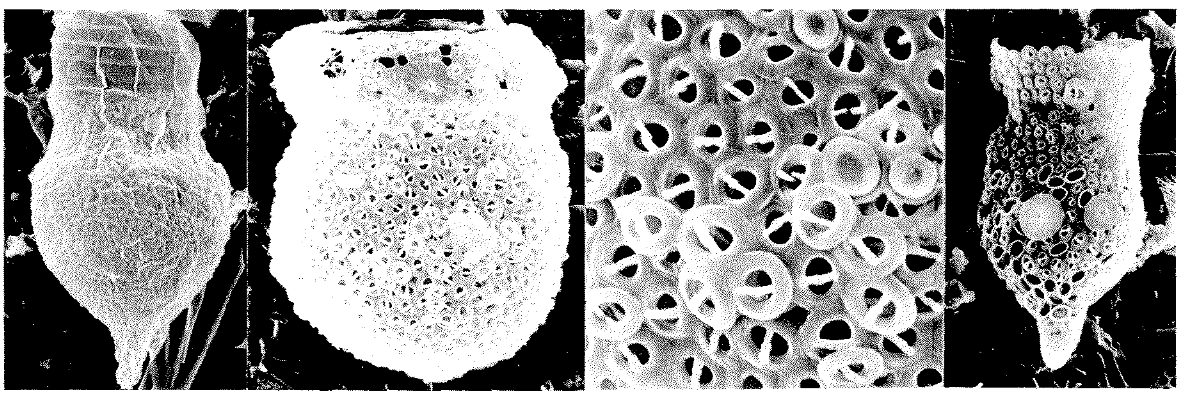
# Tintinnids:

## A Taxon-vertical Distributional Study of Settling Assemblages from the Panama Basin

**Hsin Yi Ling**



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*Ocean Biocoenosis Series No. 4*

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**Explanation of Cover Photo:** Scanning electron photomicrographs of tintinnids collected by PARFLUX sediment traps from Panama Basin ($PB_1$) during July to November, 1979. Left, *Codonellopsis minor* (Brandt) from 3,791 m trap, ×390; center left, *Codonella apicata* Kofoid and Campbell from 1,268 m trap, ×660; center right, a portion of the *Codonella apicata* Kofoid and Campbell, ×2,100, showing the details of agglutinated nature of lorica; right, *Codonella* sp. from 1,268 m trap, ×1,900.

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# Tintinnids:

## A Taxon-vertical Distributional Study of Settling Assemblages from the Panama Basin

**Hsin Yi Ling**

**Abstract**

*A series of samples collected in sediment traps deployed in the Panama Basin at various depths for 112 days were analyzed to examine the vertical flux of tintinnids, the trumpet-shaped ciliate protozoans. Tintinnids in the 63–250 μm size range reveal that: (1) faunal composition does not change significantly through the water column; (2) at approximately 1,200 m there is a slight increase with depth in the abundance of* Codonellopsis, *a lorica with a hyaline neck and an agglutinated bowl, and an associated slight decrease in the abundance of* Rhabdonella, *a lorica consisting entirely of a delicate hyaline nature; and (3) no apparent effect of dissolution was noticed in tintinnid specimens in sediment traps at all depths.*

## Introduction

The trumpet-shaped ciliate protozoans, tintinnids, constitute approximately 40 percent of all known marine and fresh-water infusorians. They have been known to biological oceanographers for their abundance, their wide geographic occurrence, and their distinct biogeographic distributional pattern, which is closely related to the physico-chemical properties of surface water-masses (Campbell, 1942; 1954). However, it is the occurrence of calpionellids, microfossils of similar trumpet-shaped outlines in the Late Mesozoic strata of Tethyan region which was attracted the most attention of geologists (Colom, 1948). The finding of a Late Eocene assemblage from a sequence in Mississippi lead Tappan and Loeblich (1968) to affirm the close relationship of fossil forms with living ones.

However, a significant discrepancy between the living plankton forms and their fossil counterparts is apparent in the assemblage composition. Living tintinnids consist of both the delicate hyaline organic lorica and lorica with outer walls agglutinated by foreign substances—either organic or inorganic (e.g., Kofoid and Campbell, 1929, 1939; Campbell, 1942). In contrast, tintinnid fossil forms, including those observed from the surface sediments of the modern ocean floor, contain only agglutinated lorica (e.g., Eicher, 1965; Echols and Fowler, 1973), and hyaline lorica, or a hyaline part of the lorica, have not been observed.

This poses several interesting questions. (1) What is the degree of difference between the water column assemblage and that found in surface sediments directly below? (2) At what depth in the water column, if any, do hyaline lorica decrease in abundance? (3) Is the destruction of these lorica on the ocean floor due to diagenesis (dissolution) or sub-bottom current action? Investigation of depth-series flux samples of tintinnoids is critical to answer these questions, as was attempted in this report.

## Material Studied and Methods of Investigation

The samples examined in this study were collected from a sediment trap array deployed in the Panama Basin at 5°20'N, 81°53'W (3,856 m deep, Figure 1) for a period of 112 days from July to November, 1979 (Station $PB_1$). The array consisted of a series of sediment traps placed at depths of 667, 1,268, 2,860, 3,769, and 3,791 m (Honjo et al., 1982).

Aliquots, 1/256 of the original samples of 63–250 $\mu$m size range, were examined under a Nikon inverted microscope with 200 X and 400 X magnification. Sample preservation and splitting followed Honjo (1980). Photomicrography of tintinnid taxa was made with a phase contrast attachment. Some agglutinated forms were later picked under a Leitz stereomicroscope and photographed with a JEOL U3 Scanning Electron Microscope.

