atlantic (Jörgensen, 1924); South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929); Mascarene Current in the Indian Ocean (Laackmann, 1909).

Comparison:—The species differs from *X. mascarensis* Kofoid & Campbell in having a stout pedicel.

Remarks:—This species is widely distributed in tropical waters, but rarely occurs in other parts. Kofoid & Campbell's allied species, *X. cyclas* Kofoid & Campbell, *X. spicata* (Brandt), and *X. crassispinosa* Kofoid & Campbell, are probably varieties of this species. The first is a variety having striae on the caudal knob, the next is one with a wide elevated aboral band, and the last is a form provided with a stout apical lance which is slender in the typical form. Brandt's variety is constricted below the suboral expansion; this specimen was probably artificially deformed by contraction caused by the fixer of the plankton as shown by Jörgensen (1924) in fig. 57 b.

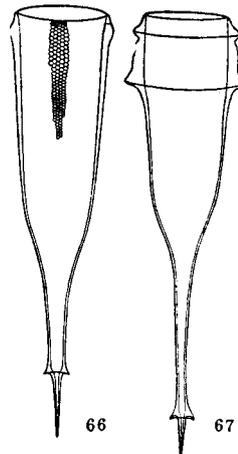


Fig. 66. *Xystonellopsis cymatica* (BRANDT)
250 \times

Fig. 67. *Xystonellopsis dicymatica* (BRANDT)
250 \times

67. *Xystonellopsis dicymatica* (BRANDT) KOFOID & CAMPBELL

Fig. 67

Cyttarocybis (*Xystonella*) *dicymatica*: BRANDT, 1906, p. 6, pl. 46, figs. 1, 2, pl. 68, fig. 10; 1907, p. 252.

Xystonella dicymatica: LAACKMANN (pt.), 1909, p. 452.

Xystonellopsis dicymatica: KOFOID & CAMPBELL, 1929, p. 245, fig. 467.

Lorica elongated goblet-shaped, 5.4 oral diameters in length; oral margin entire; suboral region forming an elevated band with two angular rings, the lower a little larger than the upper, respectively 1.4 and 1.3 oral diameters in diameter, distance between them 1.5 of the total length; bowl slightly narrowing (15°) below the suboral band, more abruptly (38°) in the aboral region; pedicel slender with a knob and an apical lance, 0.45 of the total length including a lance, posteriorly tapering (9°); knob an erect cone of 50° with a sharply edged skirt, its basal diameter 0.22 oral diameter; lance conical (8°) to a pointed terminal, 0.1 of the total length; wall thickened in the suboral band. Length 242 μ ; oral diameter 45 μ .

Occurrence:—Tinian, remarkably rare.

Distribution:—Sargasso Sea, Florida and North Equatorial Streams of the Atlantic, New Pomerania (Brandt, 1907); Mascarene Current (Laackmann, 1909); South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *X. inaequalis* Kofoid & Campbell in the shape of the lower suboral ring which is not expanded so widely in this species as in *X. inaequalis* and from *X. mascarensis* Kofoid & Campbell in having two suboral rings.

Remarks:—This species is a eupelagic form found rarely in the tropical regions.

68. *Xystonellopsis heros* (CLEVE) KOFOID & CAMPBELL

Fig. 68

Undella heros: CLEVE, 1900; BRANDT, 1906, pl. 42, figs. 1, 1a, b, 2; 1907, pp. 370, 372; LAACKMANN, 1909, p. 476.

Undella heros var. *gaussi*: LAACKMANN (pt.), 1909, p. 477, pl. 49, figs. 23, 24.

Xystonellopsis heros: KOFOID & CAMPBELL, 1929, p. 247, fig. 484.

Xystonellopsis gaussi: KOFOID & CAMPBELL, 1929, p. 246, fig. 480.

Xystonellopsis acuminata: KOFOID & CAMPBELL, 1929, p. 239, fig. 482.

Lorica slender, 7.1-7.7 oral diameters in length; bowl cylindrical in the anterior 0.45-0.55 of the lorica, tapering aborally (17° - 20°) into an indefinite pedicel with a slight knob having a somewhat serrated skirt; knob 0.31-0.35 oral diameter in transdiameter; lance conical (13° - 15°), 0.095 of the total length, its tip sharply pointed; wall almost translucent due to very minutely prismatic structure, sub-

uniform in thickness in the bowl, with about eight ridges occupying 0.2 of the total length from the skirt. Length 516-555 μ ; oral diameter 67-72 μ .

Occurrence:—Outside of the barrier of the Palao Islands, common.

Distribution:—Widely distributed in tropical and subtropical waters of the Atlantic (Cleve, 1900; Brandt, 1906; Laackmann, 1909); Mascarene Current (Laackmann, 1909); California Current (Kofoid & Campbell, 1929).

Comparison:—The species differs from *X. dahli* (Brandt) in the stout pedicel and the fully developed skirt of the knob.

Remarks:—Laackmann's *X. heros* var. *gaussi* (1909) and Kofoid & Campbell's *X. acuminata* (1929) seem to be stout forms of this species.

**69. *Xystonellopsis brandti*
(LAACKMANN) JÖRGENSEN**

Fig. 69

Undella heros var. *c*: BRANDT, 1907, p. 373.

Undella tenuirostris var. *brandti*: LAACKMANN, 1909, p. 478, pl. 50, figs. 1, 2.

Xystonellopsis brandti: JÖRGENSEN, 1924, p. 53, fig. 60; KOFOID & CAMPBELL, 1929, p. 241, fig. 474.

Lorica elongate, 6.7 oral diameters in length; oral rim entire; bowl dilated by thickening of the wall in the suboral region, gradually tapering very slightly (5°) below the suboral expansion, more abruptly (20°) in the suboral region, again slightly (8°) in the part regarded as a pedicel; lance 0.17 of the total length, conical (10°) with an acute tip; wall almost translucent, with a very fine prismatic structure; vertical short fins present on the conjunction of the pedicel and the lance. Length 195 μ ; oral diameter 29 μ .

Occurrence:—Tinian, very rare.

Distribution:—Gulf Stream, Sargasso Sea (Brandt, 1907); Mas-

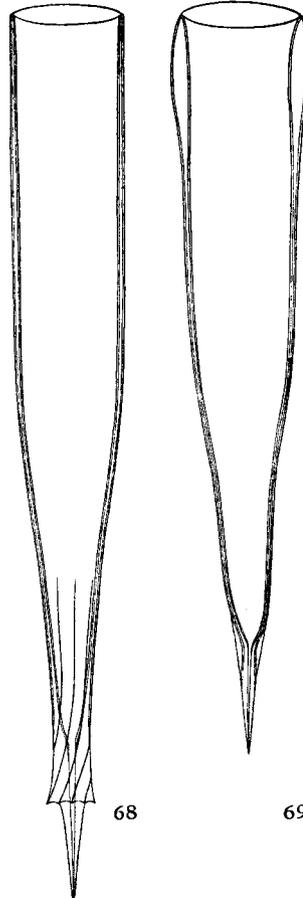


Fig. 68. *Xystonellopsis heros*
(CLEVE) 200 \times

Fig. 69. *Xystonellopsis brandti*
(LAACKMANN) 500 \times

carene Current (Laackmann, 1909); South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929); Mediterranean (Jørgensen, 1924).

Comparison:—The species differs from *X. heros* (Cleve) in smaller size and having a pedicel-like aboral part and from *X. heroica* Kofoid & Campbell in the construction of the aboral region including a lance.

Remarks—This species is probably one of the ocean dwellers of rare occurrence in tropical waters.



Fig. 70. *Xystonellopsis dahli* (BRANDT) 220 \times

70. *Xystonellopsis dahli* (BRANDT)
KOFOID & CAMPBELL

Fig. 70

Undella heros var. *b dahli*: BRANDT, 1906, pl. 43, figs. 1, 1a, 2, 3; 1907, p. 372.

Xystonellopsis dahli: KOFOID & CAMPBELL, 1929, p. 245, fig. 483.

Lorica chalice-shaped, 6.7 oral diameters in length; oral margin smooth; bowl cylindrical in the anterior half of the lorica, aborally narrowing (25°); pedicel and a lance not differentiated, having about six aboral ridges extending up to the posterior part of the aboral region; wall almost translucent because of a very fine prismatic structure. Length 388 μ ; oral diameter 58 μ .

Occurrence:—Outside the barrier of the Palao Islands, very rare.

Distribution:—New Pomerania (Brandt, 1907); widely distributed in the eastern tropical Pacific (Kofoid & Campbell, 1929).

Family Undellidae KOFOID & CAMPBELL, 1929

Genus *Undella* DADAY, 1887

Undella: DADAY (pt.), 1887, p. 565; BRANDT (pt.), p. 343; LAACKMANN (pt.), 1909, p. 467; JØRGENSEN (pt.), 1924, p. 37; KOFOID & CAMPBELL, 1929, p. 258.

Lorica capusular or pot-shaped without a suboral ledge or a definite inner collar; bowl cylindrical or globose; aboral end rounded,

conical, or flattened; wall entirely separated, hyaline, usually thinning towards the aboral end.

Type species—*Undella hyalina* DADAY.

This genus belongs to the warm water group of oceanic plankton. In the present investigation only two globose species have been found.

Key to species

1. Lorica stout, with a slight suboral inflation...*U. hemispherica* LAACKMANN
2. Lorica minute, with a wide suboral dilated band.....
.....*U. turgida* KOFOID & CAMPBELL

71. *Undella hemispherica* LAACKMANN

Fig. 71

Undella hemispherica: LAACKMANN, 1909, p. 472, pl. 49, fig. 22; KOFOID & CAMPBELL, 1929, p. 263, fig. 505; MARSHALL, 1934, p. 652, text-fig. 30.

Undella claparedei: OKAMURA, 1912, p. 34, pl. 5, fig. 98.

Lorica rotund, cup-shaped, 1.26–1.41 oral diameters in length; oral rim with a slight brim, not acute; bowl more or less dilated in the suboral 0.22–0.25 of the lorica, weakly constricted below its expansion, broadest at the point of the anterior 0.4 of the lorica, its greatest diameter 1.24–1.34 oral diameters and a little larger than or nearly equal to that of the suboral dilated part; aboral region hemispherical or broadly convex conical with a round aboral end; wall thickened in the suboral inflated region, gradually thinning towards the thinnest aboral end. Length 60–65 μ , oral diameter 46–50 μ ; greatest transdiameter 57–64 μ .

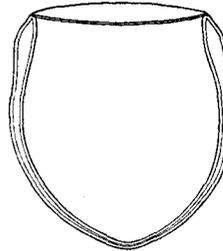


Fig. 71. *Undella hemispherica* LAACKMANN 450 \times

Occurrence:—Saipan, Tinian, rare.

Distribution:—Guinea Stream (Laackmann, 1909); Kurosiwo (Okamura, 1912); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *U. turgida* Kofoid & Campbell in showing greater dimensions and having no marked aboral inflation.

Remarks:—The specimens of the Mariana Islands examined in this work were slightly different from Laackmann's (1909) and Marshall's (1934) figures in bearing a bluntly thinning oral rim which is sharp in the present specimens and in having a slightly dilated suboral region which is invisible in their figures.

72. *Undella turgida* KOFOID & CAMPBELL

Fig. 72

Undella turgida: KOFOID & CAMPBELL, 1929, p. 266, fig. 502; MARSHALL, 1934, p. 652, text-fig. 31.



