

REPORT

ON THE

DANISH OCEANOGRAPHICAL EXPEDITIONS 1908-1910

TO THE

MEDITERRANEAN AND ADJACENT SEAS

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REPORT ON THE DANISH OCEANOGRAPHICAL EXPEDITIONS 1908—10
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Mediterranean Tintinnidae.

By

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Bergen's Museum, Bergen, Norway.

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I. INTRODUCTION.

THE Tintinnids belong to the most important plankton organisms, most of them being "oceanic" (holoplanktonic), whilst, on the other hand, they also comprise truly "neritic" (meroplanktonic) coast forms, especially the members of the comprehensive genus *Tintinnopsis*.

In plankton samples, however, one has nearly always to deal only with empty loricae, the animalcules leaving them when disturbed, or contracting and soon perishing, if not immediately treated with special fixation fluids. Empty loricae make, on the whole, an essential part of the plankton, apparently even in the sea.

The exact constitution of the animalcules has been little known, almost down to the present time, chiefly on account of their rapid motion and the disturbing effect of the powerful rotating ciliary plates, the membranelles or pectinelles. In later years, however, several zoologists have studied some of these interesting organisms more thoroughly in a living state, so that we now know the main features of their organization as regards several of the commoner species.

The first more exact study of the living animalcules was made by CLAPARÈDE and LACHMANN (1858—59) with material from the Norwegian west coast. Later on Tintinnids were occasionally dealt with by some few authors, among whom HAECKEL (1873), FOL (1881, 1884) and ENTZ (1885, 1886) worked with Mediterranean material. The first author, however, who devoted himself to a special and thorough study of the whole group of species in a living state, was DADAY (1887), who gave the first complete monograph, dealing with in all 10 genera and 69 species, of which 3 genera and 29 species were established as new ones. He succeeded in stating the shape of the living animal, its mode of fixation in the lorica, the number of membranelles — which he considered of generic value — and the number of nuclei in a great many species. In later years the difficult study of living Tintinnids has been continued and furthered by SCHWEYER (1905, 1909) and MERKLE (1909), whilst LAACKMANN (1906) has studied the nuclear phenomena during fission and reproduction and ENTZ jun. (1909) has made a careful and comprehensive study of stained material in toto and in sections.

In spite of these careful studies by several scientists there are still several very important questions waiting elucidation, as for instance the formation of the lorica. Also, the conclusions arrived at by the different authors are often contradictory.

A new and very important paper on the Tintinnids has just been published (FAURÉ-FREMIET 1924) which gives new and very interesting details of their organization.

With a view to what is to follow, I give here a brief survey of this organization of the animalcules, according to the experience obtained in the last twenty years.

The shape of the animalcule in a swimming state is usually campanulate or conical, below mostly more or less abruptly narrowing into a pedicle, fixed at the bottom or lateral wall of the lorica, frequently on one side with some myofibrils, passing over into the lower half of the body (fig. 1). Sometimes the body is only attenuated below, in other cases divided into 2—4 short pedicles. At the upper

end the body is cut off to a more or less broad peristomial disc, surrounded by a tubular incrassate peristomial collar, carrying on its top a wreath — or rather, ventrorse spiral (ENTZ jun. 1909, SCHWEYER 1909) — of, usually 16—24, powerful, long and narrow triangular, obliquely fixed ciliary plates, the membranelles or pectinelles. The peristomial disc, sunk into the upper end of the body carries the mouth in

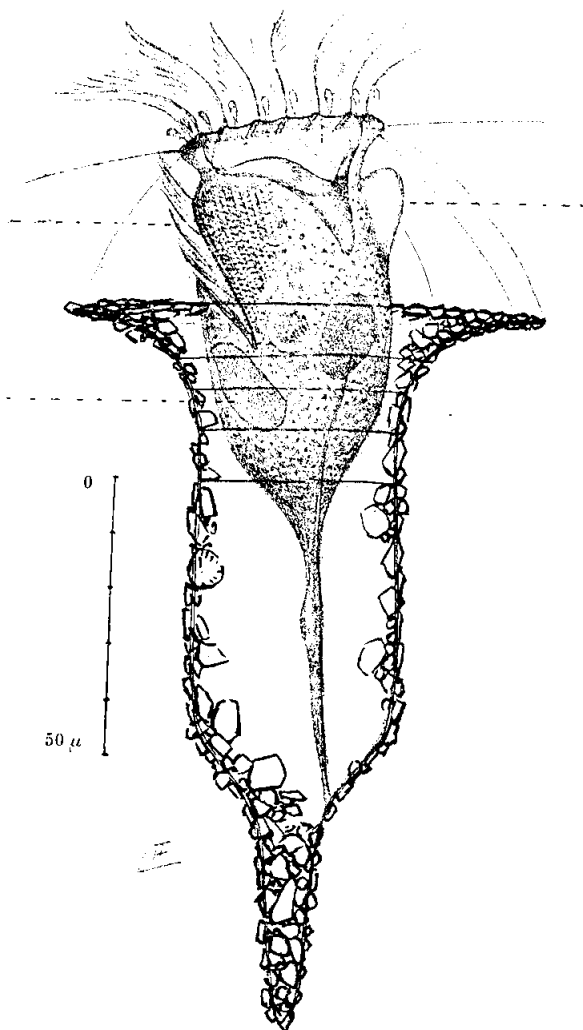


Fig. 1. *Tintinnopsis campanula* (Ehrb.) Dad., copy from Fauré-Fremiet 1924.

species of *Tintinnopsis* and in *Stenosemella ventricosa* (l. c. pp. 90—97) also another lateral field of cilia, on one side, below the peristome collar (fig. 1), in close series, short, with exception of the limiting series on the right side which consists of coalescent longer ones, making an undulating membrane. He also found in the same species some fine and long, less mobile, but elastic setae, spreading out from the outer side of the peristome collar to the broadest part of the lorica (fig. D), probably acting as a support for the outstretched animalcule.

Most of the marine Tintinnids have proved to possess two large, roundish or ovoid macronuclei, each with a smaller, round, micronucleus. The number of nuclei is, however, very often differently reported by different authors which may in many cases be due to disturbing phenomena of reproduction. In

a more or less deep, eccentric "preoral cavity", where some of the membranelles descend. About in the middle of the disc there is a more or less thick and elevated "piston" which sometimes shows a pumping motion. The membranelles somewhat resemble long and narrow knives with their backs turned outwards, where they are limited by a strong rim; inwards they are more or less deeply fringed into cilia. The peristome collar appears frequently or mostly lobulate, with rounded lobes, the membranelles being inserted lower down and the interstices occupied by more or less elevated plasma bodies running parallel to the insertion-lines of the membranelles (Deckplättchen and Begleitkämme, ENTZ jun.). In these interstices between the bases of membranelles, on the inner side of the peristome collar (SCHWEYER) there are in certain species peculiar stalked, clavate or tentaculiform organelles — in the following for the sake of brevity called tentaculoids — which seem to be very variable in length and shape and therefore perhaps very contractile in the living animal. They were already seen by HAECKEL (1873) and were later observed by SCHWEYER, ENTZ jun. and FAURÉ-FREMIET. We have here perhaps a character which may be useful in systematic respects, together with the shape of the collar. Between this latter and the body there is frequently a more or less marked constriction.

The number of membranelles has been considered constant for a definite genus; MERKLE (1909) found it, however, considerably varying in the genus *Tintinnopsis*.