## Previous Investigation of Tintinnids from the Panama Basin

Tintinnid assemblages from the Eastern Tropical Pacific, including the Panama Basin, were the sources of Kofoid and Campbell's (1929, 1939) monographs, which are now regarded as the standard taxonomic references for subsequent investigations of this group. Their samples were collected by plankton net towing during the Agassiz Expedition in 1904–1905 of the R/V CARNEGIE cruise VII. Some of these stations were located adjacent to the Panama Basin sediment trap station ($PB_1$). However, these earlier samples were limited to collections taken between the surface and about 550 m depth.

## Systematic Micropaleontology

Throughout the present study the classification scheme proposed by Kofoid and Campbell (1929, 1939), Campbell (1942), and Loeblich and Tappan (1968) is generally adopted. The following synonymy list refers to publications since 1929. For earlier references, see Kofoid and Campbell (1929).

Phylum PROTOZOA GOLDFUSS, 1818, emend. VON SIEBOLD, 1845
Class CILIATEA PERTY, 1852
Order TINTINNIDA CORLISS, 1955
Superfamily CODONELLIDEA KENT, 1881
Family CODONELLIDAE KENT, 1881
Genus *Codonella* HAECKEL, 1873

*Codonella apicata* KOFOID AND CAMPBELL
Plate 1, figure 1; Plate 2, figures 1, 2

*Codonella apicata* KOFOID AND CAMPBELL, 1929, p. 53, fig. 116; 1939, p. 47; CAMPBELL, 1942, p. 8; BALECH, 1962, p. 53, 54, pl. 1, figs. 13–16.

REMARKS: The species is characterized by a rounded collar. Outer surface of lorica is covered almost exclusively by a monospecific coccolith but apparently without any preferred orientation (see Plate 2, figure 2).

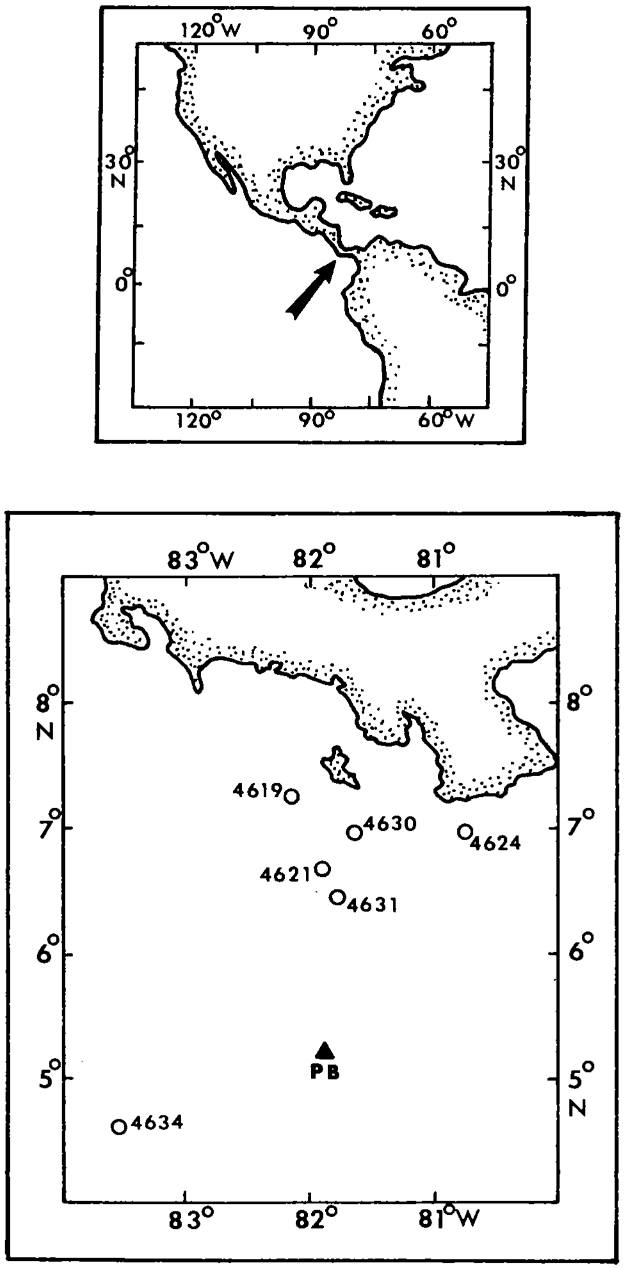


Figure 1: Index map showing location of PARFLUX sediment trap array ($PB_1$) in the Panama Basin. R/V ALBATROSS stations (Kofoid and Campbell, 1939) are superimposed.

MEASUREMENTS: Total length, 60–75 $\mu$m (based on five specimens).

*Codonella cuspidata* KOFOID AND CAMPBELL
Plate 1, figure 2

*Codonella cuspidata* KOFOID AND CAMPBELL, 1929, p. 58, fig. 109; 1939, p. 49, pl. 1, figs. 17–19, 21; BALECH, 1962, pp. 52, 53, pl. 1, figs. 1–4.

REMARKS: The specimens agree well with the description by Kofoid and Campbell (1929) except for a slightly wider size range shown in the present study (e.g. length, 82–92 $\mu$m vs. 70–95 $\mu$m).

MEASUREMENTS: Total length, 70–95 $\mu$m (based on 10 specimens).

*Codonella* sp.
Plate 2, figure 3

REMARKS: Rather elongate, cylindrical lorica with a strong aboral horn and distinct wavy oral margin characterized the present species.

MEASUREMENTS: Total length of illustrated specimen, 23 $\mu$m.

Family CODONELLOPSIDEAE KOFOID AND CAMPBELL, 1929
Genus *Codonellopsis* JÖRGENSEN, 1924

REMARKS: Specimens belonging to the genus are characterized by a distinct hyaline neck with prominent annular or spiral nature. This is the most abundant form in the samples studied.

