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Taxonomic Key and Illustrated Guide to the Tintinnine Ciliates of the Cays-Hellshire Region near Kingston Harbour, Jamaica

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ABSTRACT. – Tintinnines, planktonic loricate ciliates, were collected during 1985 and 1986 in the Cays-Hellshire region on the southeast coast of Jamaica. Species were observed, measured, and identified. A total of twenty species was identified from this region. A dichotomous key, intended for use as a field guide, was constructed based on lorica characteristics. The guide includes revised descriptions and illustrations for all tintinnine species in the region.

INTRODUCTION

Study on the ecological roles of planktonic ciliates is still relatively new. Planktonic marine ciliates, a component of the microzooplankton, may, in many coastal regions, represent a numerically significant and productive component of the planktonic community (Beers and Stewart, 1971; Sorokin, 1977; Verity, 1987). The high size-specific metabolic rates of ciliates (Taylor and Shuter, 1981) are such that they should be expected to contribute significantly to the turnover of organic material in the oceans (Heinbokel, 1982). In addition to their role as recyclers of nutrients throughout the water column (Johannes, 1965; Raymont, 1983; Porter et al., 1985), planktonic ciliates have also been implicated in energy transfer between the nanophytoplankton and the crustacean zooplankton in aquatic food webs (Berk et al., 1977; Porter et al., 1985) challenging the classical view of marine food chains which indicates that energy is cycled from phytoplankton to zooplankton (predominantly crustaceans), and ultimately to fish (Hardy, 1954).

Tintinnine ciliates (Phylum Ciliophora, Order Choreotrichida) (Small and Lynn, 1985) are a group of marine planktonic ciliates characterised by possessing a lorica (or test) in which they are housed. This particular characteristic has allowed tintinnines to be more easily sampled than soft-bodied or aloricate choreotrichids. They have been studied widely and in a variety of different ecosystems and biomes (Johansen, 1976; Balech and Souto, 1980; Rogers et al., 1981; Middlebrook et al., 1987; Verity, 1987; Gilron et al., 1990).

Tintinnines pose a number of problems with regard to their classification and identification, since (a) they are the only Ciliophoran group that has been classified solely on characteristics of the lorica (Laval-Peuto and Brownlee, 1986); and (b) although it has been widely assumed that lorica morphology is a species-specific character, some tintinnine species have been found, under certain environmental conditions, to construct loricae previously attributed to other species (Laval-Peuto, 1981). These problems, and suggestions for their resolution, such as the emphasis of cytological, biochemical, and ecological characteristics, are considered and reviewed in Laval-Peuto and Brownlee (1986).

An environment in which planktonic ciliates have only recently been studied (Gilron and Lynn, 1989; Gilron et al., 1990; Lynn et al., 1990) is the tropical ecosystem of the Caribbean Sea near the southeastern

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coast of Jamaica, a region where other planktonic organisms have been well studied (Goodbody, 1970; Grahame, 1976; Grahame, 1977). There is presently no information available for the identification of microzooplankton in Caribbean coastal waters, where these plankters may commonly reach abundances of $10^6 m^{-2}$ (Gilron et al., 1990; Lynn et al. 1990). Previous identifications of planktonic protists in the Caribbean relied upon descriptions from other tropical regions (e.g., the Mediterranean Sea). This may explain why previous studies of planktonic communities in the region have not reported on this potentially important group of planktonic organisms (Grahame, 1976; Moore and Sander, 1979).

The present report includes a dichotomous taxonomic key and illustrated guide for the resident species of tintinnine ciliates in the Cays-Hellshire region near Kingston Harbour, Jamaica, collected during 1985 and 1986. It also contains revised species descriptions with an account of the spatial occurrence of abundant species.

Materials and Methods

Study Region

Sampling was carried out in coastal waters of the Caribbean Sea surrounding the southeastern coast of Jamaica near the city of Kingston (Lat. 17°58'N; Long. 76°48'W) (Fig. 1). The area is bordered on the northwest by the Hellshire coast and on the east by a shelf extending 15 km off the coast. The coastal region is characterised by many small sandy cays: Kingston Harbour, a semi-enclosed body of water, has a surface area of approximately 52 km^2 and empties directly into the Caribbean Sea. Salinity in the region usually ranges between 31–36% and water temperatures range between 27–29°C.