Otherwise the body is usually provided with more or less long and distant longitudinal rows of generally short cilia. FAURÉ-FREMIET (1924) found in

certain genera, especially in those having a lorica provided with a collar, the number of nuclei seems to be constantly 8 or more, according to ENTZ jun. (l. c.) even sometimes (in *Petalotricha* and *Codonellopsis orthoceras*) reaching 50—300. HAECKEL, however, believed to have seen *Cyttarocyclus cassis* and *Tintinnopsis campanula* in a stage of sporulation, and LAACKMANN (1906) also reports the same phenomenon for the latter species and others. It seems therefore necessary to wait for the results of further investigations in regard to these cases of numerous nuclei, before they are used for establishing special genera or subfamilies.

While hoping for further important reports on the animalcules in a living state, our knowledge in this respect is, however, as yet too inconsiderable to be used as the chief base for a systematic treatise of the whole group, containing now a great many forms, which, judging from their loricae, are, on the one hand very multiform, on the other certainly uniform enough to permit the distinction of very well defined species.

We must still provisionally found the system of Tintinnids on the loricae, utilizing the knowledge obtained as to the organization in the best way possible. Such a system will, of course, be an artificial one, but may be gradually amended, by clearing out the disturbing elements.

The first system, comprising a greater number of species, was that of DADAY (1887), which, in my opinion, is still the most practical or useful one, needing, however, certain reservations and developments. It was, in the first hand, based upon the structure of the wall as seen in optical section, especially upon the difference between simple (single) and double walls, with differentiated inner and outer limiting lamellæ. This difference is not sharp enough to afford a completely certain character in all cases; it gives, however, in well developed loricae often or mostly an excellent distinguishing mark which, in any case, should not be ignored.

After DADAY, the most comprehensive work on Tintinnids was published by BRANDT (1906/7), properly consisting of two or three separate works, the pictorial work (1906) by GLOCKENTÖGER and the treatise by BRANDT (1907), based to a great extent on these figures and also containing the result of countings on board the Humboldt Plankton Expedition. The huge material of this expedition seems only partly to have been examined by BRANDT himself, apparently often by means of slides (containing selected individuals?); he has also utilized other materials. His system is primarily based on the mostly very fine and inconspicuous "primary" Waben-structure, detected by BIEDERMANN (1892) and later, by BRANDT, stated for all (or nearly all) genera of Tintinnids. This "primary" structure was used by BRANDT, in connection with a similar, much coarser "secondary" structure — this term only applicable when a double structure is present — and even sometimes a "tertiary" one (in *Codonella* and *Tintinnopsis*). This "primary" structure seems, however, to be a general feature among the Tintinnids, therefore giving no good distinguishing characters, except when strikingly coarser than usual, or uneven, or, at all extraordinary in some way or other. BRANDT ignored some other, more easily applicable, characters, for the sake of consistency, as for instance the normal posterior aperture in *Tintinnus lusus-undæ* etc., the "double" wall in most cases, in contradistinction to "single", and therefore withdrew some of DADAY's genera, restoring the species to the old genus *Tintinnus*. On the other hand, he found considerable difficulty in limiting some of his newly established genera or subgenera, as is plainly seen from the vacillating denominations of species within the genus *Cyttarocyclus* and its subgenera. This difficulty is a very natural one.

BRANDT left the genus *Tintinnus* in a very complicated state, consisting of very different members; this is also the case with his genera *Ptychocyclus* and *Cyttarocyclus*. In the latter, however, he introduced several subgenera, partly very natural ones, partly making the border line towards the genus *Undella* very uncertain and unnatural. This inconvenience is with BRANDT and other German authors on Tintinnids in part counterbalanced by introducing special groups of species, their so-called Formenkreise, which in complicated cases — e. g. in the genera *Tintinnus* Bdt. and *Ptychocyclus* Bdt. — are of great use.

As regards the Mediterranean our knowledge of its Tintinnids before the cruises of the "Thor" was chiefly due to DADAY (1887), before him in some degree to HAECKEL, FOL, ENTZ sen. and GRUBER, later to CLEVE, LOHMANN, BRANDT, ENTZ jun. and LAACKMANN, occasionally also others.

In dealing with the great material of the "Thor" I have considered it necessary to try to make the system based on the loricae as natural as possible, in accordance with our present knowledge of the animalcules on the one hand, and with the supposed relationship, as judged from our extended knowledge of the loricae, on the other hand. In this connection it is very unfortunate that we are still almost wholly unacquainted with the way in which the loricae of the marine species are built up. ENTZ sen. (1885 p. 195) describes this process for the fresh-water species *Tintinnidium fluviatile*: secretion of a jellied substance, at first glutinous, then firmer, surrounding the animal in all directions save above; these young, thimble-shaped loricae then grow, according to ENTZ very probably by repeated secretion of "annuli or tubular segments" at the mouth, though no trace of annulated zones of growth is to be found on the finished lorica. Much later SCHWEYER (1905, 1909 p. 143) found that *Tintinnus inquilinus* and *Cyrtarocydis (Favella) ehrenbergi* secretes an annulus of a similar structure to their loricae, (without a structure in the first species, with an alveolated "Waben"-structure in the other), the secretion taking place exteriorly from a constriction below the peristome collar of the former animal in fission-stages. SCHWEYER is of the opinion that this process is the beginning of the formation of lorica.

Provisionally it must be considered doubtful whether the loricae are built in this way, though some other experiences (of mine) point to the same conclusion; it seems, however, very probable that the growth in length takes place in a similar way. This is probably also the mode of formation of the peculiar loricae occasionally met with, in which the upper part of another lorica protrudes from their mouth (fig. 79 p. 67; see also e. g. LAACKMANN 1906, pl. I fig. 14). Perhaps also the tubular loricae open below, e. g. in *Tintinnus lusus-undae*, are (wholly) built in this way, it should, however, a priori, seem most probable that the ordinary loricae, without posterior aperture, are formed in this posterior portion in a similar way to that described by ENTZ for *Tintinnidium*. ENTZ jun. (1909) considers the special closing apparatus found in *Codonella* and allied genera to be formed — as well as the lorica itself — by some sort of "Häutung"; he is, however, otherwise of the opinion that the lorica in different genera is formed in different ways, also partly as SCHWEYER suggests, and that the "annuli" gradually conglutinate, the limiting lines disappearing.

To obtain more "natural" genera I have thought it necessary to propose several new names, to be used for new genera or subgenera. I will here give a brief survey of these new names and at the same time of the most important differences and connections between the generic groups.

The simplest wall of lorica is a thin membrane, apparently destitute of structure, as in *Tintinnus lusus-undae*. A further developed stage shows a finely reticulated wall, the "primary" "Waben"-structure (BRANDT). In a certain sense this wall is already a "double" one, showing a (single) layer of "prismatic elements" (Κοφιδ) between the outer and inner side of the wall. A further development shows thickened outer and inner sides, two lamellae, with one, or perhaps two or more, layers of prismatic elements between, the two lamellae being connected by thinner walls.

Such is the structure in the genus *Cyrtarocydis*, only with the difference that the prismatic elements between the lamellae are "secondary" ones, showing also a much finer "primary" reticulation. BRANDT seems always to presume that this primary reticulation is due to much the same elements as the secondary, and that these finer prismatic elements both constitute the walls of the secondary ones and fill up their lumina. This is a difficult question which cannot be decided by GLOCKENTÖGER's figures; a priori one should, however, think that there might be some difference in this respect between the lamellae and their interstices.

When young or thin, the wall with a single layer of small prismatic elements may appear single, though in a more developed state it proves to be obviously double. This seems to be the case for instance with some forms of *Favella azorica* from the Mediterranean. An apparently single wall is therefore no infallible mark of distinction, at any rate in reticulated species.