Fig. 72. *Undella turgida*
KOFOID & CAMPBELL 500X

Lorica stout, pot-shaped, 1.46 oral diameters in length; bowl ovate, sloping outwardly (80°) almost from the oral margin by an inflated suboral part in the anterior 0.45 of the lorica, broadest at the position of the suboral 0.36 of the total length, its greatest transdiameter 1.50 oral diameters; aboral region widely convex conical (110°); aboral end bluntly pointed; wall thicker in the suboral dilated part, thinnest in the aboral end. Length 38μ ; oral diameter 26μ ; greatest transdiameter 40μ .

Occurrence:—Tinian, exceedingly rare.

Distribution:—South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *U. hemispherica* Kofoid & Campbell in being smaller in size and having a great suboral dilated part.

Remarks:—A single specimen, shown in fig. 72, was secured in this collection. It differs somewhat from Kofoid & Campbell's fig. 502 (1929) in having a smaller oral aperture and a distinct suboral inflated part. It differs from Marshall's text-fig. 31 (1934) in its slender proportions and the convex conical aboral region with a bluntly pointed end instead of the broadly rounded end, and besides a reticulated structure could not be seen as observed by Marshall.

Genus *Proplectella* KOFOID & CAMPBELL, 1929

Proplectella: KOFOID & CAMPBELL, 1929, p. 272; HADA, 1937, p. 208.

The species of this genus are eupelagic inhabitants of warm waters. Three species have been reported in this paper. Two already known have the distinct inner collar which is an important characteristic in this genus, but the other, probably new to science, exhibits some relation to other genera of the family Undellidae by the weak development of the inner collar.

Key to species

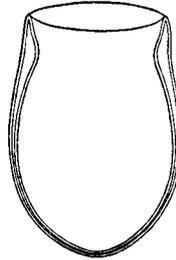
- A. Inner collar well-developed.
 1. Lorica oblong.....*P. claparèdei* (ENTZ) KOFOID & CAMPBELL
 2. Lorica small globose.....*P. perpusilla* KOFOID & CAMPBELL
 B. Inner collar indistinct.
 3. Lorica with two dilations.....*P. biorbiculata* n. sp.

73. *Proplectella claparèdei* (ENTZ) KOFOID & CAMPBELL

Fig. 73

Tintinnus claparèdei: ENTZ, *Sr.*, 1885, p. 202, pl. 14, figs. 10, 11.*Undella claparèdei*: DADAY, 1887, p. 566, p. 19, fig. 1; BRANDT, 1906, p. 64, figs. 1, 2, 31; 1907, p. 362; JÖRGENSEN, 1924, p. 38, fig. 42a.*Undella clapedii*: CLEVE, 1901, p. 10.*Proplectella claparèdei*: KOFOID & CAMPBELL, 1929, p. 276, fig. 525.

Lorica elongate ovate, 1.6-1.8 oral diameters in length; oral margin showing a trace of erectness; inner collar narrowing to its least diameter of 0.81-0.85 oral diameters at the point of the anterior 1.4-1.8 of the total length; bowl ellipsoidal, broadest a little below the middle of the lorica, its greatest transdiameter 1.21-1.25 oral diameters; aboral end hemispherical. Length 63-72 μ ; oral diameter 36-41 μ ; greatest transdiameter 46-50 μ .

Fig. 73. *Proplectella claparèdei* (ENTZ) 450 \times

Occurrence:—Outside the barrier of the Palao Islands, very rare; Saipan rare.

Distribution:—Mediterranean (Entz, 1885; Daday, 1887; Jörgensen, 1924); warm water regions of the Atlantic (Brandt, 1907); Indian Ocean (Cleve, 1901); Madagascar, New Pomerania (Brandt, 1907); South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *P. fastigata* (Jörgensen) and *P. ovata* (Jörgensen) in its smooth contour and from *P. perpusilla* Kofoid & Campbell in being larger in size and more slender in form.

Remarks:—In this study elongated specimens were more frequently found than rotund ones like the figures of Entz (1885), Daday (1887), and Jörgensen (1924) from specimens of the Mediterranean.

74. *Proplectella perpusilla* KOFOID & CAMPBELL

Fig. 74

Proplectella perpusilla: KOFOID & CAMPBELL, 1929, p. 281, fig. 524; MARSHALL 1934, p. 653, text-fig. 32.

Lorica pot-shaped, 1.5 oral diameters in length; collar cylindrical externally, narrowing internally (38°) to the inner constriction situated in the anterior 0.18 of the total length, its shortest inner diameter 0.8 oral diameter; bowl globose, broadest near the middle of the lorica, its greatest transdiameter 1.3 oral diameters, aboral end broadly rounded. Length 44μ ; oral diameter 29μ ; greatest transdiameter 37μ .

Occurrence:—Palao Islands, remarkably rare.

Distribution:—Eastern tropical Pacific (Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *P. claparèdei* (Entz) and *P. globosa* (Brandt) in being smaller and having a more or less marked outer collar.

Remarks:—According to Kofoid & Campbell's report (1929) this species is widely distributed in the eastern tropical Pacific where Agassiz made an expedition. However, in the western tropical Pacific in which these materials were collected, this species was only once detected in a vertical haul outside the barrier of the Palao Islands.

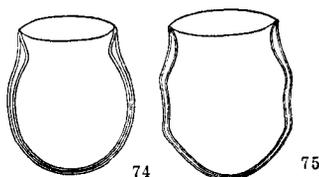


Fig. 74. *Proplectella perpusilla*
KOFOID & CAMPBELL 450 \times

Fig. 75. *Proplectella biorbiculata*
n. sp. 450 \times

75. *Proplectella biorbiculata* n. sp.

Fig. 75

Lorica 1.45 oral diameters in length; oral margin very slightly flaring; inner collar weakly developed, outer one somewhat erect below the oral rim; bowl with two expansions, nearly equal to each other in diameter (1.2 oral diameters), located respectively at the points of the anterior one-third and the posterior one-third of the lorica; aboral region broadly convex conical (110° – 135°) to a round aboral end; wall not remarkably thickened at the lower part of the inner collar, gradually thinning from the collar to the aboral end. Length 45μ ; oral diameter 31μ .

Occurrence:—Palao Islands, Tinian, very rare.

Comparison:—The new species differs from *P. biangulata* Kofoid & Campbell in having stouter proportions and a wide aperture.

Remarks:—This new species seems to be more or less related to *Cricundella* in respect of possession of two expansions and the poorly developed inner collar.

Family Dictyocystidae HAECKEL, 1873

Genus Dictyocysta EHRENBERG, 1854

Dictyocysta: EHRENBERG, 1854; DADAY, 1887, p. 584; BRANDT, 1907, p. 48; LAACKMANN, 1909, p. 430; JÖRGENSEN, 1924, p. 81; 1927, p. 14; KOFOID & CAMPBELL, 1929, p. 285.

Lorica pot-shaped, consisting of a cylindrical collar and an ovate bowl; oral margin usually smooth, rarely with spines, generally more or less undulating; collar constructed of one or two rows of windows of which frames usually curve outwardly; bowl often surrounded with fenestrae; aboral end rounded or sometimes pointed; wall single layered, composed of a reticulated structure which is visible or invisible, often with coccoliths attached to the surface.

Type species—*Dictyocysta elegans* EHRENBERG.

Being characteristic in form and structure, species of this genus are easily distinguished from those of other genera, and are mostly dwellers in warm waters. In the present investigation the following six were secured. On account of the scarcity of the specimens variations of these forms could not be studied. Hence, their identification wholly follows Kofoid & Campbell's paper (1929).

Key to species

- A. Bowl with a reticulate structure on which coccoliths sometimes are attached.
 - a. Fenestration present in the bowl.
 - a'. Reticulation visible in the collar.
 - 1. Anterior group of small fenestrae visible....*D. lepida* EHRENBERG
 - 2. Wall of the bowl covered thick with coccoliths, anterior fenestration absent.....*D. occidentalis* KOFOID & CAMPBELL
 - a''. Reticulation invisible in the collar.
 - 3. Frames of windows on the collar narrow; reticulation uniform....
.....*D. reticulata* KOFOID & CAMPBELL
 - b. No fenestrae in the bowl.
 - 4. Wall of the bowl composed of a regular polygonal reticulation
.....*D. polygonata* KOFOID & CAMPBELL
 - 5. Wall of the bowl covered with coccoliths.....*D. duplex* BRANDT
- B. Reticulated structure inobservable in the lorica.
 - 6. Wide clear zone present above the fenestrate part of the bowl....
.....*D. verticosa* n. sp.

76. *Dictyocysta lepida* EHRENBERG

Fig. 76

Dictyocysta lepida: EHRENBERG, 1854; KOFOID, 1915, p. 65; JÖRGENSEN, 1924, p. 83, fig. 95; 1927, p. 14, fig. 30; KOFOID & CAMPBELL, 1929, p. 294, fig. 558.

Dictyocysta templum: KENT, 1882, p. 625, pl. 32, fig. 27; ENTZ, *Sr.*, 1885, p. 208, pl. 14, figs. 18-21, 23; BRANDT, 1906, pl. 2, fig. 13, pl. 3, figs. 1-3; 1907, p. 68; OKAMURA, 1907, p. 136, pl. 6, figs. 55a, b; LAACKMANN (pt.) 1909, p. 432.

Lorica 1.43 oral diameters in length, oral margin smooth; collar cylindrical, 3.1 of the total length in height, consisting of 6-7 quadrate windows arranged in a single row, their width 1.25 of their height, their vertical beams comparatively wider and straight; bowl broadest at the portion of its anterior 0.2, 1.1 oral diameters in greatest transdiameter; aboral region broadly rounded; wall finely reticulated throughout the lorica even in the collar, provided with one row of 6-7 large, round, subequal fenestrae near the middle of the bowl, of which the upper part has numerous small pores scattered closely and small fenestrae are also present in the aboral region. Length 50-52 μ ; oral diameter 35-37 μ ; length of the collar 18-20 μ ; greatest transdiameter of the bowl 38-40 μ .

Occurrence:—Outside the barrier of the Palao Islands, very rare.

Distribution:—Reported by many authors everywhere in warm waters of the world.

Comparison:—The species differs from *D. nidulus* Kofoid & Campbell in the shorter collar and wider frames and from *D. reticulata* Kofoid & Campbell in having a minute reticulation appearing even in the frames of the windows on the collar besides in the bowl.

Remarks:—As the species is one of the old species and variable in shape, it has been confused in identification. The specimens of the examination were comparatively smaller in size than ones known from other localities.

77. *Dictyocysta occidentalis* KOFOID & CAMPBELL

Fig. 77

Dictyocysta templum var. h: LAACKMANN, 1909, p. 434, pl. 49, fig. 3.

Dictyocysta occidentalis: KOFOID & CAMPBELL, 1929, p. 298, fig. 556.

Dictyocysta reticulata: HADA (pt.), 1935, p. 246.