Collection and Preservation of Specimens

Collections were made between November 6, 1985 and December 10, 1986 at three sites in the Cays–Hellshire region as described in Gilron et al. (1990). Vertical water column samples were collected using a standard 20 µm mesh plankton net and preserved in modified Bouin's fixative (5% vol/vol) (Lee et al., 1985). All three sites (Fig. 1) were sampled on at least six different occasions during the year. Sites at the West Harbour Mouth (HM) and Lime Cay (LC) were sampled weekly to biweekly, while Wreck Reef (WR) was sampled only occasionally.

Identification and Measurement of Specimens

Organisms were concentrated by settling and were examined in a Sedgwick-Rafter chamber using a Wild Heerbrugg M4D inverted microscope under 100× magnification. Two-dimensional measurements were made using a high-precision, optical microcomputer-based measuring system (Roff and Hopcroft, 1986). For biovolume determinations, the third dimension was calculated by approximating the shape of the lorica and cell to simple geometric shapes (Gilron, 1988).

Species identifications using lorica characteristics were based on Kofoid and Campbell (1929, 1939), Marshall (1969), Bakker and Phaff (1976), Burkovsky et al. (1974), and Small and Lynn (1985). Illustrations were modified from Marshall (1969) and based on visual observations and light micrographs taken with a Zeiss MC63 photomicrographic camera on a Zeiss standard stereomicroscope.

Results

The following is a dichotomous key to the tintinnine ciliates of the Cays-Hellshire Region of Jamaica. The key is based on lorica characteristics of the tintinnine loricae and their dimensions; it is intended mainly as a field guide. For identification, it is recommended that samples taken be viewed under at least 100× magnification using an inverted microscope for best recognition of the characters used in the construction of this key.

Key to Species of Tintinnine Ciliates of the Cays-Hellshire Region

Note: 1) numbers in parentheses after species names refer to figure number; 2)

for terminology related to lorica morphology (e.g., collar, pedicel, gutter, etc.) please refer to Corliss (1979).

1. Lorica agglutinated 2
1'. Lorica hyaline 8
2(l). Lorica possesses collar 3
2'(1). Lorica without collar 4
3(2). Collar agglutinated 7
3'(2). Collar hyaline 5
4(2'). Lorica cylindrical, tapering to a pedicel 6
4'(2'). Lorica cylindrical, rounded at aboral end . . . . . *Tintinnopsis lobiancoi* (2)
5(3'). Collar annulated *Codonellopsis schabi* (3)
5'(3'). Collar not annulated . *Stenosemella oliva* (4)
6(4). Length of lorica 150-200 µm; pedicel often broken . . . . . *Tintinnopsis radix* (5)
6'(4). Length of lorica 80-120 µm; pedicel intact . . . . . *Tintinnopsis strigosa* (6)
7(3). Oral end of lorica strongly flared, bowl bulges near the aboral end; pedicel absent . . . . . *Tintinnopsis* sp. B(7)
7'(3). Oral end of lorica not flared, bowl bulges near the aboral end; bowl with pedicel *Tintinnopsis* sp. A (8)
8(1'). Collar present, no tapering, with large fenestrae . . . . . *Dictyocysta lepida* (9)
8'(1'). Collar absent, possible tapering of oral end 9
9(8'). Lorica open at both ends; resembles a truncated cone 10
9'(8'). Lorica open only at oral end 11
10(9). Oral end of lorica slightly flared; length of lorica 150-250 pm . . . . . *Eutintinnus macilentus* (10)
10'(9). Oral end of lorica without flare; length of lorica 80-105 µm . . . . . *Eutintinnus tubulosus* (11)
11(9'). Aboral end of lorica tapers to a point; possibly not conspicuous 12
11'(9'). Aboral end of lorica rounded; lorica length quite variable 13
12(11). Whole bowl of lorica possesses visible striations 14
12'(11). Striations absent, or four or less striations visible only at aboral end of lorica 15
13(11'). Lorica as wide as it is long; shape is globose . . . . . *Proplectella globosa* (12)
13'(11'). Lorica longer than wide; shape not as above 16
14(12). Pedicel possesses knob and lance; length of lorica 250-350 µm . . . . . *Rhabdonellopsis longicaulis* (13)
14'(12). Pedicel not as above; length of lorica 160-220 µm . . . . . *Rhabdonella spiralis* (14)
15(12'). Oral end of lorica with vertical ribs, number variable *Dadayiella ganymedes* (15)
15'(12'). Oral end of lorica not as above 17
16(13'). Oral end of lorica not flared, with 3-5 annulations . . . . . *Metacylis annulata* (16)
16'(13'). Lorica not as above; with obvious flare 18
17(15'). Lorica much longer than oral width, strongly flared oral end, clarinet-shaped . . . . . *Salpingella acuminata* (17)
17'(15'). Lorica bowl-shaped, tapers slightly to a point 19
18(16). Lorica cylindrical with rounded aboral end; very abrupt trumpet-like flare . . . . . *Steenstrupiella steenstrupii* (18)
18'(16). Lorica cylindrical with obvious constriction in first third of oral end (wall of lorica is thickened at this constriction); four striations at base . . . . . *Amphorides quadrilineata* (19)
19(17'). Oral wall of lorica with inner and outer lips and distinct, but narrow gutter . . . . . *Ascampbelliella obscura* (20)
19'(17'). Oral third of bowl tapers inward toward oral opening . . *Ascampbelliella urceolata* (21)