In the genus *Undella* it is quite different. Here there are two thick and well defined lamellae,

separated by an apparently structureless interstice. This latter seems in many cases to possess a reticulation, whilst this mostly is more or less coarse and conspicuous in the lamellae. Here is just a case in which one should think there might be a considerable difference in structure between the lamellae and their interstice.

Closely allied to the genus *Undella*, with the characteristic double wall as set forth above, is, on the one hand, the genus *Xystonellopsis* n. gen., one of the "Lanzentintinnen" (BIEDERMANN, BRANDT), on the other hand the genus *Epiplocyclus* n. gen., comprising *Ptychocyclus undella* (Ostf. et Schm.) Bdt. and its near allies. In both genera the two lamellae of *Undella* are very well defined and conspicuous. *Xystonellopsis* is in part very similar to the genus *Xystonella* (Bdt.) LAACKMANN, but different from that genus in having the same thin-walled mouth as in (most species of) *Undella*, not the broad, channelled (double-rimmed) one, as in *Rhabdonella* and *Xystonella* (here below). In *Epiplocyclus*, the same two conspicuous lamellae as in *Undella* are seen in the upper half of the lorica, in the lower, however, the outer lamella shows a coarse reticulation of excavated meshes, at the bottom of which it is nearly clapped down upon the inner lamella.

The old-established genus *Cyttarocyclus* was already limited by LAACKMANN (1911) to comprise only the two species *C. cassis* and *C. eucecryphalus* (*C. plagiostoma*). It belongs to a natural series of genera, in which the lorica in its uppermost part is provided with a "collar", more or less distinctly set off from the "body" by an inward protruding edge. In this series we find the well-established genera *Dictyocysta* and *Petalotricha*; as regards the genus *Codonella*, I have removed from it a series of species with an "annulated" collar — *C. orthoceras* etc. — under the newly proposed name of *Codonellopsis*. For the rest of the earlier genus *Cyttarocyclus*, after further removing of *Coxiella* and *Xystonella* (with *Xystonellopsis*), I have proposed the name *Favella*. A transition to the single-walled genera is formed by *Undella azorica* Cl. (or properly by some of its forms) which I have provisionally listed as a species of *Favella*, by the isolated *Tintinnus subulatus* Ehrb., for which I have proposed the new name *Helicostomella*, also including some other species with a lorica "annulated" above (but without a collar), as well as by *Amphorella mediterranea*, another isolated species, for which I have proposed a provisional new name, *Metacyclus*. Perhaps both this latter species and the above mentioned *Favella azorica*, or those "forms" of it, may be included in the proposed genus *Helicostomella*. Further I may mention that the singular species *Coxiella scalaria* has provisionally been placed in a separate genus, *Climacocyclus*.

Among the loricae with a simple (single) wall it will be natural to include *Tintinnus lusus-undae* and the similar, closely allied tubular loricae in a special genus *Tintinnus* Schrank, Daday, a generic group, also well defined on account of the organization of the animalcules. *Tintinnus acuminatus* and similar forms also possess a normal posterior aperture, but their loricae differ essentially in shape and development; I have therefore placed them in a special genus, for which I have proposed the name *Salpingella*. BRANDT and, after him, LAACKMANN seem to lay no special weight on this normal posterior aperture, obviously because of different other species, *Tintinnopsis "aperta"* and *T. "fracta"* (see below under *T. radix*) as well as *Rhabdonella spiralis* and sometimes *Cyttarocyclus cassis* (see fig. 90 p. 78) being occasionally found with a fine or irregular aperture at the end of the tail-like prolongation of the lorica.

The most primitive types of loricae are found in the genera *Tintinnus*, as defined above, and *Amphorella*. This latter genus still remains a rather artificial one, including many, as yet little known, species of small size, as well as forms differentiated in different directions. It contains, perhaps, the most ancient forms, connecting different genera, f. i. *Amphorella simplex* Cl., a form, transitional to the characteristic and easily distinguished genus *Rhabdonella*. This genus is nearly allied to the genus *Xystonella*, but differs in having many longitudinal, slightly elevated plicae on the outer lamella. The wall is obviously double towards the channelled mouth, less distinctly so below. *Amphorella simplex* is, however, single-walled and has only few striae or low plicae, and there is no channelled mouth. For this species and a nearly related one, more similar to a small species of *Rhabdonella*, I have proposed the new genus

Protorhabdonella. In this connection it is of interest to find, also in the genus *Amphorella*, a transition to the channelled mouth of *Rhabdonella* (see *Amphorella torulata* and *A. oxyura*, figs. 23, 24).

The genus *Tintinnopsis* seems to contain at least two different genera or series of species, one around the higher developed *T. campanula*, with tentaculoids and an "annulated" lorica, another comprising more simple forms, without "annuli" (i. e. helicoidal spiral). A few words may here be added in regard to these "annuli" which — when distinctly visible near the oral aperture — have always proved to be no true rings, but parts of a single helicoidal band. BRANDT speaks, in this connection, of a "Spiralleiste" between both lamellae, often calling it a "Verstärkungsleiste". Though this "Leiste" properly speaking is only formed by the — frequently somewhat protruding — upper sides of the different turns of the spirally twisted band, BRANDT is certainly right in assuming that it is just this intermediate firmer layer which gives the band its value as a support. The close-set lamellae at the mouth of loricae in *Undella* and *Xystonellopsis*, and at the bottom of the meshes in *Epiplocylis* probably act in the same way; they will prevent a displacement. It may therefore be expected that, in cases where the growth in length takes place more rapidly and continually, or a special supporting of the wall is not needed, the limiting lines between the successive turns may soon become indistinct or disappear. If this is correct, there may be no essential difference between the "annulated" and the not "annulated" loricae — or parts of loricae — in regard to their formation.

For the species *Tintinnopsis ventricosa* and *T. nucula*, which have firmer loricae and a narrow, thin-walled collar round the constricted mouth, I have proposed the new generic name *Stenosemella*. FAURÉ-FREMIET (1924 p. 96) describes and figures the animalcule, which seems sufficiently different from those of the commoner species of *Tintinnopsis* to justify the separation.

KEY TO THE GENERA.

- A. Lorica not "annulated" (save in *Favella ehrenbergi* var. and *F. azorica* var.).
- I. Wall single (simple) or not with distinct and well separated limiting lamellae.
 - a. Lorica always open below (posteriorly), without caudal prolongation.
 1. tubular, everywhere thin-walled *Tintinnus*.
 2. trumpet-shaped, at the dilation above more or less thick-walled *Salpingella*.
 - b. Lorica not open below, or occasionally with a small opening at the end of a caudal prolongation,
 1. with agglutinated "foreign bodies" *Tintinnopsis*,
 2. without — — — *Amphorella*, *Protorhabdonella*.
 - II. Wall double, with two well defined and separated lamellae.
 - a. Lorica with two collars, the upper dilated above *Petalotricha*.
 - b. — — only one collar, or, when two, the upper narrowed above.
 1. Collar with 5 to 20 large "windows" *Dictyocysta*.
 2. — without large windows.
 - α. Lorica with a reticulated structure, without "foreign bodies" *Cyrtarocylis*.
 - β. Lorica with a different structure, usually or frequently with agglutinated bodies.
 - * Collar very low, rather inconspicuous *Stenosemella*.
 - ** Collar large and conspicuous *Codonella*.
 - c. Lorica without a collar.
 1. Lamellae and their interstice without structure, or only with a fine "primary" one.
 - α. Caudal prolongation with a lance-socket *Xystonellopsis*.
 - β. No lance-socket *Undella*.