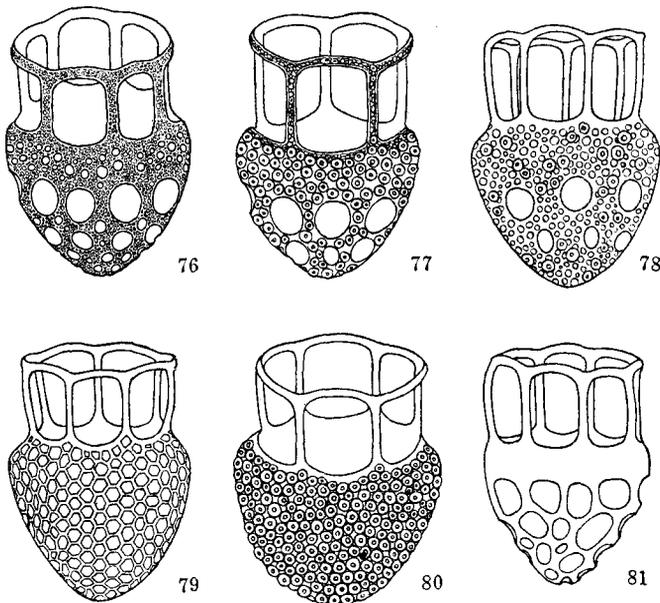
Lorica 1.57-1.66 oral diameters in length; collar cylindrical 3.4-4.0 of the total length in height, consisting of 5-6 rectangular windows arranged side by side, their frames somewhat wide; bowl broadly ovate with a rounded shoulder, its greatest diameter 1.14 oral diameters; aboral end round; wall of the bowl having a median series of 8-9 large fenestrae, posterior one of 5-7 small and an aboral group

scattered irregularly, entirely covered with coccoliths, wall of the collar composed of a fine reticulation. Length 55-58 μ ; oral diameter 35 μ ; length of the collar 20-23 μ ; greatest diameter of the bowl 40 μ .

Occurrence:—Center of the Java Sea, very rare.

Distribution:—Ascension and South Equatorial Stream in the Atlantic (Laackmann, 1909); California and South Equatorial Currents, Panamic Area, and Easter Island Eddy in the Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *D. lepida* Ehrenberg in the presence of a cover of coccoliths and the absence of the anterior group of small fenestrae and from *D. duplex* Brandt in having fenestrae in the bowl.



- Fig. 76. *Dictyocysta lepida* EHRENBERG 550 \times
 Fig. 77. *Dictyocysta occidentalis* KOFOID & CAMPBELL 550 \times
 Fig. 78. *Dictyocysta reticulata* KOFOID & CAMPBELL 550 \times
 from the Java Sea
 Fig. 79. *Dictyocysta polygonata* KOFOID & CAMPBELL 550 \times
 from the Java Sea
 Fig. 80. *Dictyocysta duplex* BRANDT 550 \times
 Fig. 81. *Dictyocysta verticosa* n. sp. 550 \times

Remarks:—It has been impossible to observe the structure of the wall of the bowl in specimens from the Java Sea, because their surfaces were almost concealed by closely attached coccoliths.

78. *Dictyocysta reticulata* KOFOID & CAMPBELL

Fig. 78

Dictyocysta templum: DADAY, 1887, p. 585, pl. 21, figs. 8, 9; ZACHARIAS, 1906, p. 520, fig. 9.

Dictyocysta templum var. b: BRANDT, 1906, pl. 3, figs. 8, 9; 1907, p. 70.

Dictyocysta lepida var.: KOFOID, 1915, p. 65, figs. 2, 3.

Dictyocysta reticulata: KOFOID & CAMPBELL, 1929, p. 300, fig. 560; MARSHALL, 1934, p. 653; HADA (pt.), 1935, p. 246.

Lorica consisting of a cylindrical collar and a subspherical bowl, its length 1.3-1.5 oral diameters; collar 0.35 of the total length, with a single row of 6-7 rectiangular windows with narrow beams, their height a little greater than their width; bowl stout, broadest at its anterior 0.2, its greatest transdiameter 1.2 oral diameters, aboral region broadly convex conical with a rounded aboral end; wall of the bowl with a rather uniform reticulation which is not seen in the collar, sometimes bearing coccoliths on the surface, having one row of 6-7 large ovate fenestrae in its middle and a posterior row of a few small ones. Length 52-60 μ ; oral diameter 35-40 μ .

Occurrence:—Palao Islands, very rare; central area of the Java Sea, very rare.

Distribution:—Mediterranean (Daday, 1887; Zacharias, 1906); Agulhas Current (Brandt, 1907); eastern tropical Pacific (Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *D. lepida* Ehrenberg in the lack of anterior small fenestrae and of a reticulation in the collar and from *D. occidentalis* Kofoid & Campbell in having narrower frames of windows of the collar on which a reticulation is not visible in this species.

Remarks:—The specimens from the Palao Islands had no coccoliths on the bowl, but ones from the Java Sea were observed to carry them fixed on the surfaces of the bowls.

79. *Dictyocysta polygonata* KOFOID & CAMPBELL

Fig. 79

Dictyocysta polygonata: KOFOID & CAMPBELL, 1929, p. 299, fig. 557; HADA, 1935, p. 246.

Lorica 1.6 oral diameters in length; collar subcylindrical, consisting of a row of 6-7 rectangular windows with rather narrow frames, its height 0.35 of the total length; bowl broadly globose or ovate, without fenestration, 1.1-1.2 oral diameters in greatest transdiameter; aboral end rounded; wall composed of a reticulation of rather uniform polygonate meshes. Length 55-58 μ ; oral diameter 35-36 μ ; length of the collar 20 μ ; greatest diameter of the bowl 40-42 μ .

Occurrence:—Central part of the Java Sea, very rare.

Distribution:—California and Peruvian Currents, South Equatorial Stream, Galapagos Eddy, and Panamic Area in Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from all of the species except *D. duplex* Brandt in *Dictyocysta* in the absence of a fenestration on the bowl and from the latter in the shape of meshes of the reticulation in the wall.

Remarks:—The specimens taken from the Java Sea bore a fine reticulation in comparison with Kofoid & Campbell's figure (1929), and there were also observed among them individuals showing a convex conical aboral region as drawn in fig. 79.

80. *Dictyocysta duplex* BRANDT

Fig. 80

Dictyocysta templum var. e *duplex*: BRANDT, 1906, pl. 2, fig. 9; 1907, p. 72.

Dictyocysta templum var. d: BRANDT, 1906, pl. 2, fig. 10, pl. 4, fig. 7; 1907, p. 71.

Dictyocysta lepida var. *coccolitholega*: JÖRGENSEN, 1924, p. 84.

Dictyocysta duplex: KOFOID & CAMPBELL, 1929, p. 289, fig. 564.

Dictyocysta sp.: HADA, 1935, p. 247.

Lorica 1.45 oral diameters in length; collar subcylindrical, slightly narrowing posteriorly, composed of a zone of six quadrate windows, 0.30-0.33 of the total length in height; bowl roundly ovate with a wide end, broadest in the rounded shoulder of 1.2 oral diameters; wall of the bowl having no fenestration, covered with coccoliths. Length 50-52 μ ; oral diameter 35 μ ; length of the collar 15-17 μ ; greatest diameter of the bowl 42 μ .

Occurrence:—Center of the Java Sea, very rare.

Distribution:—Gulf, South Equatorial, Benguela and Brazil Streams in the Atlantic (Brandt, 1907; Jörgensen, 1924); Mediterranean (Jörgensen, 1924); Peruvian and South Equatorial Currents in the Pacific (Kofoid & Campbell, 1929).

Comparison:—The species differs from *D. polygonata* Kofoid & Campbell in possessing closely aggregated coccoliths on the surface of the bowl.

Remarks:—Specimens collected from the Java Sea were generally smaller than those from the other known localities. They were covered with coccoliths which kept the ground structure out of sight throughout the bowl, though Brandt's figs. 9, 10 in Pl. 2 (1906) indicate overlapping round meshes which seem to be a ground structure. Jörgensen (1924) and Kofoid & Campbell (1929) reported that coarse overlapping meshes and coccoliths were visible on the surface of the bowl of this species, but an overlapping structure could not be observed in the present examination as just mentioned.

81. *Dictyocysta verticosa* n. sp.

Fig. 81

Lorica subcylindrical in the anterior half, posteriorly conical, 1.54 oral diameters in length; oral margin more or less undulating; collar cylindrical, 0.4 of the total length in height, with seven quadrangular windows arranged in a single row, their height as much as twice their width and their vertical beams somewhat curved outwardly; bowl forming an inverted low convex cone below a slight dilation at the middle of the lorica, its greatest diameter 1.1 oral diameters; aboral end rounded; fenestration consisting of several rows of pores becoming gradually smaller to the aboral end and located in the posterior half of the lorica; wall hyaline, reticulation invisible. Length 57 μ ; oral diameter 37 μ ; length of the collar 23 μ ; greatest diameter of the bowl 43 μ .

Occurrence:—Palao Islands, exceedingly rare.

Comparison:—The new species differs from *D. dilatata* Brandt, *D. minor* Jörgensen, and *D. obtusa* Jörgensen in the high distinct collar and the stout conical bowl.

Remarks:—The new species is characteristic in having a high differentiated collar and a wide clear band in the anterior part of the bowl in spite of reticulation being invisible in the bowl.

Family Tintinnidae CLAPARÈDE & LACHMANN, 1858

Genus *Amphorella* DADAY, 1887

Amphorella: DADAY (pt.), 1887, p. 535; JÖRGENSEN (pt.), 1924, p. 15; KOFOID & CAMPBELL, 1929, p. 307; HADA, 1937, p. 209.

The genus is represented by the following two species resembling each other in this investigation: one is a cosmopolitan species and the other is a tropical form.

Key to Species

1. Lorica stouter, with excellent fins.
.....*A. quadrilineata* (CLAPARÈDE & LACHMANN) DADAY
2. Lorica elongate, slender....*A. brandti* (JÖRGENSEN) KOFOID & CHAMPBELL

**82. *Amphorella quadrilineata* (CLAPARÈDE
& LACHMANN) DADAY**

Amphorella quadrilineata: HADA, 1937, p. 209, fig. 52.
Length 92-125 μ ; oral diameter 42-50 μ .

Occurrence:—Outside the barrier of the Palao Islands, lagoon of Yap, very rare; Tinian, rare; near Formosa, off Nhatrang, Saigon, and Singapore, everywhere in the Java Sea, Strait of Sunda, Sulu Sea, very rare.

Remarks:—This is a cosmopolitan species widely distributed in warm waters.

83. *Amphorella brandti* JÖRGENSEN

. Fig. 82

Tintinnus amphora: BRANDT, 1906, pl. 69, fig. 6;
1907 (pt.) p. 433.

Amphorella quadrilineata brandti: JÖRGENSEN,
1924, p. 18.

Amphorella brandti: KOFOID & CHAMPBELL, 1929,
p. 309, fig. 588; MARSHALL, 1934, p. 655, text-fig. 36;
HADA, 1935, p. 247.

Lorica elongate, 3.1-3.7 oral diameters in length; collar funnel-shaped, widely flaring (70°-85°), its basal diameter 0.58-0.61 of an oral diameter; bowl cylindrical in its anterior one third, becoming triangular aborally in cross section owing to development of three ridges stretching up to the upper 0.37 of the total length of the lorica from truncated aboral end which is slightly concave transversely; wall hyaline, separated in the upper part of a circular cross section and single-layered in the lower. Length 118-176 μ ; oral diameter 40-47 μ .

Occurrence:—Palao Islands, rare; west coast of Borneo, very rare; Indian Ocean off the Strait of Sunda, very rare.



Fig. 82. *Amphorella brandti* (JÖRGENSEN) 400 \times
from the Palao Islands

Distribution:—North Equatorial Current of the Atlantic (Brandt, 1907); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *A. quadrilineata* (Claparède & Lachmann) in slender contour.

Remarks:—The distribution of this species is localized in tropical waters from the known localities.

Genus *Steenstrupiella* KOFOID & CAMPBELL, 1929

Steenstrupiella: KOFOID & CAMPBELL, 1929, p. 311.

Lorica consisting of a flaring collar and an elongate bowl; oral aperture circular, entire, sometimes with double margins; aboral end rounded or convex conical; folds or striae generally present on the aboral region; wall usually separated in the anterior part of the lorica.

Type species — *Steenstrupiella steenstrupii* (CLAPARÈDE & LACHMANN) KOFOID & CAMPBELL.