Species Descriptions

Legend: L = length, MD = maximum diameter, V = lorica volume, L/OD = ratio of length to oral diameter of lorica, N/A = not available.

Note: two dimensional variables are expressed in µm; volume is expressed in cubic µm; L/OD is expressed as a ratio.

Phylum CILIOPHORA Dolfein, 1901
Subphylum
POSTCILIODESMATOPHORA
Gerassimova & Seravin, 1976
Class SPIROTRICHEA Bütschli, 1889
Subclass CHOREOTRICHIA
Small & Lynn, 1985
Order CHOREOTRICHIDA
Small & Lynn, 1985
Suborder TINTINNINA
Kofoid & Campbell, 1929

Family Ascampbelliellidae
Corliss, 1960

Ascampbelliella obscura Brandt, 1906
(Fig. 20)

Relatively cone-shaped, tapering in the aboral quarter to a point; inner lip erect, with the outer lip, slightly flaring; gutter apparent between inner and outer lips; wall hyaline; depending on microscopy, alveolar wall structure present.

Dimensions: L 50-75; MD 45-55; V 92,000; L/OD 1.6; occurrence: Very common at all stations.

Ascampbelliella urceolata Ostenfeld, 1899
(Fig. 21)

Small, conical bowl tapering to a slight aboral point; upper third of lorica tapers

inward, gutter absent; wall completely hyaline.

Dimensions: L 115-130; MD 45-50; V 210,000; L/OD 2.3; occurrence: Rare; only present in harbour area.

Family Codonellidae Kent, 1881

Tintinnopsis sp. A
(Fig. 8)

An undescribed species; long, slender, agglutinated in bowl and collar, cylindrical collar greater than half the length of the lorica; with round, spherical bowl, which in aboral region, tapers to a strongly pointed pedicel; wall of lorica agglutinated.

Dimensions: L 60-75; MD 25-30; V 28,000; L/OD 2.5; occurrence: Very common in all regions but most abundant in harbour waters.

Tintinnopsis radix Imhof, 1886
(Fig. 5)

Long, slender, mostly cylindrical, tapering in the last quarter to a pedicel which is often broken; wall of lorica agglutinated.

Dimensions: L 150-250; MD 15-30; V 450,000; L/OD 5.0; occurrence: Very common in all regions.

Tintinnopsis strigosa Meunier, 1919
(Fig. 6)

Cylindrical as in *T. radix*, but shorter and stouter, tapering at the aboral end to a pedicel, which is rarely broken; wall of lorica agglutinated.

Dimensions: L 55-85; MD 29-40; V 350,000; L/OD 2.4; occurrence: Rare; only present in harbour region.

Tintinnopsis sp. B
(Fig. 7)

An undescribed species; round, spherical bowl with a narrower collar at least half the length of the lorica; collar flared at the oral end; wall of lorica agglutinated.

Dimensions: L 60-80; MD 30-45; V 30,000; L/OD 2.5; occurrence: Very common, mostly in coastal region.

Tintinnopsis lobiancoi Daday, 1887
(Fig. 2)

Cylindrical bowl with a rounded aboral end; wall of lorica agglutinated.

Dimensions: L 50-75; MD 25-40; V 29,000; L/OD 2.0; occurrence: Very common all year at all stations.

Family Codonellopsidae
Kofoid & Campbell, 1929

Codonellopsis schabi
(Brandt) Kofoid & Campbell, 1929
(Fig. 3)

Lorica sharply divided into hyaline collar and heavily agglutinated bowl; collar narrower than bowl, with 5-7 annulations.

Dimensions: L 75-1 10; MD 50-55; V 110,000; L/OD 2.5; occurrence: Very common in all regions.