2. Outer lamella all over with more or less anastomosing, longitudinal plicae (ribs); mouth channelled *Rhabdonella*.
 3. Outer lamella below coarsely reticulated, above as in 1.; mouth not channelled. *Epiploeylis*.
 4. Outer lamella with a more or less coarse, "secondary" structure; no longitudinal plicae, at any rate in the upper half of lorica.
 - a.* Mouth of lorica channelled (double-rimmed) *Xystonella*.
 - β.* — — — simple, not channelled *Favella*, *Porococcus*.
- B. Lorica "annulated" (i. e., with a helicoidal band), at any rate towards the mouth.
- I. Wall simple (single) or without distinct or well separated lamellae, with a fine or indistinct structure.
 - a. Lorica without "foreign bodies", diaphanous,
 1. "annulated" only in the upper half or towards the mouth.
 - a.* No collar *Helicostomella*.
 - β.* A low, "annulated" collar, rarely simple *Metacylis*.
 2. "annulated" all over (formed by a single helicoidal band) *Protocochliella* (see *Coxliella*).
 - b. Lorica with agglutinated "foreign bodies" *Tintinnopsis*.
 - II. Wall with two distinct and well separated lamellae, with a more or less coarse "secondary" structure or with "foreign bodies".
 - a. Lorica with an "annulated" collar, but not "annulated" "body" *Codonellopsis*.
 - b. Lorica without a collar, "annulated" all over, with a "secondary", almost regular structure.
 1. Lorica only open above; no coarse helicoidal rib on its outer side *Coxliella*.
 2. Lorica frequently also open below, with a large helicoidal rib outside *Glimacocyliis*.

II. THE SPECIES FOUND IN THE MATERIAL OF THE "THOR".

TINTINNUS Schrank.

Loricae plainly tubular, wall thin, simple, without visible structure or only with very fine "primary" reticulation. Animalcule fixed by a (simple or branched) thin pedicle to the lateral wall of the lorica; when disturbed, it leaves its house through the posterior aperture. Adoral membranelles 18 (DADAY, FAURÉ-FREMIET); normally 4 macro- and 2 micronuclei present (DADAY, ENTZ JUN., BRANDT, FAURÉ-FREMIET). Peristome-collar with more or less long-peduncled tentaculoids and rounded lobes, alternating with the membranelles (SCHWEYER, FAURÉ-FREMIET).

1. TINTINNUS LUSUS-UNDAE Entz (Figs. 1—4).

Entz (sen.) 1885 p. 202, pl. 14, fig. 12.

This species and the following, *T. fraknoi*, are nearly allied and so closely connected by intermediate forms, that it is very difficult to draw any line of separation between them. The present species being, however, the first established, it seems to me most correct to include in it all the forms which

seem to be naturally and closely allied to it, even if they are in certain respects similar to those of the following species.

According to the figure and description in ENTZ, the form which should be considered the main species (fig. 1) is a large one, somewhat resembling the following species. It is tubular and nearly cylindrical, slightly increasing in diameter towards the upper end, here, however, by evenly arched outlines dilated to an obliquely spreading orificial border. Wall throughout simple and devoid of structure, or with scarcely discernible "primary" reticulation.

Length $210\ \mu$ — $230\ \mu$, oral diameter $51\ \mu$ — $55\ \mu$, aboral diameter $30\ \mu$ — $31\ \mu$. A longer form (forma *longa*) is considerably lengthened, $246\ \mu$ — $280\ \mu$, with an oral diameter of $49\ \mu$ — $57\ \mu$, and an aboral diameter $32\ \mu$ — $34\ \mu$. It is all together a characteristic feature of the present and the following species, as

also of the species of the next following genus, that the length of lorica is considerably varying, while the diameter and the shape keep much more uniform.

Port Alice, 12, 14, 15, 16, 18, 20, 23, 25, 26, 28, 29, 31, 33, 36, 38, 40, 42, 46, 55; 126 (0 m., 200 m.—100 m., 500—120 m., 275 m. wire), 152 (950 m. wire), 156 (250 m. wire, 950 m. wire), 158, 160 (0 m., 100 m.—30 m.), 161, 163 (0 m., 80 m.—0), 170 (20 m.—0, 80 m.—20, 1000 m.—195), 174, 175 (30 m. wire, 350 m. wire, 1150 m. wire.), 181, 182 (0 m., 545 m. wire), 183, 184 (0 m., 945 m. wire), 185, 186 (245 m. wire, 1145 m. wire, in salpæ), 187 (945 m. wire), 192 (545 m. wire), 194 (0 m., 1145 m. wire), 196, 197, 198, 199 (0 m., 30 m.—0, 200 m.—80, 945 m. wire), 200, 202, 204, 206 (1945 m. wire), 209 (80 m.—33, 200 m.—85, 1945 m. wire), 210, 213, 218, 221, 223 (1945 m. wire), Gibraltar. Never numerous and very often but singly.

This species was discovered by ENTZ at Naples. Otherwise it is widely distributed in the Atlantic, from 41° S (6° E), through the warmer regions to the northern part of the Florida Current, but in the colder northern waters seems to be replaced by the following variety. Also widely distributed in the Indian Ocean; in the Pacific it was taken at New Pomerania (BRANDT 1907).

Var. *tubulosus* (Ostf.) (Fig. 2).

Tintinnus tubulosus Ostenfeld 1899 a, p. 63, 1899 b, p. 439 fig. f (p. 437). *Tintinnus lusus undae* Daday 1887 pl. 18, figs. 3, 14.

Lorica quite evenly and slightly narrowing from the mouth to the posterior end, with (almost) perfectly straight lateral outlines. At the oral aperture a more or less distinct, narrow, almost divaricated border. Considerably smaller than the main species, length $94\ \mu$ — $150\ \mu$, diameter of mouth $32\ \mu$ — $44\ \mu$, of the posterior end $21\ \mu$ — $36\ \mu$.

This smaller form is less frequent in the Mediterranean. I have only noted it for sts. 14, 25; 79, 80, 91, i. e. for two stations (in the Adriatic and off Naples) in winter, besides for the Bays of Cadiz and Biscay in June. In our northern waters it is the most frequent form, usually the only form present, very rare on the west coast of Norway and in Skagerrack, in the open sea to 63° N.

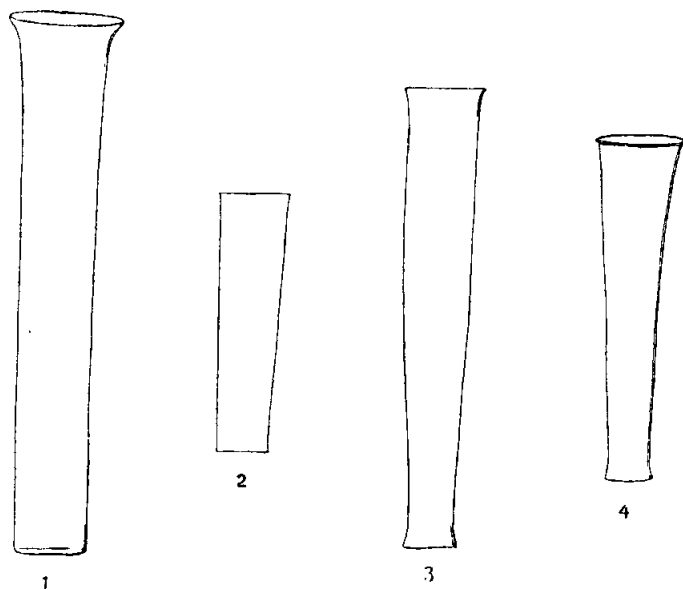


Fig. 1. (Lorica of) *Tintinnus lusus-undae* Entz; $350/1$. St. 16. In this and many of the following figures the optical section is shown at the right side only, in others at both sides or at the left. Fig. 2. *Tintinnus lusus-undae* Entz., var. *tubulosus* (Ostf.); $350/1$. St. 79. Fig. 3. *Tintinnus lusus-undae* Entz., var. *elegans* n. var.; $350/1$. St. 28. Fig. 4. *Tintinnus lusus-undae* Entz., var. *macilentus* n. var.; $350/1$. St. 182, 545 m wire.