In this paper have been reported two known species of which specimens in the present collection differ from those of prior examinations in the absence of folds or striae on the surface of the posterior part. This construction is probably variable according to localities.

Key to species

1. Lorica elongate, slender, 4-5 oral diameters in length.....
.....*S. steenstrupii* (CLAPARÈDE & LACHMANN) KOFOID & CAMPBELL
2. Lorica short, stout, 2.1-2.6 oral diameters in length.....
.....*S. gracilis* (JÖRGENSEN) KOFOID & CAMPBELL

84. *Steenstrupiella steenstrupii* (CLAPARÈDE & LACHMANN)

KOFOID & CAMPBELL

Fig. 83

Tintinnus steenstrupii: CLAPARÈDE & LACHMANN, 1858, p. 200, pl. 8, fig. 5; KENT, 1882, p. 606, pl. 31, fig. 20; BRANDT (pt.), 1906 pl. 69, fig. 9; 1907, p. 437; FELDHAUS, 1920, p. 58.

Amphorella steenstrupii: DADAY, 1887, p. 537, pl. 18, figs. 9, 21; CLEVE, 1900a, p. 18; 1900b, p. 21; 1901, p. 9; 1902, p. 17; 1903, p. 30; JÖRGENSEN, 1924, p. 20, fig. 16; 1927, p. 10, fig. 13.

Steenstrupiella steenstrupii: KOFOID & CAMPBELL, 1929, p. 314, fig. 596; MARSHALL, 1934, p. 655; HADA, 1935, p. 247.

Lorica slender, 4-5 oral diameters in length, consisting of a funnel shaped collar and a tubular bowl; collar an inverted truncated conical cone of 90° - 110° , its basal diameter 0.6 oral diameter; bowl subcylindrical, more or less tapering (3° - 5°) to a slightly inflated aboral region without any ornamentation; aboral end rounded; wall thickest in the nuchal part where it is separated. Length 108-175 μ ; oral diameter 33-35 μ .

Occurrence:—Outside the coral reefs of the Palao Islands, rare; Saipan, Tinian, very rare; sea surrounded by Java, Borneo, and Celebes, very rare.

Distribution:—Has a wide distribution in the Atlantic, the North Sea, and the Mediterranean (Claparède & Lachmann, 1858; Daday, 1887; Cleve, 1900-1903; Brandt, 1907; Feldhaus, 1920; Jörgensen, 1924, 1927); Indian Ocean (Cleve, 1901); Great Barrier Reef Marshall, 1934).

Comparison:—The species differs from *S. gracilis* (Jörgensen) in being longer and slender.

Remarks:—In specimens of this species and the next collected from the South Sea Islands and the East Indies, no folds or striae have been seen on the aboral region of the lorica. About half the specimens examined by Marshall (1934) from the Great Barrier Reef also had no aboral appendages. From these facts it is probable that folds of the aboral region are poorly developed or lacking in specimens in the Indo-Pacific, but they are well-developed in those of the Atlantic and the Mediterranean.

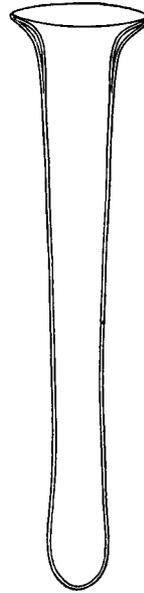


Fig. 83. *Steenstrupiella steenstrupii* (CLAPARÈDE & LACHMANN) 500 \times from the Palao Islands

85. *Steenstrupiella gracilis* (JÖRGENSEN) KOFOID & CAMPBELL

Fig. 84

Amphorella gracilis: JÖRGENSEN, 1924, p. 21, fig. 19.

Steenstrupiella gracilis: KOFOID & CAMPBELL, 1929, p. 313, fig. 597; HADA, 1935, p. 247.

Lorica elongate sac-shaped, 2.1-2.6 oral diameters in length; collar shallow dish-like, its basal diameter 0.55-0.60 of an oral diameter; bowl cylindrical with

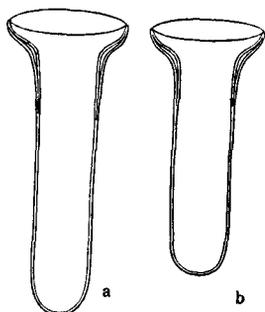


Fig. 81. *Steenstrupiella gracilis* (JÖRGENSEN) 500×
from Tinian

almost straight sides, roundly ending in the aboral region; wall translucent, separated in the upper one-third of the lorica. Length 65–85 μ ; oral diameter 30–35 μ .

Occurrence:—Tinian, rare; off Takao, very rare.

Distribution:—Ionian Sea in the Mediterranean (Jörgensen, 1924).

Comparison:—The species differs from *S. steenstrupii* (Claparède & Lachmann) in the small and stouter lorica.

Remarks:—The species found from the Ionian Sea was guessed by Jörgensen (1924) to belong to *S. intumescens* (Jörgensen) with an incomplete lorica, but the latter having not been secured in this research, the present species seems to be an independent one.

Genus *Amphorellopsis* KOFOID & CAMPBELL

Amphorellopsis: KOFOID & CAMPBELL, 1929, p. 314.

Lorica usually elongate, consisting of a low funnel-shaped collar and a subcylindrical or fusiform bowl with a blunt or pointed end; oral margin usually entire; aboral region tapering to an aboral end, from which a number of vertical fins or ridges sometimes extend to the collar; wall single-layered except an anterior flaring part of the lorica.

Type species—*Amphorellopsis acuta* (SCHMIDT) KOFOID & CAMPBELL.
The above mentioned type species has been secured in this work.

86. *Amphorellopsis acuta* (SCHMIDT) KOFOID & CAMPBELL

Fig. 85

Amphorella acuta: SCHMIDT, 1901.

Tintinnus acutus: BRANDT, 1906, p. 70, figs. 6, 7; 1907, p. 435.

Amphorellopsis acuta: KOFOID & CAMPBELL, 1929, p. 315, fig. 598; MARSHALL, 1934, p. 656; HADA, 1935, p. 247.

Lorica fusiform, 2.3–2.8 oral diameters in length; oral aperture circular; collar low-funnel-shaped (70°–85°), its nuchal smallest diameter 0.54–0.60 of an oral diameter; bowl circular in cross section below the collar, then gradually becoming triangular,

posteriorly with three ridges in the aboral 0.6 of the total length; aboral end acute; wall composed of separated laminae in the anterior 0.2 of the lorica. Length 85–108 μ ; oral diameter 33–42 μ .

Occurrence:—Palao Islands, frequently; Yap, common; off Singapore and Batavia, very rare.

Distribution:—Gulf of Siam (Schmidt, 1901); west coast of Africa (Brady, 1907); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from the other species of *Amphorellopsis* in having three ridges.

Remarks:—This species is a warm water dweller occurring in tropical waters of the Indo-Pacific.

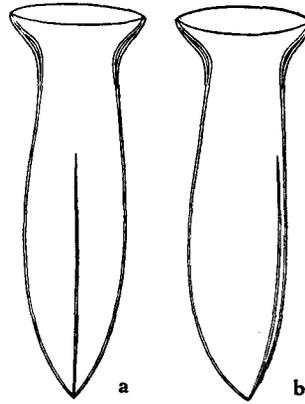


Fig. 85. *Amphorellopsis acuta*
(SCHMIDT) 500 \times
from the Palao Islands

Genus *Dadayiella* KOFOID & CAMPBELL, 1929

Dadayiella: KOFOID & CAMPBELL, 1929, p. 319.

Lorica elongate goblet-shaped, with or without a flaring distinct collar, usually having a pedicel with or without a bulb at its tip; oral aperture circular, entire; wall single-layered with a number of striae on the surface of the anterior part of the lorica.

Type species—*Dadayiella ganymedes* (ENTZ) KOFOID & CAMPBELL.

Only the type species has been reported in this paper. It is exceedingly variable in size and form and widely distributed in warm water regions.

87. *Dadayiella ganymedes* (ENTZ) KOFOID & CAMPBELL

Fig. 86

Tintinnus ganymedes: ENTZ, 1884, p. 409, pl. 24, figs. 17, 18; BRANDT, 1906, pl. 70, fig. 2; 1907, pp. 409, 412.

Amphorella ganymedes: DADAY, 1887, p. 539, pl. 18, fig. 18; JÖRGENSEN, 1924, p. 22, figs. 22a–d; HOFKER, 1931, p. 384, fig. 79.

Tintinnus bulbosa: BRANDT, 1906, pl. 70, figs. 4, 5; 1907, p. 412.

Tintinnus bulbosa var. a: BRANDT, 1906, pl. 70, fig. 3; 1907, p. 413.

Dadayiella ganymedes: KOFOID & CAMPBELL, 1929, p. 321, fig. 610; MARSHALL, 1934, p. 657; HADA, 1935, p. 247.

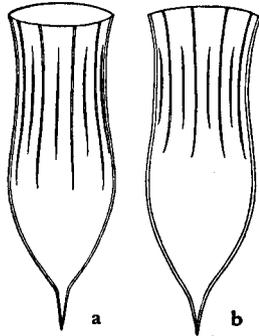


Fig. 86. *Dadayiella ganymedes* (ENTZ) 450×
from the Palao Islands

Dadayiella acuta: KOFOID & CAMPBELL, 1929, p. 320, fig. 609.

Dadayiella bulbosa: KOFOID & CAMPBELL, 1929, p. 320, fig. 611.

Dadayiella jørgenseni: KOFOID & CAMPBELL, 1929, p. 321, fig. 613.

Lorica tall goblet-shaped, 2.9–3.2 oral diameters in length; oral margin entire, more or less flaring (18°–20°); bowl narrowest near the anterior one-half of the lorica, 0.85 of an oral diameter in smallest diameter, then gradually dilating to the widest part, its greatest diameter usually equal to that of the oral aperture; aboral region convex conical; pedicel tapering (20°–25°) to a pointed tip, 0.07–0.11 of the total length; wall provided with seven long striae and with short ones to the same number on the surface of the upper half of the lorica. Length 75–105 μ ; oral diameter 25–30 μ .

Occurrence:—Lagoons of the Palao Islands, Yap, rare; Java Sea, rare; Allas Strait, very rare.

Distribution:—Widely distributed in warm waters of the world (Entz, 1884; Daday, 1887; Brandt, 1907; Jørgensen, 1924; Kofoid & Campbell, 1929; Marshall, 1934).

Comparison:—The species differs from *D. pachytoecus* (Jørgensen) in bearing no differentiated collar.

Remarks:—This species is variable in total length, general contour, and number of suboral striae, especially a marked variation is seen in the shape of the pedicel. Specimens of the South Sea Islands and the Malay Archipelago on which the present descriptions have been based, have a short hyaline pedicel pointed at the terminal without an ornamentation or an appendage as shown by Marshall (1934) in specimens obtained from the Great Barrier Reef. The present writer observed specimens having variously formed pedicels from Japanese waters: some of them are provided with a diamond-shaped, globose, or irregular bulb at the tip of the pedicel, while others show several vertical striae or ridges on a conical pedicel. Such forms, different from each other and including various intermediate ones, often appear together in the same collection. From these observations on the variations of this species, Brandt's species, *bulbosa* (1906–07), Jørgensen's variety, *tenuicauda*, and formae, *obtusa* and *acuta* (1924), and Kofoid & Campbell's species, *jørgenseni* (1929), are variable forms of this

species. This is one of the cosmopolitan species occurring widely in warm waters of the world.

Genus *Brandtiella* KOFOID & CAMPBELL, 1929

Brandtiella: KOFOID & CAMPBELL, 1929, p. 325.