Stenosemella oliva Meunier, 1910
(Fig. 4)

Long, oval agglutinated bowl with small, almost inconspicuous (under 100 × magnification) hyaline collar; agglutination of bowl quite variable depending on particulate matter in the water column.

Dimensions: L 25-30; MD 10-15; V 6,300; L/OD 2.0; occurrence: Very common in all regions.

Family Dictyocystidae Haeckel, 1873

Dictyocysta lepida Ehrenberg, 1854
(Fig. 9)

Cylindrical collar, less than half the total length of the lorica, with a row of tall rectangular fenestrae; bowl short, conical, bluntly pointed aborally, with a zone of smaller fenestrae in the bowl; wall hyaline.

Dimensions: L 65-75; MD 40-45; V N/A; L/OD 1.6; occurrence: Rare; only present in coastal region.

Family Metacylidiidae
Kofoid & Campbell, 1929

Metacylis annulata Meunier, 1910
(Fig. 16)

Cylindrical with rounded aboral end; between three to five annuli in upper third of lorica, the upper edges of which overlap slightly; wall completely hyaline.

Dimensions: L 45-65; MD 20; V 6,600; L/OD 5.0; occurrence: Occurs frequently in coastal regions, but not very abundant.

Family Rhabdonellidae
Kofoid & Campbell, 1929

Rhabdonellopsis longicaulis
Kofoid & Campbell, 1929
(Fig. 13)

Lomg, slender, conical bowl with tapering pedicel for aboral half of length with prominent knob and lance; oral rim slightly above flaring lip; distinct laminae throughout bowl, with fenestrae.

Dimensions: L 250-350; MD 55-75; V 320,000; L/OD 5.0; occurrence: Common in coastal regions.

Rhabdonella spiralis (Fol) Brandt emended
Kofoid & Campbell, 1929
(Fig. 14)

Cylindrical and conical with a slender pedicel for aboral third of length; oral rim emergent, lip flaring; distinct laminae throughout bowl, thicker in pedicel; laminae with fenestrae.

Dimensions: L 160-220; MD 55-65; V 180,000; L/OD 3.5; occurrence: Common in all regions.

Family Tintinnidae
Claparède & Lachmann, 1858

Amphorides quadrilineata
Claparède & Lachmann, 1858
(Fig. 19)

Vase-shaped, with flaring collar and truncated aboral end; obvious striae in aboral third of bowl; wall hyaline.

Dimensions: L 90-180; MD 40-65; V N/A; L/OD 3.0; occurrence: Rare; only present in coastal regions.

Dadayiella ganymedes Entz, Sr., 1884
(Fig. 15)

Cone-shaped with slightly flaring oral region, tapering to a slender, pointed pedicel, about a quarter of total length; oral region possesses ribs which extend a third of the way down the bowl; wall hyaline.

Dimensions: L 85-105; MD 25-35; V 21,000; L/OD 3.0; occurrence: Rare; only present in coastal regions.

Eutintinnus macilentus Jorgensen, 1924
(Fig. 10)

Truncated, cone-shaped lorica, widely open at both ends; slight flare at oral end; wall completely hyaline; sometimes seen with particulate matter accumulated around lorica *(not* agglutination).

Dimensions: L 150-250; MD 40-50; V 290,000; L/PD 4.0; occurrence: Very common in all regions.

Eutintinnus tubulosus Ostenfeld, 1899
(Fig. 11)

Similar to *E. macilentus,* but smaller and without flare at oral end; never seen with particulate matter around lorica.

Dimensions: L 80-105; MD 20-30; V N/A; L/OD 3.5; occurrence: Rare, only present in coastal regions.

Salpingella acuminata
Claparède & Lachmann, 1858
(Fig. 17)

Long, very slender and tubular with strongly flaring oral end and tapering aboral end (clarinet-shaped); aboral end also has slight striae; wall hyaline.

Dimensions: L 150-250; MD 20-35; V 29,000; L/OD 8.0; occurrence: Common, mostly in the coastal region.

Steenstrupiella steenstrupii
Claparède & Lachmann, 1858
(Fig. 18)

Elongate, trumpet-shaped with flaring mouth, cylindrical shaft and rounded, slightly tapering aboral end; aboral end often seen with striae.

Dimensions: L 90-110; MD 25-40; V 22,000; L/OD 2.5; occurrence: Occurs frequently in coastal area but not very abundant.