*Codonellopsis biedermanni* (Brandt) KOFOID AND CAMPBELL
Plate 1, figure 3; Plate 2, figures 4–8

*Codonellopsis biedermanni* (Brandt) KOFOID AND CAMPBELL, 1929, p. 75, fig. 181; 1939, pp. 70, 71, pl. 5, fig. 10; CAMPBELL, 1942, p. 24.

REMARKS: The species is characterized by a long hyaline neck, an elongate oval shaped bowl and a strong aboral horn. Some specimens show a rather distinctly flared oral margin. There is a distinct tendency for the spacing of annular or spiral rings to become gradually narrower toward the oral end, as is clearly shown in SEM photographs (Plate 2, figures 4, 5, 7, 8).

MEASUREMENTS: Total length, 225–275 $\mu$m (based on 20 specimens).

*Codonellopsis ecaudata* (Brandt) KOFOID AND CAMPBELL
Plate 1, figure 4; Plate 2, figure 9

*Codonellopsis ecaudata* (Brandt) KOFOID AND CAMPBELL, 1929, p. 79, fig. 154; 1939, pp. 74, 75, pl. 3, fig. 9; CAMPBELL, 1942, pp. 25, 26, fig. 7; BALECH, 1962, p. 62, pl. 6, figs. 56–59.

REMARKS: Generally oval shaped bowl with smooothly rounded to very slightly pointed aboral end characterize the present species.

MEASUREMENTS: Total length, 90–100 $\mu$m (based on 20 specimens).

*Codonellopsis minor* (Brandt) KOFOID AND CAMPBELL
Plate 1, figure 4; Plate 2, figures 10, 11

*Codonellopsis minor* (Brandt) KOFOID AND CAMPBELL, 1929, p. 83, fig. 168; 1939, pp. 79, 80, pl. 4, figs. 2–4, 10; CAMPBELL, 1942, pp. 27, 28.

REMARKS: A distinctly globose shaped bowl, a strong aboral horn, and a flared oral rim characterize the present species. This is the most common *Codonellopsis* in the area, and the relative abundance in the assemblage slightly increases with depth.

MEASUREMENTS: Total length, 150–230 $\mu$m (based on 20 specimens).

Family EPIPLOCYLIDIDAE KOFOID AND CAMPBELL, 1939
Genus *Epiplocylis* JÖRGENSEN, 1924

*Epiplocylis undella* (Ostenfeld and Schmidt) JÖRGENSEN emend. KOFOID AND CAMPBELL
Plate 1, figure 6

*Epiplocylis undella* (Ostenfeld and Schmidt) JÖRGENSEN, KOFOID AND CAMPBELL, 1929, p. 185, fig. 345; MARSHALL, 1934, p. 645, fig. 18; KOFOID AND CAMPBELL, 1939, pp. 133, 134, pl. 9, figs. 1, 2, 4, 7, 10; CAMPBELL, 1942, p. 72, figs. 71, 77; BALECH, 1962, pp. 74–76 (also see for synonymy).

REMARKS: A cylindrical bowl and a distinct narrow aboral horn characterize the present species. Based on samples collected during expeditions of NORPAC and DOWNWIND in the Pacific by Scripps Institution of Oceanography, Balech (1962) took a broader view of this species including numerous species previously proposed by Kofoid and Campbell (1929, 1939), such as *E. atlantica, E. pacifica*. The present author agrees with this practice until more observations of comparative materials can be made.

MEASUREMENTS: Total length, 110–125 $\mu$m (based on 5 specimens).

### Family DICTYOCYSTIDAE KENT, 1881
### Genus *Dictyocysta* EHRENBERG, 1854

#### *Dictyocysta reticulata* KOFOID AND CAMPBELL

*Dictyocysta reticulata* KOFOID AND CAMPBELL, 1929, p. 300, fig. 560; 1939, p. 306, pl. 26, figs. 3, 5; CAMPBELL, 1942, pp. 36, 37.

REMARKS: Kofoid and Campbell (1939) reported that the present species constituted 66% of the assemblage from R/V ALBATROSS's #4621 station (0–550 m). Only a few specimens were observed in the sediment trap samples examined in the present study.

MEASUREMENTS: Total length, 50–65 μm (based on 3 specimens).

### Superfamily TINTINNIDEA CLAPAREDE AND LACHMANN, 1938, emend. TAPPAN AND LOEBLICH, 1968
### Family CYTTAROCYLIDIDAE KOFOID AND CAMPBELL, 1929
### Genus *Cyttarocylis* FOL, 1881

#### *Cyttarocylis acutiformis* KOFOID AND CAMPBELL
Plate 1, figure 7; Plate 2, figure 12

*Cyttarocylis acutiformis* KOFOID AND CAMPBELL, 1929, p. 111, fig. 221; 1939, pp. 109, 110; CAMPBELL, 1942, p. 17, figs. 35–37, 45, 48; BALECH, 1962, pp. 69, 70, pl. 6, fig. 67.

REMARKS: A conical shaped lorica with irregular reticulate pattern and a very delicate denticulate oral rim are characteristics of this species.

MEASUREMENTS: Total length, 220–250 μm (based on 2 specimens).

### Family RHABDONELLIDAE KOFOID AND CAMPBELL, 1929
### Genus *Rhabdonella* BRANDT, 1906

REMARKS: Specimens belonging to this genus constitute the second abundant forms in the present study. However, their gradual decline in abundance with depth is an important trend noticed in the present study.

#### *Rhabdonella conica* KOFOID AND CAMPBELL
Plate 1, figure 8

*Rhabdonella conica* KOFOID AND CAMPBELL, 1929, pp. 214, 215, fig. 418; 1939, p. 163, pl. 14, figs. 2, 10, 11; CAMPBELL, 1942, pp. 56, 57.

REMARKS: Specimens of this species are characterized by a slender lorica with an elongate aboral horn. Ribs on the bowl are distinct and parallel at least at the oral end.

MEASUREMENTS: Total length, 300–370 μm (based on 20 specimens).