Lorica covered with gelatinous substance; collar consisting of a low truncated funnel and a suboral angular ledge; bowl sac-like; wall finely prismatic, separated in the anterior part.

Type species—*Brandtiella palliata* (BRANDT) KOFOID & CAMPBELL.

In this genus only one species, just mentioned as the type, is known.

88. *Brandtiella palliata* (BRANDT) KOFOID & CAMPBELL

Fig. 87

Tintinnus palliatus: BRANDT, 1906, p. 9, pl. 70, fig. 1; 1907, p. 436; LAACKMANN, 1909, p. 438.

Brandtiella palliata: KOFOID & CAMPBELL, 1929, p. 325, fig. 623.

Lorica covered with a capsular gelatinous coating mixed with fine foreign particles, 3 oral diameters in length; collar short, 0.08-0.10 of the total length in height, consisting of a low truncated funnel (50° - 55°) formed by a suboral constriction and of an expanding angular ledge (68° - 77°) which is nearly equal to the oral diameter; bowl narrowest below the collar, inflated at its middle, circular in cross section in its anterior part, usually becoming gradually triangular towards the blunt aboral end; wall separated in the upper one-third of the lorica. Length 150-155 μ ; oral diameter 50-53 μ .

Occurrence:—Outside the barrier of the Palao Islands, very rare.

Distribution:—Florida, Guinea, and South Equatorial streams, and Sargasso Sea in the Atlantic (Brandt, 1907); South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929).

Remarks:—The species coated characteristically with gelatinous matters is easily distinguishable from forms of the other genera. This is a eupelagic plankter appearing rarely in tropical waters.

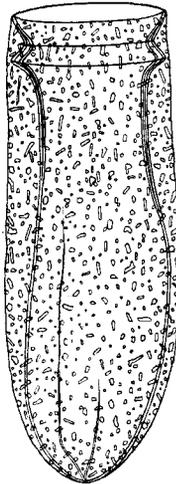


Fig. 87. *Brandtiella palliata* (BRANDT) 400 \times

Genus *Tintinnus* SCHRANK, 1803

Tintinnus: SCHRANK, 1803; CLAPARÈDE & LACHMANN (pt.), 1858, p. 195; DADAY (pt.), 1887, p. 525; BRANDT (pt.), 1907, p. 374; LAACKMANN (pt.), 1909, p. 479; JÖRGENSEN (pt.), 1924, p. 9; KOFOID & CAMPBELL, 1929, p. 329; HADA, 1937, p. 210.

Seven species and five varieties have been described in this paper. All of the species of this genus are so simple tubular in the form of the lorica, that their identification is confused on account of slight differences among them. Kofoid & Campbell (1929) published many new species from the collections of the Agassiz Expedition to the eastern tropical Pacific, and raised forms which had been reported by prior authors as varieties or formae to the status of species. Their classification was probably based upon dimensions of the lorica besides differences of the form, but being generally variable within a wide range, the length of the lorica seems not to be a chief feature by which species are distinguished. Hence, the identification of the species of this genus in this study has been principally carried out only by differences in the form of the lorica.

Key to species

- A. Lorica without an aboral flare.
- a. Oral margin with a distinct brim.
 1. Lorica stout, without a median bulge.....*T. lusus undae* ENTZ
 2. Lorica slender, without a median bulge.....
.....*T. lusus-undae* var. *tenuis* KOFOID & CAMPBELL
 3. Lorica with a median bulge.....
.....*T. lusus-undae* var. *turgescens* KOFOID & CAMPBELL
 - b. Oral margin with a faint brim.
 4. Lorica small, stout, with a slight flare and a median bulge.....
.....*T. pacificus* KOFOID & CAMPBELL
 5. Lorica slender, without a median dilation.....
.....*T. stramentus* KOFOID & CAMPBELL
- B. Lorica with an aboral flare.
- c. Lorica without a median bulge.
 6. Aboral flare fairly developed.....*T. fraknóii* DADAY
 7. Aboral region widely flaring.....
.....*T. fraknóii* var. *birictus* KOFOID & CAMPBELL
 8. Oral and aboral flares well-developed..*T. fraknóii* var. *bilatifinis* n. var.
 - d. Lorica with a median bulge.
 9. Lorica without a posterior constriction.....*T. elegans* JÖRGENSEN
 10. Lorica with a slight posterior constriction.....
.....*T. elegans* var. *procurrens* KOFOID & CAMPBELL

C. Lorica aborally narrowing.

11. Lorica without a definite aboral tube... *T. apertus* KOFOID & CAMPBELL12. Lorica with a conspicuous aboral tube..... *T. angustatus* DADAY89. *Tintinnus lusus-undae* ENTZ

Fig. 88

Tintinnus lusus-undae: ENTZ, 1885, p. 202, pl. 14, fig. 12; DADAY (pt.), 1887, p. 527, pl. 18, fig. 3; CLEVE, 1901, p. 10; ZACHARIAS (pt.), 1906, p. 510; BRANDT, 1906, pl. 65, fig. 11; 1907, p. 420; LAACKMANN, 1909, p. 482, pl. 50, fig. 3; FELDHAUS, 1920, p. 57; JÖRGENSEN, 1924, p. 9, fig. 1; KOFOID & CAMPBELL, 1929, p. 335, fig. 656; HOFKER (pt.), 1931, p. 387, fig. 84 (right); MARSHALL (pt.), 1934, p. 657, text-fig. 39b; HADA, 1935, p. 248.

Tintinnus franknoi: OKAMURA (pt.), 1907, p. 140, pl. 6, fig. 67a.

Tintinnus tubulosus: HADA, 1935, p. 247.

Lorica comparatively stout, 3.5-4.0 oral diameters in length, consisting of a truncated cone of 2°-4°; oral margin flaring outwardly to a brim; sides always nearly straight, sometimes very slightly dilated; aboral end usually without a flare, occasionally with a hardly visible one, 0.5-0.7 oral diameters in aboral diameter. Length 140-216 μ ; oral diameters 38-53 μ ; aboral diameter 25-39 μ .

Occurrence:—Palao Islands, very rare; Nhatrang, very rare; Java Sea, rare; Strait of Sunda region, very rare.

Distribution:—Widely distributed in warm water regions of the world.

Comparison:—The species differs from *T. franknoi* Daday in having no distinct aboral flare.

Remarks:—This species is widely variable in size and form. The author separates the following two varieties from the typical form in this study.

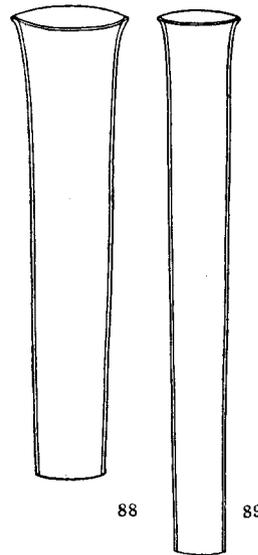


Fig. 88. *Tintinnus lusus-undae* ENTZ 250 \times from the Java Sea

Fig. 89. *Tintinnus lusus-undae* var. *tenuis* KOFOID & CAMPBELL 250 \times from the Palao Islands

90. *Tintinnus lusus-undae* var. *tenuis* KOFOID & CAMPBELL

Fig. 89

Tintinnus lusus-undae: ZACHARIAS (pt.), 1906, p. 518, fig. 6; BRANDT (pt.) 1907, p. 420; MARSHALL (pt.), 1934, p. 657, text-fig. 39a.

Tintinnus lusus-undae var. c: BRANDT, 1906, pl. 65, fig. 19; 1907, p. 422.

Tintinnus tenuis: KOFOID & CAMPBELL, 1929, p. 339, fig. 655; HADA, 1932, p. 571, fig. 25; 1935, p. 248.

Lorica elongated, 4.8-7.0 oral diameters in length, slightly tapering posteriorly (1.5° - 2.0°) with nearly straight sides; oral end abruptly flaring, with a conspicuous brim; aboral opening without a flare and a brim, 0.58 of an oral diameter. Length 192-317 μ ; oral diameter 40-47 μ ; aboral diameter 23-27 μ .

Occurrence:—Palao Islands, common; south-west of Formosa, common; eastern coast of Indo-China, very rare; between Borneo and Sumatra, very rare; Java Sea, rare or common; Strait of Sunda, very rare.

Distribution:—Adriatic Sea (Zacharias, 1906); California Current (Kofoid & Campbell, 1929); Mutsu Bay (Hada, 1932); New Pomerania (Brandt, 1907); Great Barrier Reef (Marshall, 1934).

Comparison:—The variety differs from the typical form of *T. lusus-undae* Entz in its slender proportions.

Remarks:—The variety is a slender form of *T. lusus-undae*. Its diversity in the length of the lorica is fairly remarkable. Specimens found in collections of the Palao Islands were generally large and slender, 240-317 μ in length and 43-47 μ in oral diameter, but ones of the East Indies were rather short, 192-240 μ in length and 40-43 μ in oral diameter. In the latter it is difficult to discriminate from somewhat slender individuals of the typical forms of *T. lusus-undae*. It is also one of the warm water dwellers occurring widely among neritic plankton of the Pacific.

91. *Tintinnus lusus-undae* var. *turgescens* KOFOID & CAMPBELL

Fig. 90

Tintinnus lusus-undae var. b: BRANDT, 1907, p. 422; LAACKMANN, 1909, p. 482.

Tintinnus turgescens: KOFOID & CAMPBELL, 1929, p. 341, fig. 650.

Lorica 3.7-4.0 oral diameters in length, generally tapering (3° - 4°), more or less inflated in the middle; oral end flaring (30°) to a slight brim; aboral aperture 0.62 of an oral diameter, without a flare. Length 180-203; oral diameter 48-50 μ ; aboral diameter 30 μ .

Occurrence:—Palao Islands, very rare.

Distribution:—New Pomerania (Brandt, 1907); Brazil Stream (Laackmann, 1909); California and Peruvian Currents (Kofoid & Campbell, 1929).

Comparison:—The variety differs from the typical form of *T. lusus-undae* Entz in the presence of a median dilation.

Remarks:—The variety is a dilated form of *T. lusus-undae*. It is similar to large individuals of *T. pacifica* Kofoid & Campbell in general outline, but it is distinguishable from the latter in having an oral brim and a more gradually tapering shaft.

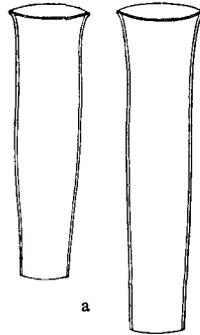


Fig. 90. *Tintinnus lusus-undae* var. *turgescens*
KOFOID & CAMP-
BELL 200×

92. *Tintinnus pacificus* KOFOID & CAMPBELL

Fig. 91

Tintinnus pacificus: KOFOID & CAMPBELL, 1929, p. 337, fig. 632; MARSHALL, 1934, p. 659, text-fig. 41.

Tintinnus pinguis: KOFOID & CAMPBELL, 1929, p. 338, fig. 640; HADA, 1935, p. 247.

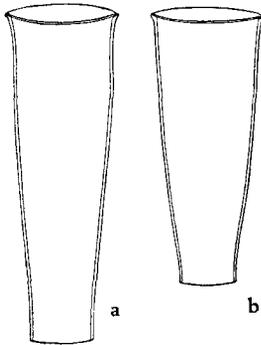


Fig. 91. *Tintinnus pacificus* KOFOID & CAMP-
BELL 350×

from the Palao Islands

Lorica short and stout, 2.2-3.5 oral diameters in length; oral margin slightly flaring with a scarcely visible brim; shaft gradually tapering (4° - 12°) with a slight median bluge; aboral end without a flare, 0.47-0.67 oral diameters in aboral diameter. Length 70-142 μ ; oral diameter 30-40 μ ; aboral diameter 15-27 μ .