Family Undellidae
Kofoid & Campbell, 1929

Proplectella globosa Brandt, 1906
(Fig. 12)

Short, bowl-shaped (globose) with round aboral end; wall is thickened in the oral end of the lorica (can be seen, since lorica is hyaline); wall hyaline.

Dimensions: L 35-50; MD 35-45; V 40,000; L/OD 1.2; occurrence: Rare; only present at coastal stations.

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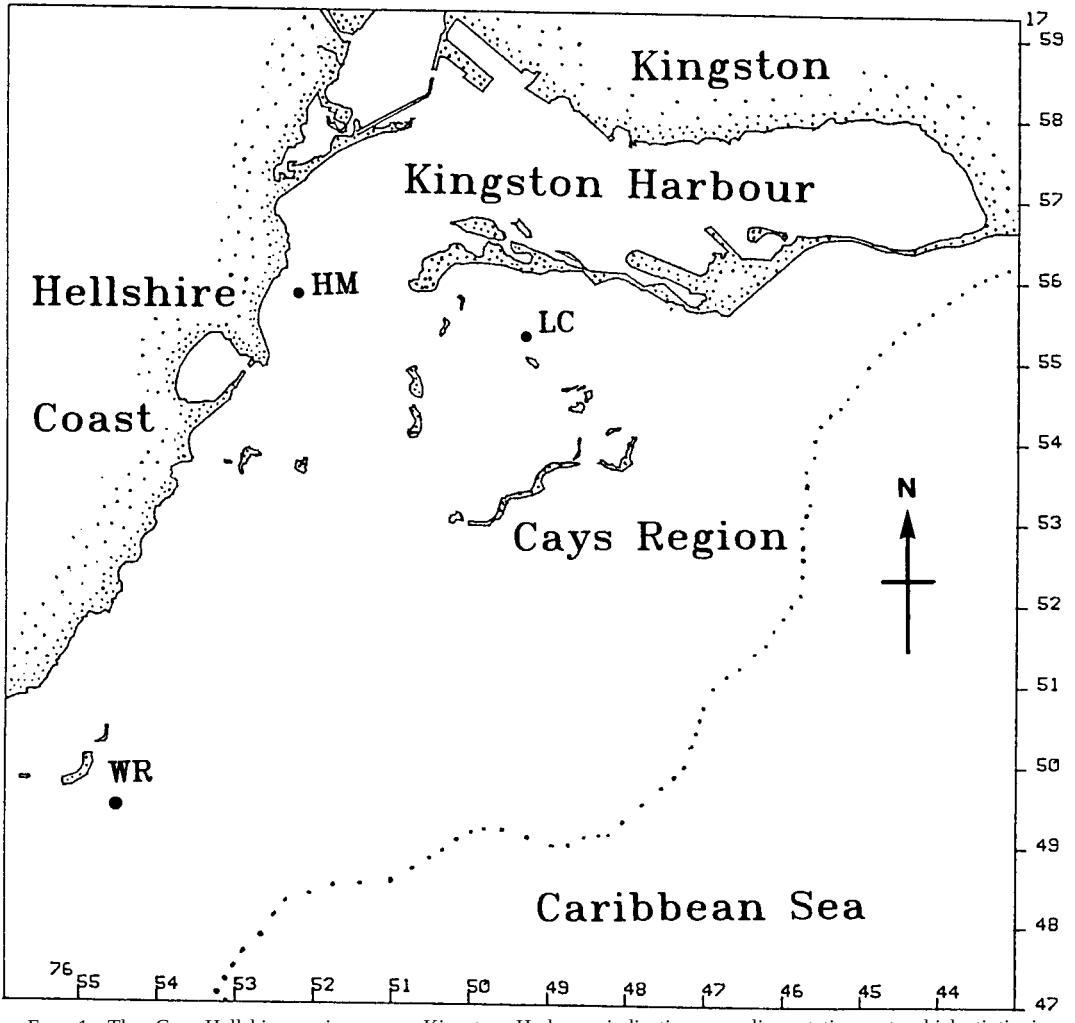


FIG. 1. The Cays-Hellshire region, near Kingston Harbour, indicating sampling stations at which tintinnine ciliates were collected during 1985 and 1986. HM = West Harbour Mouth, LC = Lime Cay, WR = Wreck Reef.

staff at the Port Royal Marine Laboratory (University of the West Indies), Jamaica, W.I. for help with the collection of samples. J. C. Roff kindly allowed us to use his digitizing equipment. G. Mackie, C. Field, and J. V. M. Gilron helped in testing out the key. We also thank an anonymous reviewer for his critical reading of the manuscript. This research was funded by NSERC operating grants awarded to D. H. Lynn and J. C. Roff.