Var. **elegans** n. var. (Fig. 3).

Sts. 25, 28, 29, 31, 33, 36, 38, 42; 91, 126 (275 m. wire), 182 (545 m. wire), 184 (945 m. wire), 186 (in Salpae), 199 (200 m.—80 m.), 206 (0 m., 1945 m. wire).

Lorica towards the mouth dilated — as in the main species — with arched outlines, with an obliquely or transversely outwards directed orificial border or rim, then of equal breadth to the middle or somewhat farther, and then again narrowing towards an unwidened or rapidly somewhat widened posterior end.

Length $147\ \mu$ — $190\ \mu$, diameter of mouth $37\ \mu$ — $53\ \mu$, diameter of the aboral end $20\ \mu$ — $34\ \mu$.

This beautiful form is somehow intermediate between smaller forms of the main species and the following variety. It varies considerably in length and width.

Var. **maclentus** n. var. (Fig. 4).

Tintinnus lusus undae var. *c* and *T. fraknói* var. *c*. Brandt 1906—1907 pl. 65, figs. 12, 16, 19, 20. *T. emarginatus* var. *b*. Brandt 1906 pl. 65, fig. 15.

Lorica above more or less evenly and conically dilated by almost straight laterally outlines and usually spreading (narrow) orificial border, then considerably narrowing, in the lower half frequently of almost equal breadth to the very end, or here again somewhat wider.

Length $142\ \mu$ — $290\ \mu$, diameter of mouth $39\ \mu$ — $54\ \mu$, diameter of the aboral end $23\ \mu$ — $26\ \mu$.

BRANDT's two forms, which are somewhat similar to the preceding variety, but of a less regular shape (and beautiful appearance) seem to me naturally to belong to the older and smaller species. BRANDT (l. c.) refers them partly to the present and partly to the following species, making a slight dilation of the posterior end the deciding character for *T. fraknói*.

This last mentioned variety, which I have only noted from st. 182, 545 m. wire, where it occurred together with the preceding variety, I have also seen from Tortugas. BRANDT figures it from the Atlantic, south of the Cape Verde Islands, from New Zealand and from New Pomerania.

2. TINTINNUS FRAKNÓII Dad. (Figs. 5, 6).

Daday 1887 p. 528, pl. 18 fig. 1.

Lorica much larger than in the preceding species, towards the mouth more slowly and conically dilated, usually with a narrow, but distinctly visible and spreading rim at the mouth. Downwards the lorica is slowly narrowing, but towards the aboral end again more rapidly and distinctly dilated.

Length $348\ \mu$ — $493\ \mu$, diameter of mouth $62\ \mu$ — $68\ \mu$, of aboral end $35\ \mu$ — $42\ \mu$. The particular long forms are not correspondingly broader at the ends, and may be designated by a special name, *f. elongata* (fig. 5 b).

A shorter and broader form is

Var. **latus** n. var. (Fig. 6).

The smallest diameter of the lorica is situated farther from the aboral end, and the lorica is more gradually dilated below.

Length $353\ \mu$ — $404\ \mu$, diameter of mouth $74\ \mu$ — $79\ \mu$, of aboral end $51\ \mu$ — $57\ \mu$, minimum diameter $38\ \mu$ — $47\ \mu$.

This is a common warm-water species which was taken at nearly all stations in the Mediterranean, in winter from the innermost stations to Bay of Cadiz, in summer from the north-western coast of Portugal (st. 81, 100 m. wire) to the Sea of Marmora, in the surface as well as below. It was generally present in rather small numbers, especially in winter, when it only occurred at st. 16 (Eastern Mediterranean) in

somewhat greater numbers. In the Bay of Cadiz in February it was only present in small numbers at st. 68, being absent in the Atlantic Current, save at st. 53, but appearing again near the south coast of Spain. During the summer cruise it was taken abundantly at sts. 87, 89 on the south-west coast of Portugal — being there the predominating species (of Tintinnids) — as well as in the Bay of Cadiz, also there the predominant species at sts. 94, 95 and 98, close to the Straits of Gibraltar, in June. The transference to the Mediterranean waters seems at this time fatal or difficult, the species immediately becoming very scarce and often lacking along the African coast. From st. 112 forwards, it is, however, present nearly everywhere, generally sparsely, sometimes (at st. 131) in great numbers. During the return voyage it was again very scarce near to the Straits, being, however, present at both stations in the Bay of Cadiz — here, at st. 231, more numerous at deeper levels — and following up to st. 237, off the north-west coast of Portugal.

Is certainly indigeneous in the Mediterranean; an immigration into the Mediterranean through the Straits could be traced, but was apparently of no greater significance. It seems to multiply in a noticeable degree at times, but the material shows no proper swelling up in numbers save in Bay of Cadiz.

Was in the first instance detected in the Mediterranean by DADAY, and later recorded from that sea by many authors. In the Atlantic it is common throughout the warmer regions, from 29° S to 33° N in the Florida Current and probably farther north. It is also widely distributed in the Indian Ocean and in the Pacific.

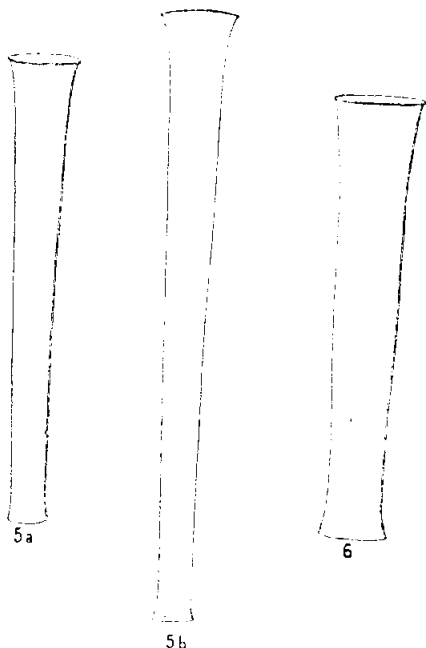


Fig. 5a. *Tintinnus franköii* Dad., main species; ¹⁷⁵/₁. St. 152, 950 m. wire. Fig. 5b. *Tintinnus franköii* Dad., *f. elongata* n. f.; ¹⁷⁵/₁. St. 152, 250 m. w. Fig. 6. *Tintinnus franköii* Dad., *var. latus* n. var.; ¹⁷⁵/₁. St. 152, 950 m. wire.

3. TINTINNUS INQUILINUS (O. F. Müll.) Schrank (Fig. 7).

Trichoda inquilina O. F. Müll. 1786 (p. p.?). *Tintinnus inquilinus* Daday p. 528, pl. 18 fig. 2; Brandt 1906/7 pl. 65 fig. 14 ("T. lusus undae var. a tubulosa").

Lorica — in the two specimens which I saw in the material of the "Thor" — slowly narrowing from the mouth to near the

aboral end, where it is rapidly constricted to a short tubular portion, only half as wide as before.

Length 89 μ —94 μ , diameter of mouth 36 μ —40 μ , of aboral end 19 μ —21 μ .

I saw it only from st. 28 and from Salpae, taken at st. 186.

This species, which I have not met with otherwise, is presumably a neritic one; it is reported to occur frequently fixed between the setae of *Chaetoceros*. According to PAVILLARD (1916 p. 44) this may also be the case with *Tintinnus lusus undae*, which is also stated sometimes to occur fixed to *Hemiaulus*.