### *Rhabdonella indica* LAACKMANN
Plate 1, figure 9

*Rhabdonella indica* LAACKMANN, KOFOID AND CAMPBELL, 1929, p. 217, fig. 397; 1939, p. 171, pl. 12, fig. 15; CAMPBELL, 1942, p. 59; BALECH, 1962, pp. 82, 83, pl. 9, figs. 105, 106.

REMARKS: This small tintinnid is characterized by a conical lorica, with a pointed aboral end. The aboral horn is nearly absent, and ribs on the bowl are very fine and faint.

MEASUREMENTS: Total length, 50–80 μm (based on 5 specimens).

### *Rhabdonella quantula* KOFOID AND CAMPBELL, 1929
Plate 1, figures 10, 11

*Rhabdonella quantula* KOFOID AND CAMPBELL, 1929, p. 218, fig. 402; 1939, pp. 175, 176, pl. 13, figs. 2, 3; CAMPBELL, 1942, p. 60.

REMARKS: Descriptions and measurements reported previously for this species are also applicable for the sediment trap specimens.

MEASUREMENTS: Total length, 140–180 μm (based on 20 specimens).

## Family XYSTEONELLIDAE KOFOID AND CAMPBELL, 1929
### Genus *Xystonella* BRANDT, 1906

### *Xystonella treforti* (Daday) LAACKMANN
Plate 1, figures 12, 13

*Xystonella treforti* (Daday) LAACKMANN, KOFOID AND CAMPBELL, 1929, p. 238, fig. 452; 1939, pp. 207, 208, pl. 19, figs. 2–5, 7; MARSHALL, 1934, p. 65; CAMPBELL, 1942, p. 94, fig. 68.

REMARKS: This large elongated lorica is characterized by the possession of a skirt near the aboral end. However, its occurrence was rather rare in the sediment trap samples. Whether the vertical distribution of the species is limited only the uppermost layer of water requires future study, since the shallowest trap sample collected from 667 m depth.

MEASUREMENTS: Total length, 530–545 μm (based on 5 specimens).

Family UNDELLIDAE KOFOID AND CAMPBELL, 1929
Genus *Undella* DADAY, 1887

*Undella pistillum* KOFOID AND CAMPBELL, 1929
Plate 1, figure 14

*Undella pistillum* KOFOID AND CAMPBELL, 1929, p. 265, fig. 500; 1939, p. 265, pl. 24, fig. 20; CAMPBELL, 1942, p. 99.

REMARKS: The tiny hyaline lorica of urn-shape which gradually tapers toward the oral end from the smoothly rounded, flattened aboral end.

MEASUREMENTS: Total length, 65–90 μm (based on 3 specimens).

## Discussion

Occurrences of the different tintinnid taxa in the respective sediment traps are listed in Table 1. As pointed out earlier, previous studies from the area by Kofoid and Campbell (1929, 1939) and Campbell (1942) were based on net-towed and pump samples collected from shallower depths than the samples examined here. The first objective of the present study was to determine the faunal change at the generic level throughout the water. The proportions of the major genera in the tintinnoid flux at Station $PB_1$ are illustrated in Figure 2 as a form of cumulative curve.

It is worth noting that the faunal composition of tintinnoids is generally uniform throughout the water column, and that the abundant taxa in shallower depths are also abundant in the deeper trap samples. Minor changes are reflected by the presence or absence of less abundant genera. In regard to the relative abundance of taxa, there is a slight increase of *Codonellopsis* with depth, and an associated decrease of *Rhabdonella*. Because the lorica of *Rhabdonella* is a typical hyaline form, whereas that of *Codonellopsis* has a hyaline neck and an agglutinated bowl, it may be argued that the decrease of *Rhabdonella* with depth (starting around 1,200 m) may be attributed to dissolution of these delicate loricae, if a constant supply from the surface water is assumed. However, during microscopic examination, loricae of *Rhabdonella*, or necks of *Codonellopsis* were intact, and the author did not notice any significant effect of dissolution. On the other hand, it is also possible that temporal variability in tintinnid production may be responsible for the observed vertical distribution pattern.

Echols and Fowler (1973), in the only published record from surface sediments of the ocean floor, reported only agglutinated loricae. The deepest sediment trap sample from the present Panama Basin was just 65 m above the basin floor. Thus, it is of great interest to determine the faunal composition in the surface sediments directly below the sediment trap array. Judging from the good state of preservation of loricae in the deep sediment trap samples, it seems that hyaline loricae, such as *Rhabdonella*, would also be deposited on the sea floor. If this is the case, then the timing and effect of the dissolution and destruction at the water-sediment interface warrants further investigation.

Although no samples shallower than 667 m depth were available from the present sediment trap array at the Panama Basin Station, qualitative and semi-quantitative data

Table 1: Distribution of tintinnid taxa from the Panama Basin sediment trap ($PB_1$) (number in parenthesis is percentage).