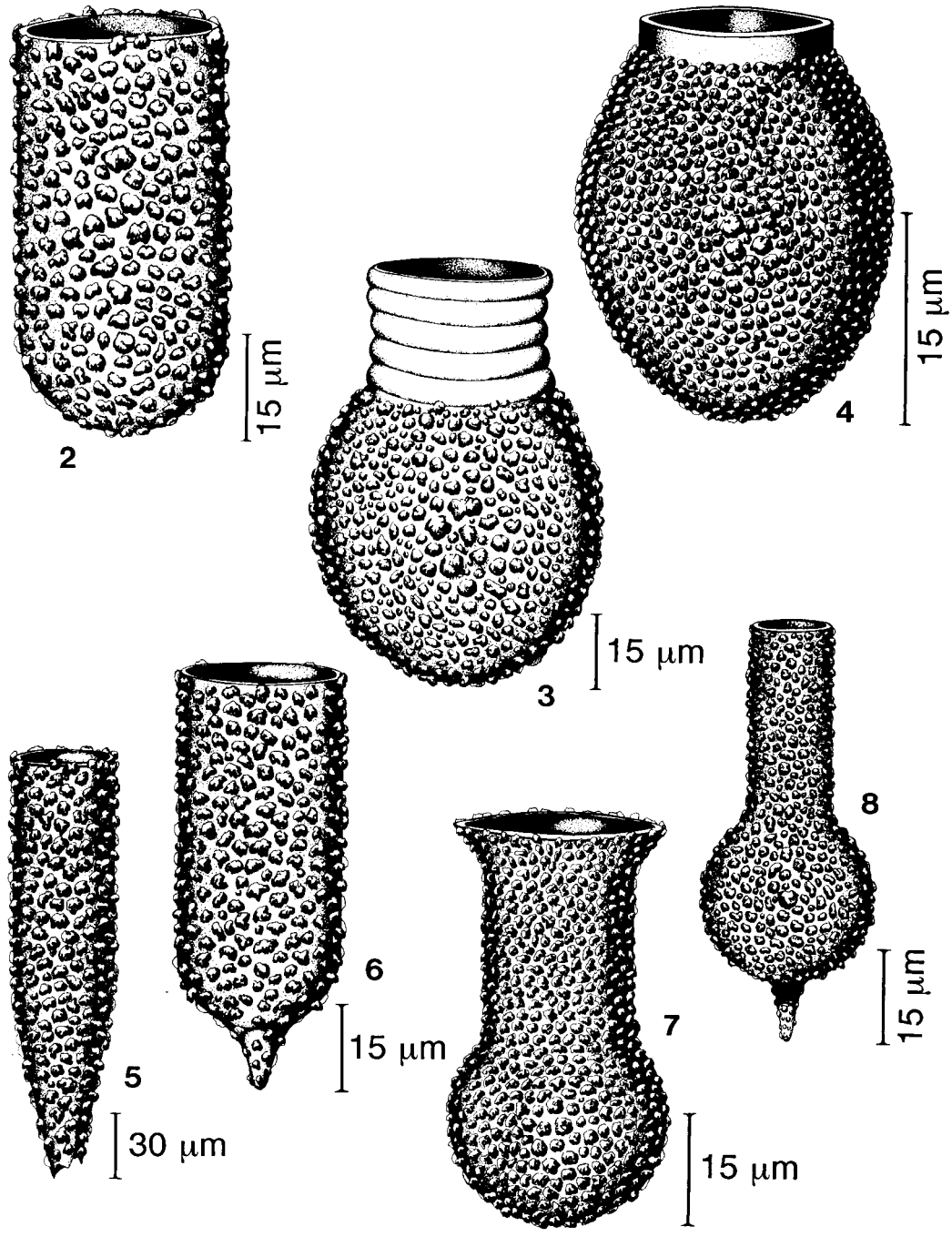


FIG. 2. *Tintinnopsis lobiancoi.*

FIG. 3. *Codonellopsis schabi.*

FIG. 4. *Stenosemella oliva.*

FIG. 5. *Tintinnopsis radix.*

FIG. 6. *Tintinnopsis strigosa.*

FIG. 7. *Tintinnopsis* sp. B.

FIG. 8. *Tintinnopsis* sp. A.