Tintinnus emarginatus Bdt., *T. angustatus* Dad., *T. datura* Bdt.

These three species are also recorded from the Mediterranean, the first and the last mentioned as taken by LOHMANN at Messina (BRANDT 1907), the second described by DADAY (1887) as a new species from Naples. I have seen none of them, but should be inclined to believe that the first one, only differing from *T. franköii* in the possession of longitudinal plicae and irregular oral and aboral apertures, might only be an artificial form of the latter species, produced by shrinkage in certain mounting or preserving substances (see *T. undatus*, under *Salpingella acuminata* p. 14). The second, *T. angustatus*, seems only to be a form of *T. inquilinus*, the third, however, *T. datura*, looks



Fig. 7.
Tintinnus inquilinus
(O. F. Müll.) Schrank;
³⁵⁰/₁. a in Salpae,
st. 186. b st. 28.

more like a well distinguished species, different from *T. franköü* in having considerably elevated longitudinal plicae, remarkably large oral but small aboral, aperture and two macronuclei (?; LAACKMANN 1911 p. 484 finds 4 or 3).

SALPINGELLA n. gen.

Lorica dilated above to a more or less trumpet-shaped anterior portion, then more or less long tubular, below plicate and narrowing to an open aboral end of very small diameter. Wall of lorica as in *Tintinnus*, but generally more or less thickened at the dilated mouth, here showing more or less developed or thickened limiting lamellae.

The animalcule has two macro- and two micronuclei.

1. SALPINGELLA ACUMINATA (Clap. et Lachm.) (Figs. 8, 9).

Claparède et Lachmann 1858 p. 199, pl. 8 fig. 5. *Tintinnus Möbii* Brandt 1896 p. 50: *T. secatus* Brandt l. c. p. 51, pl. 3 fig. 12. Brandt 1906 pl. 67, figs. 2-6, 10, 11; *T. acuminatoides* Laackmann 1911 p. 480, pl. L fig. 6.

Sts. 11, 14, 16, 18, 23, 24, 25, 26, 27, 28, 29, 31, 33, 35, 38, 40, 45, 55, 68; 80, 81, 92, 126 (275 m. wire), 129 (600 m.—0, 1100 m.—0), 134 (75 m.—0, 125 m.—75, 200 m.—125), 152 (950 m. wire), 156 (250 m. wire), 170 (80 m.—20, 200 m.—85), 175 (350 m. wire, 1150 m. wire), 182 (545 m. wire), 184 (945 m. wire), 186 (245 m. wire and in salpæ), 187 (945 m. wire), 189 (945 m. wire), 194 (0 m., 1145 m. wire), 199 (200 m.—80, 945 m. wire), 209 (80 m.—33, 200 m.—85, 1000 m.—200), 218, 220, 234 (25 m.—0, 200 m.—95, 700 m.—200).

This rather common and widely distributed species is very varying. The lorica was at first figured with an acute and closed posterior end (CLAPARÈDE et LACHMANN l. c., ENTZ sen. 1885 pl. 14 fig. 13), which is easily comprehended, this posterior end being pallid and inconspicuous, especially in certain mounting substances. This caused the establishing of the new name *T. Möbii*; a form with a closed end was never found. The lorica, however, varies considerably in length, in the development of the anterior dilated portion and in the degree of thickening there, in the diameter of lorica, in the length of the posterior, plicate portion, as well as in number and length of the plicae. These variations may occur in allied forms from the same locality; there are, however, also considerable differences between forms from warmer and forms from colder regions. On account of these great variations, in the northern waters as well as in the Mediterranean, I have thought it most convenient to try to gather the more important forms under a common name; the distinction of species being otherwise more or less arbitrary and vague.

In this comprehensive sense the species is spread almost over the whole Atlantic, from about 18° S (German South-Pole Exp. ²⁶/₈ 1903) to 80° N (13° E). It is also known from the Indian Ocean, from its antarctic regions (German South-Pole Exp., Gauss-st.), as well as from its tropical area (CLEVE 1901 d, BRANDT 1907). Also taken in the Pacific on the coasts of Japan (OKAMURA 1907).

The main species (CLAPARÈDE et LACHMANN l. c., see JÖRGENSEN 1899 p. 8, pl. I fig. 1, and BRANDT 1907 p. 388, p. 66 fig. 3) which is common in the northern temperate regions of the Atlantic, though generally scarce, seems not to occur in the Mediterranean or only exceptionally and in doubtful forms. In the material of the "Thor" I have only from one or two stations (134, 200 m.—125 m.; 152, 950 m. wire) and singly seen a form which I might refer with some doubt to the main species. When BRANDT (l. c. p. 389) reports this form from many localities in the warmer regions of the Atlantic (Sargasso Sea and North Equatorial Current) this is certainly caused by a different definition of the main species in regard to the following subspecies. This may also be seen from the dimensions quoted by BRANDT; he states the length of lorica in the main species to be 200 μ —370 μ , whereas I myself rarely found as much as 300 μ , exceptionally 310 μ .

Subsp. *glockentögeri* Brandt (1907 p. 390, as var., pl. 67 figs. 7, 8, pl. 68 figs. 1—5).

Lorica of greater length than in the main species (252μ — 433μ , usually over 300μ) diameter of mouth less great, border markedly spreading or mostly recurved, wall (above) usually less or faintly thickened. Younger(?) loricae apparently have a less broad and less spreading rim of mouth and faint, if any, thickening of wall.

The whole material of the "Thor", only the couple of individuals above mentioned excepted, belongs to this subspecies. There are, however, two forms, or series of forms, which are as a rule fairly easily distinguishable. One of them answers to the first figure in BRANDT, quoted above, pl. 67 fig. 7 = pl. 68 fig. 5; it may therefore be considered the type of the subspecies. The other is

Var. *attenuata* n. var. (Fig. 9).

Differs from the type of the subspecies in having almost straight plicae, extending farther upwards and giving the lorica the appearance of being very gradually narrowed towards the aboral aperture. The oral rim is also usually or very frequently only spreading (divaricate or slightly upwards directed, almost as in the northern main species), not reflexed. Sometimes the upper half of the lorica is slightly wider than the lower. The plicate part below nearly always makes more than $\frac{1}{3}$ of total length, while in the typical form of the subspecies, var. *glockentögeri* s. str., it is shorter, usually less than $\frac{1}{4}$.

Length 255μ — 433μ , diameter of mouth 30μ — 42μ , diameter of lorica in the middle 14μ — 25μ , number of plicae 5 or 6, the exact number being somewhat uncertain.

This variety, which is the most frequent Mediterranean form of the present species, answers very well to the figure 2, pl. 68 in BRANDT (l. c.), from New Pomerania, and to figs. 3, 4, from Messina. It is considerably varying in the respects mentioned above, and may scarcely be considered quite distinct from the preceding form; it is, however, nearly always easily distinguished. *Tintinnus acuminatoides* Laackm. (l. c.) answers in part to certain forms of the present variety, f. i. his fig. 7 on pl. L. var. *secata* Laackm., with a very short tubular antapex; this "species", however, scarcely possesses any other distinguishing character in comparison with his other species, *Tintinnus acuminatus* and *T. glockentögeri*, than the narrow, frequently more or less upwards directed rim of mouth, a variation also occurring in the other forms and very probably connected with the less pronounced thickening of wall. If such a form, narrower and with a more upward directed rim, should prove to be not only an accidental one it might be referred to as var. *acuminatoides*.

The animalcule of var. *attenuata*, as well as of the other forms of the present species, has 2 roundish makronuclei and presumably 2 micronuclei.