| | Sediment Trap Depth (m) | | | | |
|---|---|---|---|---|---|
| **Taxa** | **667** | **1,268** | **2,869** | **3,769** | **3,791** |
| *Codonella apicata* | 7 (7.4) | 2 (2.9) | 0 | 0 | 0 |
| *Codonella cuspidata* | 5 (5.3) | 1 (1.4) | 7 (6.6) | 6 (8.1) | 3 (5.4) |
| *Codonella* sp. | 1 (1.1) | 1 (1.4) | 0 | 1.(1.4) | 0 |
| *Codonellopsis biedermanni* | 7 (7.4) | 13 (18.8) | 18 (17.0) | 10 (13.5) | 14 (25.0) |
| *Codonellopsis ecaudata* | 5 (5.3) | 9 (13.0) | 12 (11.3) | 16 (21.6) | 4 (7.1) |
| *Codonellopsis minor* | 24 (25.5) | 15 (21.7) | 47 (44.3) | 24 (32.4) | 25 (44.6) |
| *Cyttarocylis acutiformis* | 0 | 1 (1.4) | 1 (0.9) | 1 (1.4) | 0 |
| *Dictyocysta reticulata* | 2 (2.1) | 0 | 2 (1.9) | 2 (2.7) | 0 |
| *Epiplocylis undella* | 3 (3.2) | 2 (2.9) | 4 (3.8) | 4 (5.4) | 1 (1.8) |
| *Rhabdonella conica* | 3 (3.2) | 6 (8.7) | 7 (6.6) | 4 (5.4) | 5 (8.9) |
| *Rhabdonella indica* | 3 (3.2) | 3 (4.3) | 1 (0.9) | 1 (1.4) | 1 (1.8) |
| *Rhabdonella quantula* | 28 (28.8) | 13 (18.8) | 5 (4.7) | 3 (4.1) | 1 (1.8) |
| *Undella pistillum* | 1 (1.1) | 1 (1.4) | 1 (0.9) | 0 | 1 (1.8) |
| *Xystonella treforti* | 3 (3.2) | 2 (2.9) | 1 (0.9) | 2 (2.7) | 1 (1.8) |
| **Total Specimens Counted** | 94 | 69 | 106 | 74 | 56 |
| **Flux/m$^2$/day ($\times 10^3$)** | 24 | 18 | 27 | 19 | 14 |

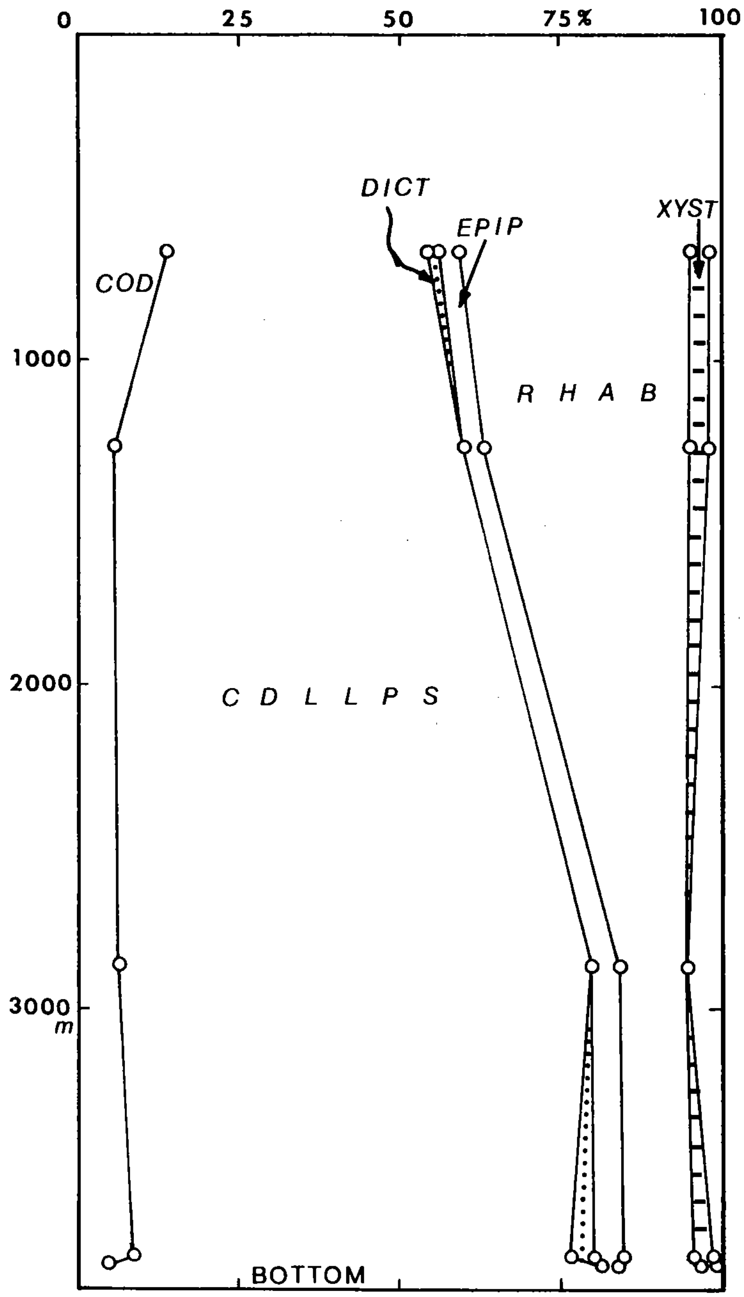


Figure 2: Cumulative percentage of tintinnid genera in the Panama Basin sediment traps at various depths. COD = *Codonella*; CDLLPS = *Codonellopsis*; DICT = *Dictyocysta*; RHAB = *Rhabdonella*; XYST = *Xystonella*. (Abbreviation of generic names after Kofoid and Campbell, 1939.)

from the R/V ALBATROSS plankton samples in the adjacent area by Kofoid and Campbell (1939) (Figure 1) can be used for comparison. Their results are given in Table 2. It is interesting to note that within the Panama Basin their tintinnid assemblages were rather diverse, and yet only a limited number of taxa were recognized from more than two stations. Such a patchy distribution of species within a limited geographic area under apparently similar oceanographic conditions requires further explanation.

Some similarities between the present flux and the previous plankton analysis can be observed; for example, relatively abundant taxa found in surface water, *Codonellopsis minor* and *Rhabdonella quantula*, are also commonly found in the flux material at all depths. On the other hand, some discrepancies are also apparent: *Dictyocysta reticulata* was widely observed in R/V ALBATROSS samples and, at Station #4621 from the surface down to 550 m depth, this species accounted for 66% of the fauna, whereas it constituted less than 3% in the flux assemblages. Furthermore, Kofoid and Campbell (1939) did not observe *Codonellopsis biedermanni* which was abundant in flux samples at all depths (Table 1). These facts suggest that the occurrence of some tintinnid assemblages could be highly seasonal, or their distribution may be patchy, thus preventing statistical matching of plankton tow data and sediment trap data.