Occurrence:—West Caroline and Mariana Islands, rare; northern part of the South China Sea, very rare.

Distribution:—California and South Equatorial Currents (Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *T. tubulosus* Ostenfeld in possession of a median dilation and from *T. elegans* Jørgensen in the lack of an aboral flare.

Remarks:—Specimens, which were 70-95 μ in length and 32-34 μ in oral diameter found from the Palao Islands, were similar to Kofoid

& Campbell's *T. pacificus* (1929) in size, but some specimens of 130–142 μ length and 40 μ oral diameter were detected from Yap, Saipan, and Tinian Islands and in dimensions resembled *T. pinguis* described by the above mentioned authors. There were also observed some intermediate forms of 100 μ in length from the South China Sea. The specimens secured by Marshall (1934) from the Great Barrier Reef were intermediate-sized, 108–120 μ in length and 33–43 μ in oral diameter. Besides such a continuous variation in the length of the lorica, the size of the lorica is usually so variable in species of *Tintinnus*, that it is probably reasonable to include these groups under a single species.

93. *Tintinnus stramentus* KOFOID & CAMPBELL

Fig. 92

Tintinnus stramentus: KOFOID & CAMPBELL, 1929, p. 339, fig. 635; MARSHALL, 1934, p. 659, text-fig. 40.

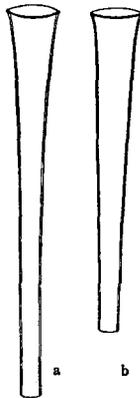


Fig. 92. *Tintinnus stramentus* KOFOID & CAMPBELL 250 \times

Lorica elongated, slender, 6.0–7.4 oral diameters in length; oral margin gradually flaring (45°), with a faint brim; shaft tapering (8°) in its anterior mian part, then becoming nearly cylindrical in the aboral region; aboral aperture 0.43 oral diameter. Length 168–208 μ ; oral diameter 28 μ ; aboral diameter 12 μ .

Occurrence:—Tinian, very rare.

Distribution:—California Current, Panamic Area, and South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *T. attenuatus* Kofoid & Campbell in the smaller size and the absence of a distinct oral funnel and from *T. tubulosus* Ostenfeld in being slender and having an oral flare.

Remarks:—The speciemans observed in the materials of the Mariana Islands are generally somewhat larger than those of the east tropical Pacific secured by Kofoid & Campbell (1929) and of the Great Barrier Reef region examined by Marshall (1934).

94. *Tintinnus fraknóii* DADAY

Fig. 93

Tintinnus fraknóii: DADAY, 1887, p. 528, pl. 18, fig. 1; CLEVE, 1901, p. 10; BRANDT, 1906, pl. 65, figs. 9, 13; 1907, p. 423; OKAMURA (pt.), 1907, p. 140, pl. 6, figs. 67b; LAACKMANN, 1909, p. 482; JÖRGENSEN (pt.), p. 11, figs. 5a, b; KOFOID & CAMPBELL, 1929, p. 334, fig. 638; HOFKER, 1931, p. 385, fig. 8; HADA, 1935, p. 248.

Tintinnus fraknoi var. c: BRANDT, 1906, pl. 65, figs. 12, 20; 1907, p. 424; LAACKMANN, 1909, p. 482.

Tintinnus lusus-undae var. *macilentus*: JÖRGENSEN, 1924, p. 11, fig. 4.

Tintinnus macilentus: KOFOID & CAMPBELL (pt.), 1929, p. 335, fig. 637.

Tintinnus elongatus: KOFOID & CAMPBELL, 1929, p. 334, fig. 631; HADA, 1935, p. 248.

Tintinnus perminutus: KOFOID & CAMPBELL, 1929, p. 337, fig. 649.

Tintinnus attenuatus: MARSHALL, 1934, p. 657, figs. 38, 38a.

Lorica forming a slender conical shaft 5.0-9.1 oral diameters in length; oral border gradually flaring funnel-shaped with a conspicuous brim; aboral region provided with a slight flare, 0.33-0.51 oral diameters in aboral diameter. Length 150-492 μ ; oral diameter 30-55 μ ; aboral diameter 14-26 μ .

Occurrence:—Palao Islands, frequent; Yap, Saipan, Tinian, rare; South China Sea, rare; Java Sea, very rare.

Distribution:—Has a wide distribution in warm waters of the world.

Comparison:—The species differs from *T. lusus-undae* Entz in the presence of an aboral flare and from *T. elegans* Jörgensen in the absence of a median bulge.

Remarks:—This species varies exceedingly in dimensions; the identification is confused on account of the presence of several synonyms due to slight differences of the size of the lorica. It seems that *T. elongatus* Jörgensen is a long form of this species and *T. macilentus* Jörgensen and *T. perminutus* Kofoid & Campbell are short ones. Though they were considered by Kofoid & Campbell (1929) as

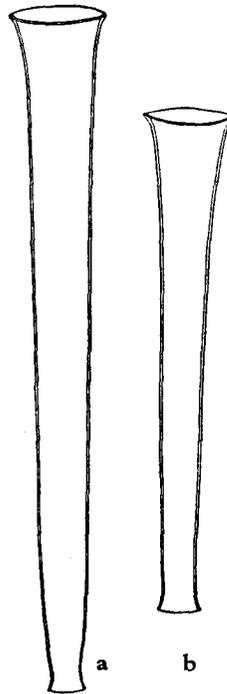


Fig. 93. *Tintinnus fraknóii* DADAY 250 \times
a from the Palao Islands
b from Saipan

distinct species, it is hardly possible to separate them from continuous variations in elongation as shown in the following table.

Group	Author	Year	Name	Length μ	Oral diame- ter μ	Aboral diame- ter μ
Large -sized	Daday	1887	<i>T. fraknóii</i>	360-416	54-72	36-45
	Brandt	1907	<i>T. fraknoi</i>	310-480	60-88	35-65
	—	—	<i>T. fraknoi</i> var. c { Atlantic Indo-Pacific	280-340 260-340	50-65	18-37
	Okamura	1907	<i>T. fraknoi</i>	300	50	30
	Jørgensen	1924	<i>T. fraknóii</i> (including var. <i>elongatus</i>)	348-493	62-68	35-42
Small -sized	Jørgensen	1924	<i>T. lusus-undae</i> var. <i>macilentus</i>	142-290	54	26
	Kofoid & Campbell	1929	<i>T. macilentus</i>	136-290		
	—	—	<i>T. perminutus</i>	140-183		
Mixed	Marshall	1934	<i>T. attenuatus</i>	228-410	52-57	17-29
	Hada	Present	<i>T. fraknóii</i>	150-492	30-55	14-26

The aboral flare is also variable in size and shape. In specimens examined by Brandt (1907) and Jørgensen (1924) there were observed, with difficulty, two groups different from each other in the form of the aboral flare besides the length of the lorica, but the author can not definitely divide specimens detected in the present collections into groups, though individuals of the northern part of the South China Sea were 220-275 μ long and stout in comparison with those of the southern area of the same sea, which were 344-352 μ long. Marshall's *T. attenuatus* Kofoid & Campbell from the Great Barrier Reef region surely belongs to this species in having an aboral flare instead of the straight aboral region of Kofoid & Campbell's *T. attenuatus*. From the author's and Marshall's investigations the aboral flare in specimens of the west tropical Pacific is generally smaller than that of those of the other seas.

95. *Tintinnus fraknóii* var. *birictus* KOFOID & CAMPBELL

Fig. 94

Tintinnus birictus: KOFOID & CAMPBELL, 1929, p. 332, fig. 634.

Lorica elongate, slender, 5.3-5.5 oral diameters in length; oral rim flaring, with a distinct brim; shaft tapering (2° - 3°) without a marked bulge, narrowest at the point of the posterior 0.07 of the lorica, its least diameter 0.54-0.58 of an oral diameter; aboral region abruptly expanding to a wide aboral aperture of 0.80-0.83 of an oral diameter with a slight brim. Length 300-320 μ ; oral diameter 54-60 μ ; aboral diameter 43-50 μ .

Occurrence:—Outside the barrier of the Palao Islands, very rare.

Distribution:—Known from tropical waters of the East Pacific (Kofoid & Campbell, 1929).

Comparison:—The variety differs from the typical form of *T. franknóii* Daday in possessing a widened aboral flare with a brim.

Remarks:—This variety is an oceanic plankter distributed in the tropical region of the Pacific. The specimens (377-650 μ in length) investigated by Kofoid & Campbell (1929) from the area of the East Pacific were longer and more slender than ones dealt with in this study, but the two forms agree in the shape of both flares and in bearing a brim on the aboral margin, whereas a brim on it is usually invisible in most species of *Tintinnus*. Therefore, they are probably the same form.



Fig. 94. *Tintinnus franknóii* var. *birictus* KOFOID & CAMPBELL 250 \times



Fig. 95. *Tintinnus franknóii* var. *bilatifinis* n. var. 250 \times

96. *Tintinnus franknóii* var. *bilatifinis* n. var.

Fig. 95

Lorica 4.7-5.6 oral diameters in length; oral region forming a tall funnel of 35° , provided with a faint brim on its margin; shaft somewhat tapering (15°), its shortest diameter 0.52 of an oral diameter at the position of the posterior 0.1 of the lorica; aboral end with a marked flare of 45° , its aboral diameter 0.71-0.73 of an oral diameter. Length 179-223 μ ; oral diameter 38-40 μ ; aboral diameter 27-29 μ .

Occurrence:—Tinian, rare.

Comparison:—The new variety differs from the typical form of *T. franknóii* Daday

in bearing well-developed oral and aboral flares distinguished from the slightly conical main part of the lorica.

Remarks:—This new variety is easily distinguished from other forms of the type species in having distinct wide flares on both ends of the lorica.

97. *Tintinnus elegans* JÖRGENSEN

Fig. 96

Tintinnus fraknoi var. b: BRANDT, 1906, pl. 65, fig. 10; 1907, p. 424.

Tintinnus lusus-undae var. *elegans*: JÖRGENSEN, 1924, p. 11, fig. 3.

Tintinnus fraknoi var. *latus*: JÖRGENSEN, 1924, p. 11, fig. 6.

Tintinnus elegans: KOFOID & CAMPBELL, 1929, p. 333, fig. 630

Tintinnus latus: KOFOID & CAMPBELL, 1929, p. 334, fig. 636.

Tintinnus brandti: KOFOID & CAMPBELL, 1929, p. 332, fig. 628.

Tintinnus medius: KOFOID & CAMPBELL, 1929, p. 336, fig. 629.



Fig. 96. *Tintinnus elegans*
JÖRGENSEN 250×
from the Palao Islands

Lorica 4.5–5.6 oral diameters in length, more or less flaring in both ends inflated near the middle; oral margin having a brim; shaft generally conical (3° – 4°); aboral aperture 0.50–0.68 of an oral diameter. Length 148–283 μ ; oral diameter 30–50 μ ; aboral diameter 15–34 μ .

Occurrence:—Palao Islands, very rare; Saipan, rare.

Distribution:—Widely distributed in warm water regions of the Mediterranean (Jörgensen, 1924) and the Pacific, Atlantic and Indian Oceans (Brandt, 1907; Kofoid & Campbell, 1929).

Comparison:—The species differs from *T. fraknoi* Daday in having a median bulge.