Occasionally and singly a striking form of this species, f. *undata* JÖRGENSEN (1900 p. 95 as var.), is met with. I cannot follow BRANDT (l. c. p. 391, pl. 67 figs. 2—6, 10, 11), in considering this form a separate species; on the contrary, I have got the impression that it is only an accidental form, probably or partly an artificial one, caused by the collapsing of the stiffly expanded orificial rim (by certain preserving or mounting fluids or less effective thickening). It is suggestive in this connection that this form, with an irregularly plicate or apparently coarsely dentate orificial rim, of a smaller diameter than usual,

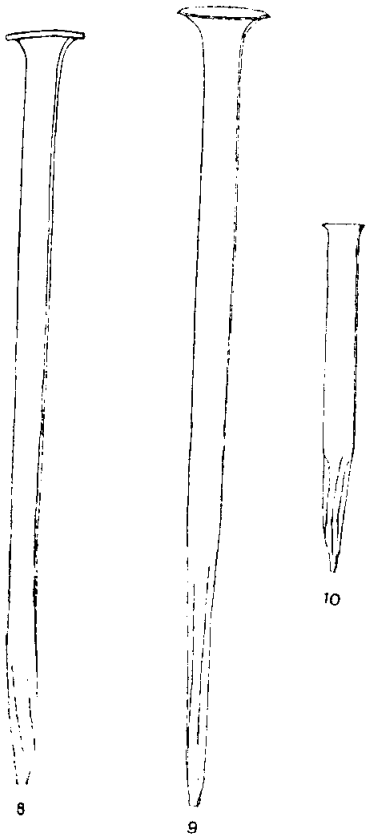


Fig. 8. *Salpingella acuminata* (Clap. et Laackm.), subsp. *glockentögeri* Bdt.; 350μ , St. 28. Fig. 9. *Salpingella acuminata* (Clap. et Laackm.), (subsp. *glockentögeri* Bdt.) var. *attenuata* n. var.; 350μ , St. 28. Fig. 10. *Salpingella decurtata* n. sp.; 350μ , St. 26.

is met with in the northern form, as well as in the subspecies *glockentögeri* and its 2 (or 3) forms (see also LAACKMANN l. c. pl. L fig. 5).

From the winter material of the "Thor" the present species proved to be spread throughout the explored regions of the Mediterranean, occurring in all at 18 of the 37 stations, most frequently in the Tyrrhenian Sea — where only absent at two stations — very rare farther west. It was generally very scarce, or found singly, at st. 26 present in somewhat greater numbers, optimum at st. 26 (var. *attenuata*). In summer it showed a similar distribution throughout the Mediterranean as far as into the Sea of Marmora (in deep layers); everywhere, however, only in deeper — mostly very deep — layers, save at two western stations on the coast of Africa, in September. A considerable immigration into the Mediterranean from the Atlantic may be traced in January and perhaps in September.

According to the data stated, *Salpingella acuminata* subsp. *glockentögeri* is probably to be considered indigenous or, at any rate, always present in the Mediterranean in deeper layers. It seems to get in from the Atlantic from late autumn to winter, and to be able to propagate there, but disappears from the surface in late winter, and in summer is only present in deeper layers.

It was recorded for the first time for the Mediterranean by ENTZ sen. 1885 (p. 201, pl. 14 fig. 13); his figure seems to represent var. *attenuatus*.

2. SALPINGELLA DECURTATA n. sp. (Fig. 10).

Sts. 11, 14, 26, 28, 29, 31, 33, 40, 55, 68; 156 (250 m. wire), 184 (945 m. wire), 186 (245 m. wire and in Salpæ), 196, 199 (200 m.—80), 206 (1945 m. wire), 216, 218.

Besides the large and very long forms belonging to the preceding species, a very small one occurred more rarely in the Mediterranean (samples). Lorica similar in form to that of *Salpingella acuminata*, but less dilated above, with a narrow and outward bent rim of mouth, without a thickening of the wall or with only a faint or indistinct one. The aboral aperture is very narrow, narrower than in the preceding species, the plicate portion, however, similar in both. The number of plicae usually appears to be 4—6, sometimes more, up to 8; these numbers should, however, be considered uncertain. The plicae in all forms of the preceding species seem to be dextrorse — as in an ordinary screw, running upwards to the right, seen in front — in the present species they seem, however, to be twisted in the opposite direction. This may, however, also be left for further verification.

Among the many individuals which I saw of this species, there was only a single one, considerably larger than the usual, which might be considered uncertain and perhaps intermediate to small forms of the preceding species. The others were always quite distinct and obviously different.

Length $128\ \mu$ — $150\ \mu$, diameter of mouth $16\ \mu$ — $23\ \mu$, of lorica in the middle $12\ \mu$ — $16\ \mu$; length of plicate portion $\frac{1}{3}$ — $\frac{1}{4}$ of total length of lorica.

This species was relatively most frequent in the winter plankton; in summer it was (apparently) very rare, and for the most part found only in deeper layers, like the preceding species. It was always very scarce; in Bay of Cadiz it was only taken at one station, in February, in the Atlantic Current only at one station in September.

As yet not otherwise known; it is, however, so small that it is probably much more frequent than samples taken with plankton nets would show.

AMPHORELLA Daday 1887.

Lorica closed at the posterior end. Wall as in *Tintinnus*, thin and simple (single), but frequently thickened above, very rarely in the middle; at these thickenings a more or less distinct outer and a similar inner lamella may be discerned, separated by an intermediate layer, apparently of a less firm consistence. No structure visible, or, at most, a very fine "primary" one.

The loricae in this genus often or generally seem to be very light and but little rigid; they are therefore frequently stiffened by ribs in the wall or plicae, sometimes with a thickened keel, or by a thickened and sometimes swollen caudal appendage.

This genus *Amphorella* seems to comprise a great many small species, hitherto only accidentally met with. It is, as here interpreted, still rather heterogeneous, showing connections with several of the other genera (*Favella*, *Undella*, *Rhabdonella*, *Tintinnopsis* and *Codonella*) by corresponding, but more primitive, forms.

The animalcule seems normally to have 2 macro- and 2 micro-nuclei (LAACKMANN 1911), answering to what is the case in most genera of Tintinnids.

1. AMPHORELLA QUADRILINEATA (Clap. et Lachm.) Jörg. (Figs. 11—13).

Jørgensen 1899 p. 12, pl. I fig. 2. *Tintinnus quadrilineatus* Claparède et Lachmann 1858 p. 201, pl. 9 fig. 3; *T. amphora* ibid. p. 199, pl. 8 fig. 3? *T. amphora* Brandt 1907, incl. vars. a, b (vix c), pl. 69 figs. 3, 4, 6, 7.

Sts. 11, 12, 14, 16, Naupaktos, 20, Taormina, 24, 25, 26, 28, 29, 31, 33, 36, 38, 39, 55, 62, 66, 68, 69; 79, 80, 126 (275 m. wire), 129 (80 m.—0 m., 600—0, 1100—0), 152 (250 m. wire, 950 m. wire), 154, 156 (250 m. wire, 950 m. wire), 160 (200 m.—100 m.), 165, 167, 170 (80 m.—20 m.), 175 (350 m. wire), 185, 186 (245 m. wire, 1145 m. wire), 187 (945 m. wire), 189 (945 m. wire), 194 (0 m., 1145 m. wire), 204 (1145 m. wire), 206 (0 m., 1445 m. wire), 209, 210, 215, 216, 218, 229, 231 (0 m., 1145 m. wire), 234 (25 m.—0 m., 100 m.—25 m.).