It is possible that samples obtained by Kofoid and Campbell (1939) contain statistically unreliably small numbers of tintinnid specimens which might lead to some overlap with the list (Table 1) of the present study. Also, 4 out of 6 of their samples were collected at the surface and this would have excluded sub-surface dwellers.

## Summary

1. Vertical distribution of tintinnids of 63–250 $\mu$m size range was investigated from 1/256 of the original sediment trap samples deployed in the Panama Basin.

2. Tintinnid fauna consists of five dominant genera. They are, in order of decreasing relative abundance: *Codonellopsis, Rhabdonella, Codonella, Epiplocylis,* and *Xystonella.*

3. Assemblage composition does not change significantly in the flux samples at all depths including the deepest which was collected at 65 m above the ocean floor.

4. Throughout the observation, tintinnid specimens failed to show any significant effect of dissolution.

5. Results of the present flux sample study revealed similarities in faunal composition with those of the previous studies based on surface and/or two samples. However, some discrepancies were also apparent, and probably due in part to their patchy occurrence, depth distribution, and/or seasonal variation of individual taxa.

Table 2: Relative abundance (in percentages) of net-towed tintinnids by R/V ALBATROSS in the Panama Basin (data after Kofoid and Campbell, 1939).

| **R/V ALBATROSS Stations:** | **4619** | **4621** | **4624** | **4630** | **4631** | **4634** |
|---|---|---|---|---|---|---|
| **Depth (fathoms):** | **0** | **0–300** | **0** | **0** | **0** | **0–300** |
| **Taxa:** | | | | | | |
| *Codonella cuspidata* | - | 4 | - | - | - | 1 |
| *Codonaria oceanica* | - | - | - | - | - | 4 |
| *Cyttarocylis acutiformis* | - | - | - | - | - | 1 |
| *Climacocylis scalaria* | - | - | - | - | - | 1 |
| *Climacocylis scalaroides* | 1 | - | - | - | - | - |
| *Codonellopsis americana* | 2 | - | 38 | - | - | - |
| *Codonellopsis meridionalis* | 2 | - | - | - | - | - |
| *Codonellopsis minor* | - | - | 1 | - | - | 21 |
| *Codonellopsis parva* | - | - | - | - | - | 1 |
| *Dictyocysta pacifica* | - | - | - | - | - | 1 |
| *Dictyocysta reticulata* | 12 | 66 | - | 4 | 2 | 1 |
| *Dictyocysta spinosa* | - | - | - | - | - | 1 |
| *Rhabdonella amor* | 18 | 12 | 1 | - | - | 1 |
| *Rhabdonella cornucopia* | 2 | - | 1 | - | - | - |
| *Rhabdonella cuspidata* | 2 | - | 21 | - | - | - |
| *Rhabdonella inflata* | 2 | - | - | - | - | - |
| *Rhabdonella poculum* | 6 | - | - | - | - | - |
| *Rhabdonella quantula* | 23 | - | - | 88 | 62 | - |
| *Rhabdonella spiralis* | 1 | - | - | - | - | - |
| *Rhabdonella striata* | - | - | - | 8 | 6 | - |
| *Rhabdonellopsis triton* | 2 | - | - | - | 2 | 3 |
| *Epiplocylis undella* | 2 | - | - | - | - | - |
| *Epiorella acuta* | - | 16 | - | - | - | 1 |
| *Acanthostomella conicoides* | - | - | - | - | - | 1 |
| *Acanthostomella lata* | - | - | - | - | - | 1 |
| *Acanthostomella obtusa* | - | - | - | - | - | 1 |
| *Xystonellopsis cyclas* | - | - | - | - | - | 4 |
| *Xystonellopsis favata* | - | - | - | - | - | 1 |
| *Xystonellopsis heroica* | - | - | - | - | - | 3 |
| *Xystonellopsis pinnata* | - | - | - | - | - | 1 |
| *Xystonellopsis pulchra* | - | - | - | - | - | 3 |
| *Xystonellopsis tropica* | - | - | - | - | - | 6 |
| *Parundella aciculifera* | - | - | - | - | - | 1 |
| *Parundella aculeata* | - | - | - | - | - | 5 |
| *Parundella invaginata* | - | - | - | - | - | 1 |
| *Parundella pretenuis* | - | - | - | - | - | 2 |

Table 2 (Continued)