Remarks:—This species is an inflated form of *T. fraknoi* group. The present writer can not see distinct differences in size and form among Jörgensen's *T. lusus-undae* var. *elegans* and *T. fraknoi* var. *latus* (1924) and Kofoid & Campbell's *T. brandti* and *T. medius* (1929). The first variety is probably a small and rather slender form of this species and the second is a large and stout one. The other two forms

Author	Year	Name	Length μ	Oral diameter μ	Aboral diameter μ
Jørgensen	1924	<i>T. lusus-undae</i> var. <i>elegans</i>	147-190	37-53	20-34
Kofoid & Campbell	1929	<i>T. medius</i>	192-254		
—	—	<i>T. brandti</i>	205-335		
Jørgensen	1924	<i>T. fraknøii</i> var. <i>latus</i>	353-404	74-79	51-57
Hada	present	<i>T. elegans</i>	148-283	30-50	15-34

seem to be intermediate ones. Therefore, these forms are probable to be comprised in the same species.

98. *Tintinnus elegans* var. *procurrerens* KOFOID & CAMPBELL

Fig. 97

Tintinnus procurrerens: KOFOID & CAMPBELL, 1929, p. 338, fig. 653.

Lorica 5.66 oral diameters in length; oral margin somewhat abruptly flaring with a marked brim; shaft conical (3°) in the main part, more or less dilated in the middle, slightly constricted in the portion of the posterior 0.18 of the lorica, its smallest diameter 0.5 oral diameter; aboral end widened, 0.7 oral diameter in aboral diameter. Length 283 μ ; oral diameter 50 μ ; aboral diameter 34 μ .

Occurrence:—Palao Islands, very rare.

Distribution:—Easter Eddy, South Equatorial Stream of the Pacific (Kofoid & Campbell, 1929).

Comparison:—The variety differs from the typical form of *T. elegans* Jørgensen in the presence of a slight constriction above the distinct aboral flare.

Remarks:—The individuals just described are somewhat longer than the specimens, 138-206 μ long, reported by Kofoid & Campbell (1929) from the above mentioned seas, but they probably belong to the same form, because there is a close resemblance in the outline of the lorica.

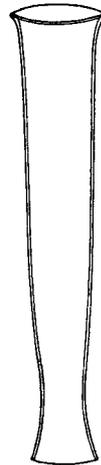


Fig. 97. *Tintinnus elegans* var. *procurrerens* KOFOID & CAMPBELL 250 \times

99. *Tintinnus apertus* KOFOID & CAMPBELL

Fig. 98



Fig. 98. *Tintinnus apertus*
KOFOID & CAMPBELL 400×

Tintinnus inquilinus: DADAY, 1887, p. 146, pl. 2, figs. 2, 10-13; JÖRGENSEN, 1924, p. 12, fig. 7; 1927, p. 9, figs. 10, 33; HOFKER, 1931, 386, figs. 82, 83.

Tintinnus apertus: KOFOID & CAMPBELL, 1929, p. 331, fig. 648; MARSHALL, 1934, p. 659; HADA, 1935, p. 247.

Lorica 3 oral diameters in length, conical (4°) in the upper 0.77-0.80, then abruptly narrowing (30° - 33°) to an aboral aperture; oral margin more or less flaring with a slight brim; aboral region sometimes inclined to form a tubular part, 0.5-0.6 of an oral diameter in aboral diameter. Length 90-112 μ ; oral diameter 30-38 μ ; aboral diameter 15-22 μ .

Occurrence:—Sulu Sea, rare.

Distribution:—Mediterranean (Daday, 1887; Jörgensen, 1924; Hofker, 1931); Baltic Sea (Jörgensen, 1927); Pacific coast of Panama (Kofoid & Campbell, 1929); Great Barrier Reef (Marshall, 1934).

Comparison:—The species differs from *T. angustatus* Daday in the presence of the oral flare and in the greater aboral diameter.

Remarks:—This species usually occurs in neritic waters. The specimens reported here were found in a collection of neritic plankton obtained from a coral reef in the Sulu Sea. Specimens from European waters often carry a colony of *Chaetoceras*, a common marine diatom, attached to the lorica as shown in Daday's (1887, Pl. 18, fig. 10), Jörgensen's (1927, fig. 33), and Hofker's (1931, figs. 82, 83) figures, but there is no record of such an example from the Pacific.

100. *Tintinnus angustatus* DADAY

Fig. 99

Tintinnus angustatus: DADAY, 1887, p. 531, pl. 18, fig. 15; KOFOID & CAMPBELL, 1929, p. 331, fig. 647.

Lorica tall goblet-shaped, 1.9-2.6 oral diameters in length; oral margin without a flare, but with a faint brim; bowl cylindrical or slightly tapering; aboral region abruptly narrowing to make a short tubular part of which the length is 0.18-0.20 of the total length; aboral opening 0.35-0.37 of an oral diameter. Length 85-100 μ ; oral diameter 38-45 μ ; aboral diameter 14-16 μ .

Occurrence:—Palao Islands, very rare.

Distribution:—Bay of Naples (Daday, 1887).

Comparison:—The species differs from *T. apertus* Kofoid & Campbell in having a conspicuous posterior tube and in lacking an oral flare.

Remarks:—The specimens of the Palao Islands were smaller in size than those of Naples examined by Daday (1889), whose fig. 15 in Pl. 18 shows a well-developed oral rim and a small aboral aperture which is 10–12 μ in diameter, while the present specimens have a slight brim and somewhat greater aboral opening of 14–16 μ . This species is closely allied to *T. apertus* in general contour, but is only different in the shape of both ends of the lorica. The latter species must be included in this species if an intermediate form between them should be found in the future.

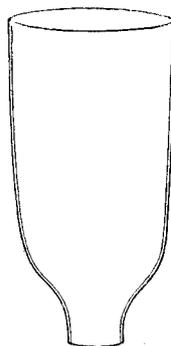


Fig. 99. *Tintinnus angustatus* DADAY 450 \times



Fig. 100. *Salpingella acuminata* (CLAPARÈDE & LACHMANN) 260 \times

Genus *Salpingella* JÖRGENSEN, 1924

Salpingella: JÖRGENSEN (pt.), 1924, p. 13; KOFOID & CAMPBELL, 1929, p. 346; HADA, 1937, p. 213.

A single species having wide distribution has been found in this study.

101. *Salpingella acuminata* (CLAPARÈDE & LACHMANN) JÖRGENSEN

Fig. 100

Salpingella acuminata: HADA, 1937, p. 213, fig. 56.

Length 313–332 μ ; oral diameter 36–37 μ .

Occurrence:—Outside the barrier of the Palao Islands, very rare.

Remarks:—The specimens secured from the Palao Islands were different from those of Akkeshi reported by the author in being of greater length and greater elongation of fins and in the more anterior position of a slight inflation.

Table showing distribution of species

Name	West Caroline Islands	Mariana Islands	South China Sea	Java Sea	Indian Ocean	Celebes Sea	Sulu Sea
Tintinnididae							
1. <i>Tintinnidium mucicola</i> (CLAPAREDE & LACHMANN) DADAY	—						
2. <i>Leprotintinnus simplex</i> SCHMIDT				—			
3. <i>L. nordqvisti</i> (BRANDT) KOFOID & CAMPBELL			—	—	—		
Codonellidae							
4. <i>Tintinnopsis beroidea</i> STEIN	—			—			
5. <i>T. nana</i> LOHMANN	—						
6. <i>T. brasiliensis</i> KOFOID & CAMPBELL	—			—			
7. <i>T. elongata</i> var. <i>yappensis</i> n. var.	—						
8. <i>T. platensis</i> CUNHA & FONSECA	—	—					
9. <i>T. gracilis</i> KOFOID & CAMPBELL	—		—	—			
10. <i>T. karajacensis</i> BRANDT	—			—			
11. <i>T. karajacensis</i> var. <i>rotundata</i> JÖRGENSEN	—		—	—	—		
12. <i>T. directa</i> HADA	—				—		
13. <i>T. nucula</i> (FOL) BRANDT	—						
14. <i>T. radix</i> (IMHOF) BRANDT	—		—	—			
15. <i>T. aperta</i> var. <i>tocantinensis</i> KOFOID & CAMPBELL	—		—				
16. <i>T. schotti</i> BRANDT	—			—			
17. <i>T. loricata</i> BRANDT	—		—				
18. <i>Codonella inflata</i> KOFOID & CAMPBELL	—						
19. <i>C. rapa</i> KOFOID & CAMPBELL	—	—					
Codonellopsidae							
20. <i>Stenosemella nivalis</i> (MEUNIER) KOFOID & CAMPBELL	—						
21. <i>S. parvicolis</i> (MARSHALL) HADA	—			—			
22. <i>Codonellopsis morchella</i> (CLEVE) JÖRGENSEN	—		—	—	—		
23. <i>C. curta</i> n. sp.	—	—					
24. <i>C. americana</i> KOFOID & CAMPBELL	—						
25. <i>C. stativa</i> n. sp.	—						
26. <i>C. fusiformis</i> n. sp.	—						
27. <i>C. ostensfeldi</i> (SCHMIDT) KOFOID & CAMPBELL	—		—	—	—		
28. <i>C. robusta</i> KOFOID & CAMPBELL	—						

(Continued)

Name	West Caroline Islands	Mariana Islands	South China Sea	Java Sea	Indian Ocean	Celebes Sea	Sulu Sea
29. <i>Codonellopsis parva</i> KOFOID & CAMPBELL	—						
Coxiellidae							
30. <i>Coxiella longa</i> (BRANDT) LAACKMANN	—						
31. <i>C. mariana</i> n. sp.		—					
32. <i>Helicostomella longa</i> (BRANDT) KOFOID & CAMPBELL	—						
Cyttarocylidae							
33. <i>Cyttarocylis brandti</i> KOFOID & CAMPBELL	—						
34. <i>C. actiformis</i> KOFOID & CAMPBELL	—						
35. <i>Porocetus apiculatus</i> (CLEVE) CLEVE	—						
36. <i>P. rotundatus</i> HADA				—			
37. <i>Favella azorica</i> (CLEVE) JÖRGENSEN	—	—					
38. <i>F. campanula</i> (SCHMIDT) KOFOID & CAMPBELL	—						
39. <i>F. campanula</i> var. <i>palaoensis</i> n. var.	—						
Ptychocylidae							
40. <i>Epiplocylis undella</i> (OSTENFELD & SCHMIDT) JÖRGENSEN	—		—		—		—
41. <i>E. undella</i> var. <i>constricta</i> KOFOID & CAMPBELL	—	—					
42. <i>E. undella</i> var. <i>blanda</i> JÖRGENSEN		—					
43. <i>E. calyx</i> (BRANDT) JÖRGENSEN		—					
44. <i>E. calyx</i> var. <i>labiosa</i> KOFOID & CAMPBELL		—					
45. <i>E. lata</i> KOFOID & CAMPBELL			—				
46. <i>E. deflexa</i> KOFOID & CAMPBELL			—				
47. <i>Epiplocyloides reticulata</i> (OSTENFELD & SCHMIDT)	—		—	—	—		
48. <i>E. reticulata</i> var. <i>acuta</i> (KOFOID & CAMPBELL)				—			
Petalotrichidae							
49. <i>Craterella retusa</i> HADA	—			—			
50. <i>C. aperta</i> MARSHALL	—	—					
51. <i>Metacylis merschkowskii</i> KOFOID & CAMPBELL	—	—					
52. <i>M. corbula</i> KOFOID & CAMPBELL	—						
53. <i>M. corbula</i> var. <i>perspicax</i> n. var.	—						

(Continued)