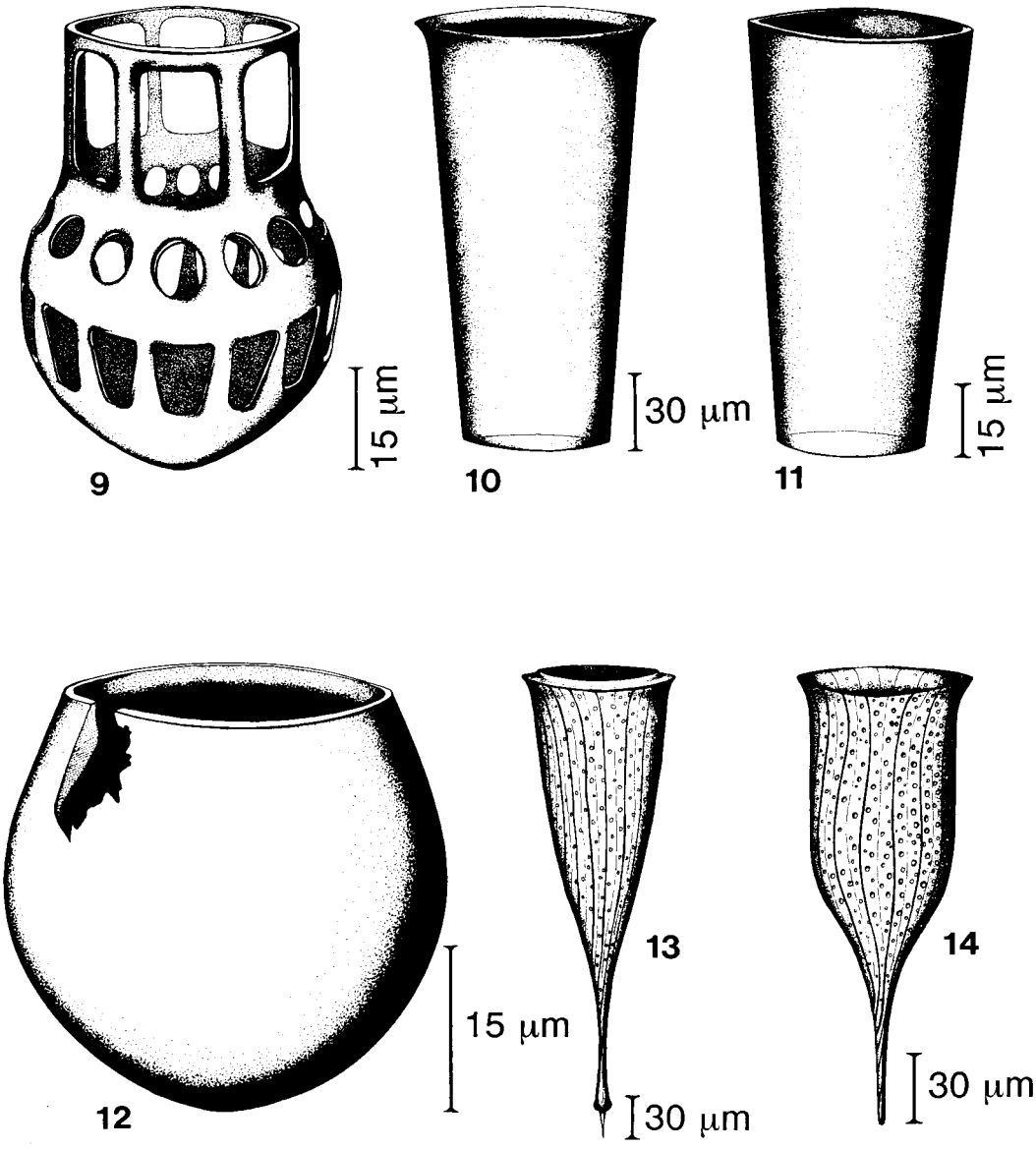


FIG. 9. *Dictyocysta lepida.*

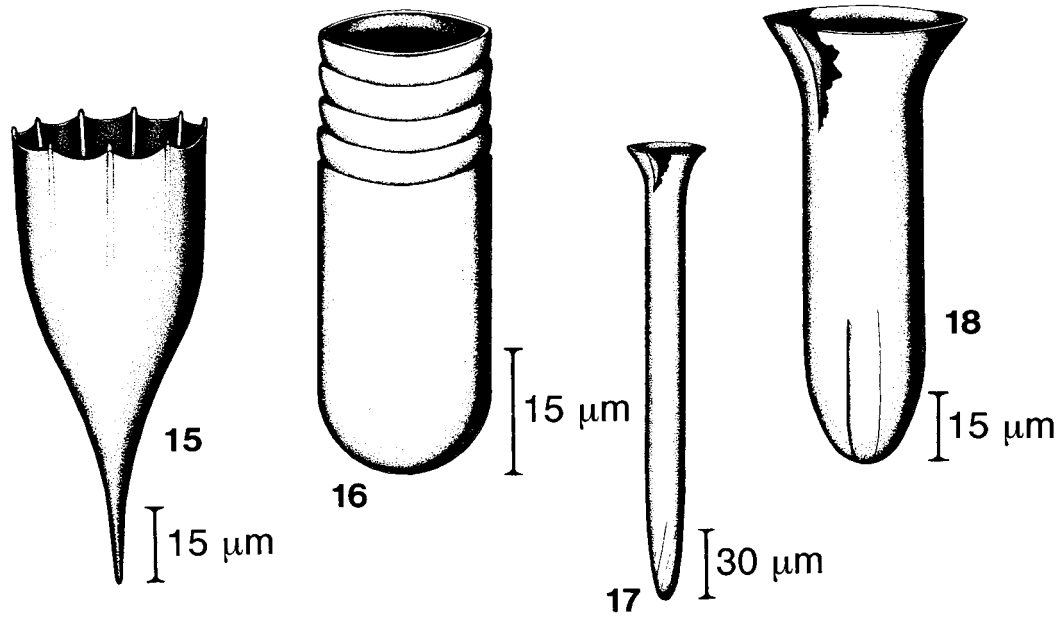
FIG. 10. *Eutintinnus macilentus.*

FIG. 11. *Eutintinnus tubulosus.*

FIG. 12. *Proplectella globosa.*

FIG. 13. *Rhabdonellopsis longiaulis.*

FIG. 14. *Rhabdonella spiralis.*



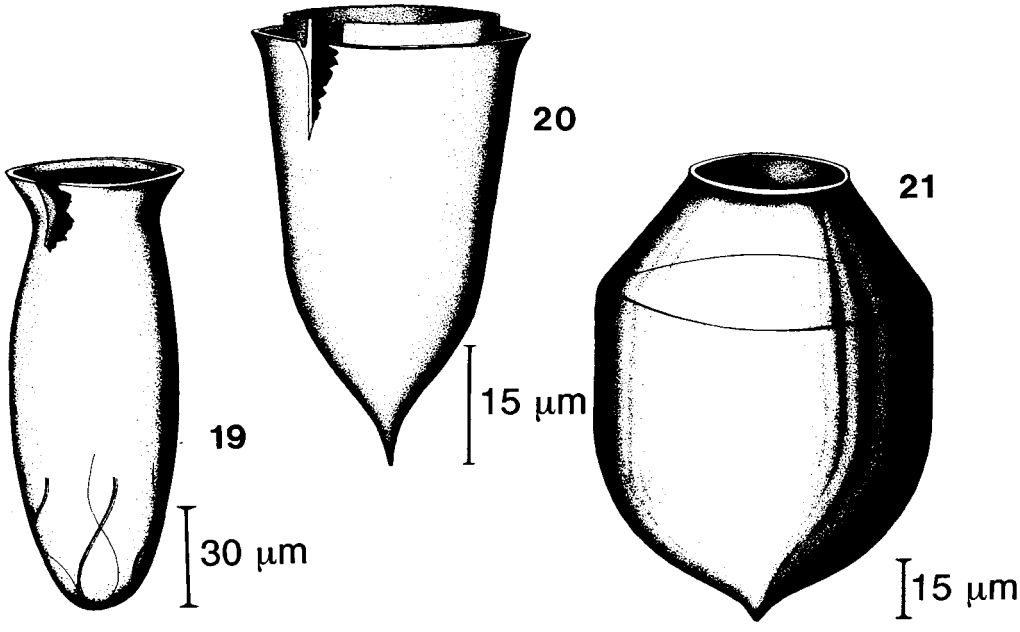


FIG. 15. *Dadayiella ganymedes.*

FIG. 16. *Metacylis annulata.*

FIG. 17. *Salpingella acuminata.*

FIG. 18. *Steenstrupiella steenstrupii.*

FIG. 19. *Amphorides quadrilineata.*

FIG. 20. *Ascampbelliella obscura.*

FIG. 21. *Ascampbelliella urceolata.*

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