| **R/V ALBATROSS Stations:** | **4619** | **4621** | **4624** | **4630** | **4631** | **4634** |
|---|---|---|---|---|---|---|
| **Depth (fathoms):** | **0** | **0–300** | **0** | **0** | **0** | **0–300** |
| **Taxa:** | | | | | | |
| *Xystonella minuscula* | - | - | - | - | - | 3 |
| *Xystonella treforti* | - | - | - | - | - | 6 |
| *Undella hemispherica* | - | - | - | - | 1 | 2 |
| *Proplectella claparedei* | - | - | - | - | 1 | 2 |
| *Proplectella cuspidata* | - | - | - | - | - | 2 |
| *Proplectella parva* | - | - | - | - | - | 3 |
| *Amphorella minor* | 1 | - | - | - | - | - |
| *Amphorella quadrilineata* | 18 | - | - | - | 1 | - |
| *Steenstrupiella gracilis* | - | - | - | - | - | 1 |
| *Steenstrupiella nivalis* | - | - | 22 | - | - | - |
| *Steenstrupiella robusta* | - | - | - | - | 1 | - |
| *Steenstrupiella steenstrupii* | 6 | - | - | - | 1 | 4 |
| *Eutintinnus apertus* | - | - | - | - | - | 1 |
| *Eutintinnus colligatus* | - | - | - | - | - | 1 |
| *Eutintinnus elongatus* | - | - | - | - | 22 | 8 |
| *Eutintinnus fraknoii* | - | - | - | - | - | 2 |
| *Eutintinnus lusus-undae* | - | - | - | - | - | 1 |
| *Eutintinnus tenuis* | - | - | 2 | - | - | 2 |
| *Daturella stramonium* | - | - | - | - | - | 1 |
| *Favella panamensis* | - | 1 | - | - | - | - |
| *Tintinnopsis beroides* | - | - | 8 | - | - | - |
| *Tintinnopsis radix* | - | - | 5 | - | - | - |
| *Tintinnopsis schotti* | - | - | 2 | - | - | - |
| *Undellopsis pacifica* | - | - | - | - | - | 1 |
| *Amphorellopsis laevis* | - | - | - | - | - | 1 |
| *Dadayiella bulbosa* | - | - | - | - | - | 1 |
| *Ormosella apsteini* | - | - | - | - | - | 1 |
| *Ormosella cornucopia* | - | - | - | - | - | 2 |
| *Stelidiella fenestrata* | - | - | - | - | - | 1 |
| *Salpingella acuminata* | - | - | - | - | - | 2 |
| *Salpingella faurei* | - | - | - | - | - | 2 |
| *Salpingella jugosa* | - | - | - | - | - | 1 |
| *Salpingella subconica* | - | - | - | - | - | 1 |
| **No. Specimens Identified** | 53 | 60 | 101 | 25 | 100 | 117 |
| **No. Specimens Unidentified** | 17 | 6 | 10 | 3 | 11 | 49 |

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# Plates

## PLATE 1

Tintinnids from PARFLUX Station $PB_1$.
Transmission optical photomicrographs.
×300, unless otherwise indicated.

**1** *Codonella apicata* Kofoid and Campbell from 667 m trap.

**2** *Codonella cuspidata* Kofoid and Campbell from 2,869 m.

**3** *Codonellopsis biedermanni* (Brandt) from 2,869 m; ×330.

**4** *Codonellopsis ecaudata* (Brandt) from 2,869 m; ×330.

**5** *Codonellopsis minor* (Brandt) from 667 m; ×330.

**6** *Epiplocylis pacifica* (Ostenfeld and Schmidt) from 1,268 m.

**7** *Cyttarocylis acutiformis* Kofoid and Campbell from 1,268 m.

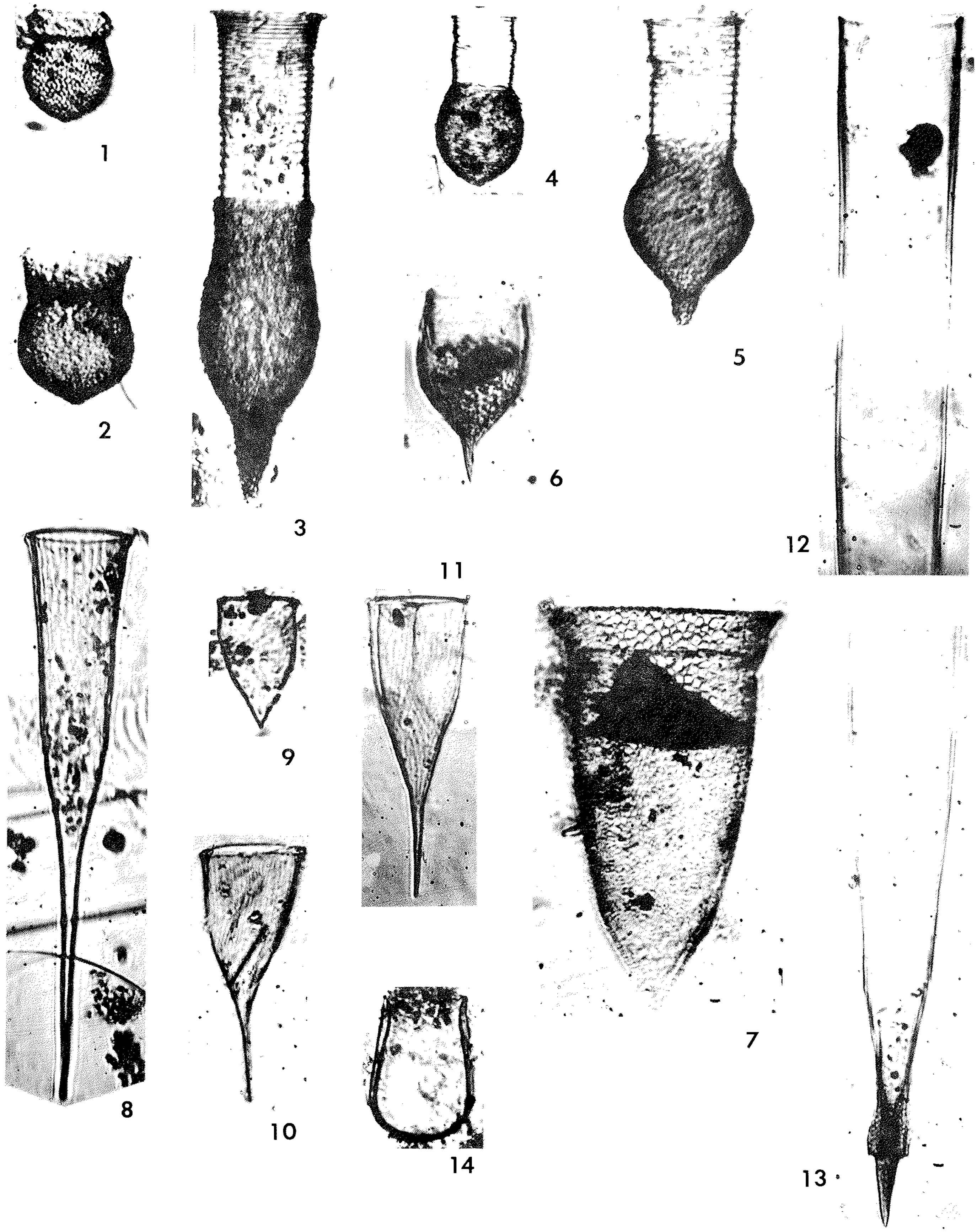
**8** *Rhabdonella conica* Kofoid and Campbell from 2,869 m.