Name	West Caroline Islands	Mariana Islands	South China Sea	Java Sea	Indian Ocean	Celebes Sea	Sulu Sea
54. <i>Petalotricha pacifica</i> KOFOID & CAMPBELL		—					
Rhabdonellidae							
55. <i>Protorhabdonella simplex</i> (CLEVE) JÖRGENSEN	—		—	—	—		
56. <i>P. curta</i> (CLEVE) JÖRGENSEN	—						
57. <i>P. striatura</i> KOFOID & CAMPBELL		—					
58. <i>Rhabdonella spiralis</i> (FOL) BRANDT			—	—	—	—	—
59. <i>R. elegans</i> JÖRGENSEN	—	—	—	—	—	—	—
60. <i>R. poculum</i> (OSTENFELD & SCHMIDT) KOFOID & CAMPBELL	—		—	—	—		—
61. <i>R. amor</i> (CLEVE) BRANDT	—	—	—				
62. <i>R. parvula</i> n. sp.	—						
63. <i>Rhabdonellopsis apophysata</i> (CLEVE) KOFOID & CAMPBELL	—	—	—				
Xystonellidae							
64. <i>Xystonella treforti</i> (DADAY) LAACKMANN	—						
65. <i>Xystonellopsis paradoxa</i> (CLEVE) JÖRGENSEN	—						
66. <i>X. cymatica</i> (BRANDT) JÖRGENSEN	—						
67. <i>X. dicymatica</i> (BRANDT) KOFOID & CAMPBELL		—					
68. <i>X. heros</i> (CLEVE) KOFOID & CAMPBELL	—						
69. <i>X. brandti</i> (LAACKMANN) JÖRGENSEN		—					
70. <i>X. dahli</i> (BRANDT) KOFOID & CAMPBELL	—						
Undellidae							
71. <i>Undella hemispherica</i> LAACKMANN		—					
72. <i>U. turgida</i> KOFOID & CAMPBELL		—					
73. <i>Proprectella claparèdei</i> (ENTZ) KOFOID & CAMPBELL	—	—					
74. <i>P. perpussilla</i> KOFOID & CAMPBELL	—						
75. <i>P. biorbiculata</i> n. sp.	—						
Dictyocystidae							
76. <i>Dictyocysta lepida</i> EHRENBERG	—						
77. <i>D. occidentalis</i> KOFOID & CAMPBELL				—			

(Continued)

Name	West Caroline Islands	Mariana Islands	South China Sea	Java Sea	Indian Ocean	Celebes Sea	Sulu Sea
78. <i>D. reticulata</i> KOFOID & CAMPBELL	—			—			
79. <i>D. polygonata</i> KOFOID & CAMPBELL	—			—			
80. <i>D. duplex</i> BRANDT	—			—			
81. <i>D. verticosa</i> n. sp.	—						
Tintinnidae							
82. <i>Amphorella quadrilineata</i> (CLAPARÈDE & LACHMANN) DADAY	—	—	—	—	—		—
83. <i>A. brandti</i> (JÖRGENSEN) KOFOID & CAMPBELL	—		—		—		
84. <i>Steenstrupiella steenstrupii</i> (CLAPARÈDE & LACHMANN) KOFOID & CAMPBELL	—	—		—			
85. <i>S. gracilis</i> (JÖRGENSEN) KOFOID & CAMPBELL	—	—	—				
86. <i>Amphorellopsis acuta</i> (SCHMIDT) KOFOID & CAMPBELL	—		—	—			
87. <i>Dadayiella ganymedes</i> (ENTZ) KOFOID & CAMPBELL	—		—	—			
88. <i>Brandtiella palliata</i> (BRANDT) KOFOID & CAMPBELL	—		—				
89. <i>Tintinnus lusus-undae</i> ENTZ	—		—	—	—		
90. <i>T. lusus-undae</i> var. <i>tenuis</i> KOFOID & CAMPBELL	—		—	—	—		
91. <i>T. lusus-undae</i> var. <i>turgescens</i> KOFOID & CAMPBELL	—		—	—	—		
92. <i>T. pacificus</i> KOFOID & CAMPBELL	—	—	—				
93. <i>T. stramentus</i> KOFOID & CAMPBELL	—	—					
94. <i>T. franknōii</i> DADAY	—	—	—	—	—		
95. <i>T. franknōii</i> var. <i>birictus</i> KOFOID & CAMPBELL	—						
96. <i>T. franknōii</i> var. <i>bilatijinis</i> n. var.	—	—					
97. <i>T. elegans</i> JÖRGENSEN	—	—					
98. <i>T. elegans</i> var. <i>procurrerens</i> KOFOID & CAMPBELL	—						
99. <i>T. apertus</i> KOFOID & CAMPBELL	—						—
100. <i>T. angustatus</i> DADAY	—						
101. <i>Salpingella acuminata</i> (CLAPARÈDE & LACHMANN) JÖRGENSEN	—						
Number of forms	73	29	26	31	16	2	6

Literature

- BIEDERMANN, R. 1892 Ueber die Structur der Tintinnen-Gehäuse. Univ. Kiel, 38 pp., 3 pls.
- 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 Sammelungen bearbeitet. IV. Die Tintinnen. Bibl. Zool. Bd. 8, pp. 45-72, pl. 3.
- 1906 Die Tintinnodeen der Plankton-Expedition. Tafelklärungen nebst kurzer Diagnose der neuen Arten. *Ergebn. Plankton-Exped.*, Bd. 3, L.a, 33 pp. 70 pls.
- 1907 *Idem.* Systematischer Theil. *Ibid.*, 488 pp.
- 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, E. & 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. 1900a The Plankton of the North Sea, the English Channel, and the Skagerak in 1898. Kgl. Svenska Vet.-Akad. Handl., Bd. 32, No. 8, pp. 1-53, 11 textfigs.
- 1900b *Idem.* in 1899. *Ibid.*, Bd. 34, No. 2, pp. 1-77.
- 1900* Some Atlantic Tintinnodea. *Ibid.*, Bd. 56.
- 1901 Plankton from the Indian Ocean and the Malay Archipelago. *Ibid.*, Bd. 35, No. 5, pp. 1-58, pls. 1-8.
- 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 textfig.
- CUNHA, A. M. & O. FONSECA 1917* O microplancton do Atlantico nas imediações de Mar de Plata. Mem. Inst. Oswaldo Cruz.
- VON DADAY, E. 1887 Monographie der Familie der Tintinnodeen. Mitt. Zool. Sta. Neapel, Bd. 7, pp. 473-591, pls. 18-21.
- DONS, C. 1921 Papers from Dr. Th. Mortensen's Pacific Expedition 1914-16. V. Notes sur quelques Protozoaires marins. Vidensk Medd. fra Dansk naturh. Foren., Bd. 73, pp. 49-84, 33 textfigs.
- EHRENBERG, C. G. 1854* Die systematische Charakteristik der neuen Mikroskopischen Organismen des tiefen atlantischen Oceans. Monatsber. Akad. Wiss., Berlin.
- ENTZ, G., Sr. 1884 Ueber Infusorien des Golfes von Neapel. Mitt. Zool. Sta. Neapel, Bd. 5, pp. 289-444, pls. 20-25.
- 1885 Zur näheren Kenntnis der Tintinnoden. *Ibid.*, Bd. 6, pp. 185-216, pls. 13, 14.

* indicates papers not available to the present writer.

- ENTZ, G., Jr. 1909 Studien über Organisation und Biologie der Tintinniden. Arch. Prot., Bd. 15, pp. 93-226, pls. 8-21, 2 textfigs.
- FELDHAUS J. 1920 Nordische Tintinnen. Inaud.-Diss., Kiel. 69 pp., 1 pl.
- FOL, H. 1881 Contribution to the Knowledge of the Family Tintinnodes. Ann. Mag. Nat. Hist., ser. 5, vol. 7, pp. 237-250, pl. 17.
- 1884* Sur la famille des Tintinnodea. Recueil Zool. Suisse, Tome 1.
- HADA, Y. 1932 Report of the Biological Survey of Mutsu Bay. 26. The pelagic Ciliata, Suborder Tintinnoinea. Sci. Rep. Tohoku Imp. Univ., 4th ser., Biol., vol. 7, 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, pp. 242-252, 3 textfigs.
- 1937 The Fauna of Akkeshi Bay. IV. The Pelagic Ciliata. Journ. Fac. Sci. Hokkaido Imp. Univ., ser. 4, Zool., vol. 5, pp. 143-216, 56 textfigs.
- HOFKER, J. 1931 Studien über Tintinnidea. 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, no. 2, pp. 1-48, pls. 1-3.
- 1924 Mediterranean Tintinnidae. Rep. Danish Oceanog. Exped. 1908-10 to the Mediterranean and Adjacent Seas, vol. 2, Biol., 110 pp., 114 textfigs.
- 1927 Ciliata: Tintinnidae. Die Tierwelt der Nord- und Ostsee, Lief. 8, T. II, c, 26 pp., 33 textfigs.
- KENT, W. S. 1881-1882 A Manual of the Infusoria. 3 vols., 913 pp., 51 pls.
- KOFOID, C. A. 1905 Some New Tintinnidae from the Plankton of the San Diego Region. Univ. California Publ. Zool., vol. 1, pp. 287-306, pls. 26-28.
- 1915 Notes on the Tintinnoida. 1. On the probable Origin of *Dictyocysta tiara* Haeckel. 2. On *Petalotricha entzi* sp. nov. *Ibid.*, vol. 16, pp. 63-69, 8 textfigs.
- KOFOID, C. A. & A. S. CAMPBELL 1929 A Conspectus of the Marine 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.
- 1909 Die Tintinnodeen der deutschen Südpolar-Expedition 1901-1903, Deutsche Südp.-Exp., Bd. 11, Zool. III, pp. 343-496, pls. 33-51.
- 1913 Adriatische Tintinnodeen. Sitzber. Kais. Akad. Wiss. Wien, Math.-nat. Klas., 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.

- LOHMANN, H. 1911 Ueber das Nannoplankton und die Zentrifugierung kleinster Wasserproben zur Gewinnung desselben in lebendem Zustande. Intern. Rev. Ges. Hyrob. Hydrog., Bd. 4, pp. 1-33, 6 textfigs.
- MARSHALL, S. M. 1934 The Silicoflagellata and Tintinnoinea. Great Barrier Reef Exp. 1928-29, Sci. Rep., vol. 6, pp. 623-664, 43 textfigs.
- MERKLE, H. 1909. Untersuchungen an Tintinnodeen der Ost- und Nordsee. Wiss. Meeresunters., N. F., Bd. 11, pp. 139-186, pl. 2, 3, 3 textfigs.
- OKAMURA, K. 1907 An annotated List of Plankton Microorganisms of the Japanese Coast. Annot. Zool. Japonenses, vol. 6, pp. 125-151, pls. 3-6.
- 1912 Katsuo Gyojo ni okeru Fuyuseibutu. Gyogyo Kihon Chosa Hokoku, vol. 1.
- OSTENFELD, C. H. & J. SCHMIDT 1901* Plankton fra det Rde Hav og Adenbugten. Vidensk. Medd. Naturh. Foren. Kjobenhavn.
- SCHMIDT, J. 1901* Some Tintinnoidea from the Gulf of Siam. *Ibid.*
- WAILES, G. H. 1929 Tintinnidae, from the Strait of Georgia, B. C. Mus. Art Not., vol. 6, pp. 124-129, pls. 2, 3.
- ZACHARIAS, O. 1906 Über Periodizität, Variation und Verbreitung verscheidener Planktonwesen in südlichen Meeren. Arch. Hydrob. Plank., Bd. 1, pp. 498-575, 23 textfigs.
-