**9** *Rhabdonella indica* Laackmann from 1,268 m.

**10, 11** *Rhabdonella quantula* Kofoid and Campbell
10 from 1,268 m; 11 from 2,869 m.

**12, 13** *Xystonella treforti* (Daday) from 667 m.

**14** *Undella pistillum* Kofoid and Campbell, from 2,869 m; ×400.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## PLATE 2

Tintinnids from PARFLUX Station $PB_1$. SEM photomicrographs.

**1, 2** *Codonella apicata* Kofoid and Campbell from 1,268 m trap.

- **1** ×660
- **2** a part of lorica of **1** in higher magnification (×2,100), showing the agglutinated nature of lorica by monospecific coccolith assemblage.

**3** *Codonella* sp. from 3,769 m; ×1,900.

**4–6** *Codonellopsis biedermanni* (Brandt) from 1,268 m.

- **4** ×280
- **5** higher magnification (×880) of neck part of **4**.
- **6** higher magnification (×1,100) of aboral part of **4**.

**7, 8** *Codonellopsis biedermanni* (Brandt) from 1,268 m.

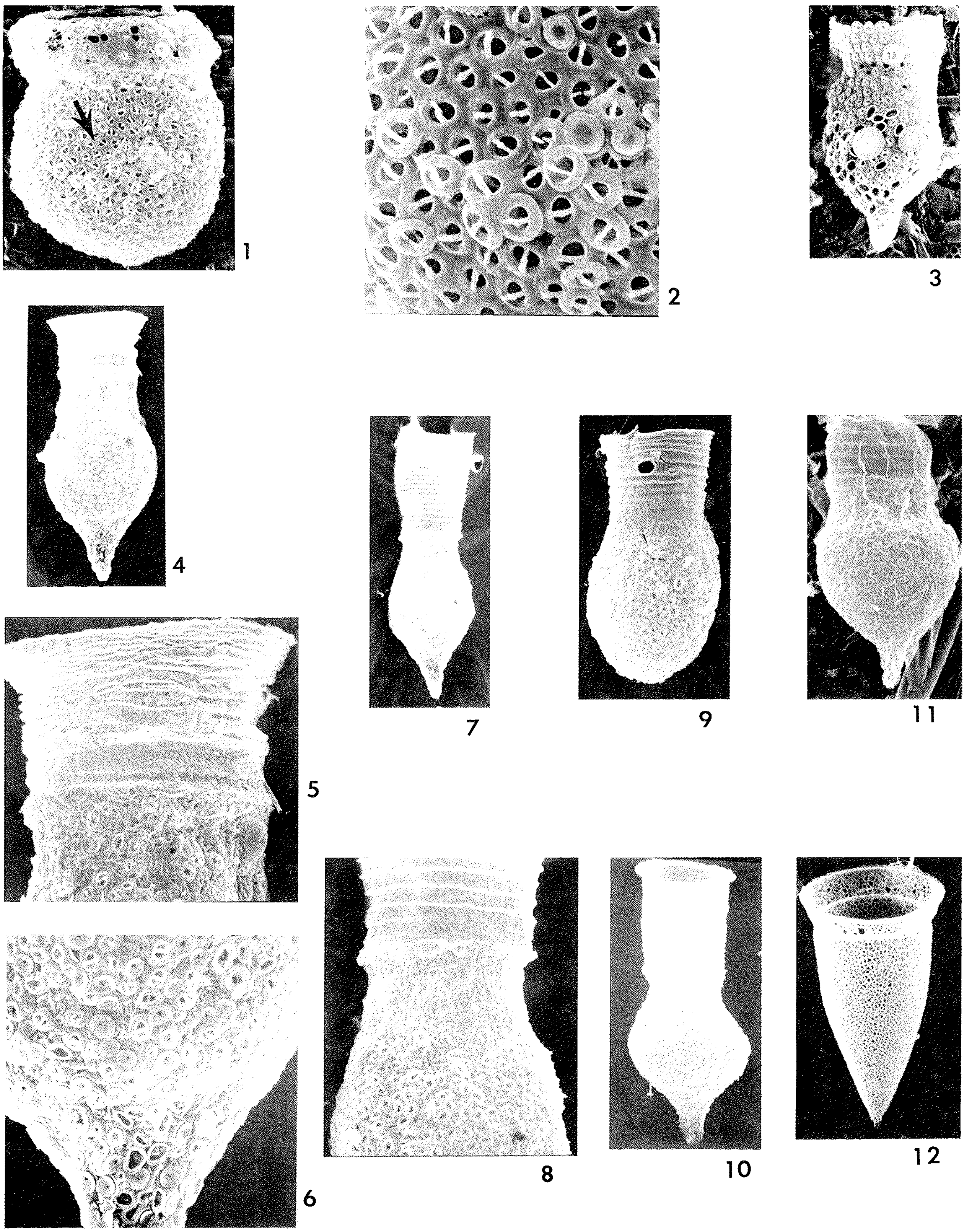
- **7** ×220
- **8** higher magnification (×600) of neck part of **7**.

**9** *Codonella ecaudata* (Brandt) from 2,869 m; ×480.

**10** *Codonellopsis minor* (Brandt) from 1,268 m; ×220.

**11** *Codonellopsis minor* (Brandt) from 3,791 m; ×390.

**12** *Cyttarocylis acutiformis* Kofoid and Campbell from 3,760 m; ×200.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