This species, widely distributed in temperate and warm seas, is now usually recorded as *Tintinnus* (or *Amphorella*) *amphora*, and I have myself (l. c.) pointed out that the latter species of CLAPARÈDE et LACHMANN may probably be the same as their *Tintinnus quadrilineatus*, established as a new species at the same time. It has, however, proved impossible to identify any Tintinnid occurring on the west coast of Norway with their figure quoted. Also, they state its length to be 200μ — 300μ , which is considerably more than the length of the greatest Norwegian forms. No corresponding form is found anywhere at all. The only safe specific name is therefore *quadrilineatus*; the corresponding figure in CLAPARÈDE et LACHMANN answers very well to the Norwegian forms, also in regard to dimensions (according to the magnification stated).

DADAY (1887) figures from the Mediterranean two forms (pl. 18 figs. 4, 5). Strange to say, he has not seen the three, well-defined longitudinal edges, so characteristic for this species, though he considers fig. 5 to be *Amphorella quadrilineata*. This figure of his is, however, so different from our Norwegian species that I have previously (l. c.) found it necessary to establish this form as a new species, *Amphorella dadayi*, whereas his fig. 4 obviously represents a form of the true *Tintinnus quadrilineatus*.

The present species proved to be rather frequent in the Mediterranean, particularly during the winter cruise, when it was present at 18 of the 37 stations there, though nearly always but singly or in very small numbers. It was relatively most frequent in the Tyrrhenian Sea; here also in somewhat greater numbers at two northern stations (31, 33). During the summer cruise it appeared sporadically throughout the Mediterranean, as far as into the Sea of Marmora, (in deeper layers), but proportionately less frequent than in winter, taken in all at 22 of the 102 stations, and nearly everywhere found for the most part only below the surface. Also in summer it was everywhere scarce, whilst at st. 80, in Bay of Biscay, it was rather plentiful.

In the material in question only a faint trace of immigration into the Mediterranean from the Atlantic, in September, is to be seen (present at st. 218 on the coast of Africa); in June the species was absent all the way from the Bay of Biscay to the Tyrrhenian Sea, and in February it was certainly present in Bay of Cadiz (almost everywhere), but absent in the Atlantic Current along the north coast of Africa. It is probably but rarely that it gets safely in through the Straits (in late autumn?) and may therefore be considered an indigenous Mediterranean species.

This is also apparent from the fact that it occurs in two rather different forms, connected by rare intermediate ones. One of them is a larger form (fig. 11), answering very well to *Tinlinus amphora* var. *brasiliensis* Laackm. (1911 p. 485, pl. L fig. 11), but also to the figure of *T. quadrilineatus* in CLAPARÈDE et LACHMANN, at any rate sufficiently to permit its being referred to the typical form of this widely distributed species. The special name var. *brasiliensis* ought, at any rate, to be abandoned — if not used as *a brasiliensis* for the main species — its distinguishing character, a vesiculous inward “dilation of the

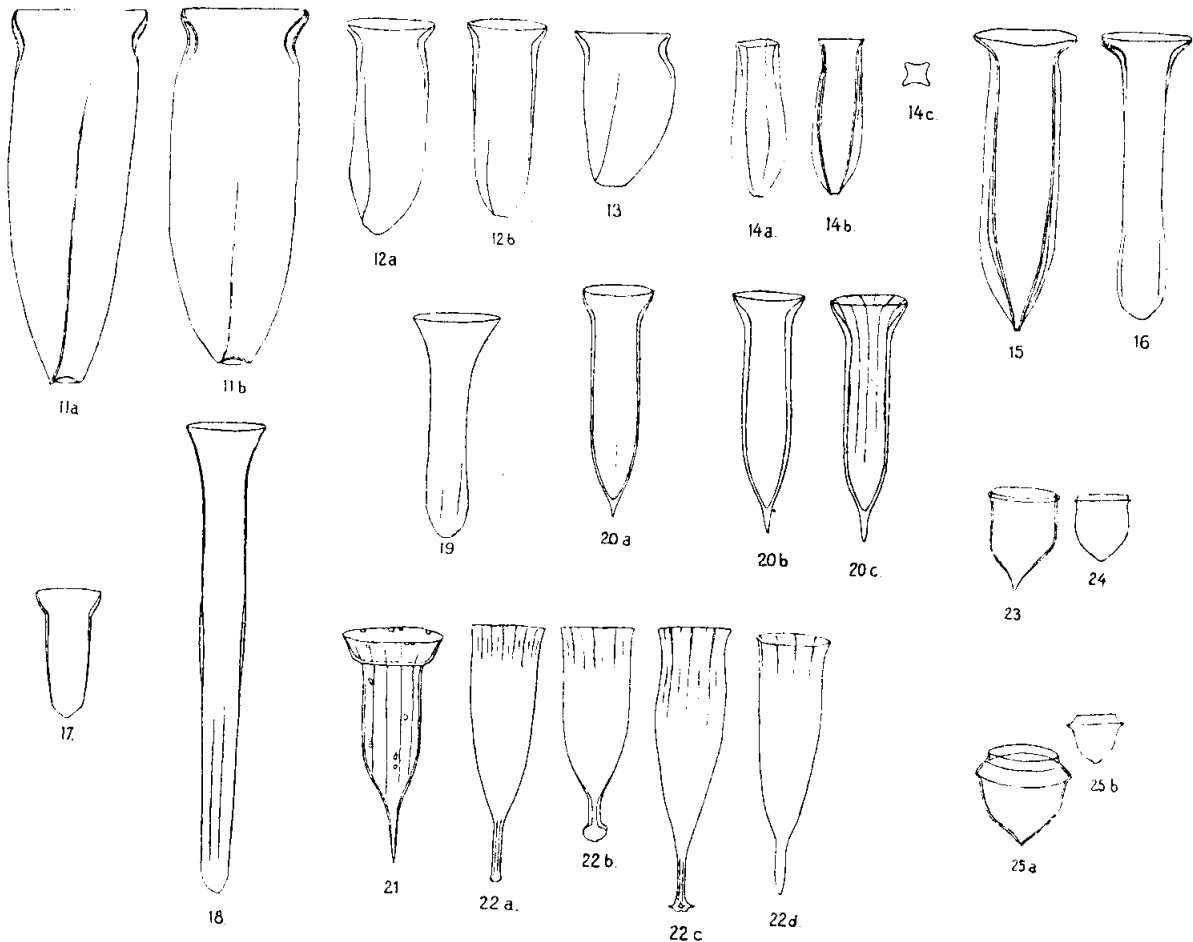


Fig. 11. *Amphorella quadrilineata* (Clap. et Lachm.); $^{350}/_1$. St. 26. a. Lorica resting on a face, b. on an edge. Fig. 12. *Amphorella quadrilineata* (Clap. et Lachm.) var. *minor* n. var.; $^{250}/_1$. a st. 26, b st. 38. Fig. 13. *Amphorella quadrilineata* (Clap. et Lachm.); $^{350}/_1$. St. 38. A small, deviating form. Fig. 14. *Amphorella laackmanni* n. nom.; $^{350}/_1$. St. 186, in Salpæ. In fig. b the inner optical longitudinal section is shown. c showing the supposed shape of a cross-section of lorica in its lower portion. Fig. 15. *Amphorella tetragona* n. sp.; $^{350}/_1$. St. 206, 945 m. wire. The (inner) optical longitudinal section is shown. Fig. 16. *Amphorella steenstrupi* (Clap. et Lachm.) Dad.; $^{350}/_1$. St. 25. Fig. 17. *Amphorella pyramidata* n. sp.; $^{350}/_1$. St. 186, in Salpæ. Fig. 18. *Amphorella intumescens* n. sp.; $^{350}/_1$. St. 156. Fig. 19. *Amphorella gracilis* n. sp. ad int.; $^{350}/_1$. St. 187, 945 m. wire. Probably the upper half of an incomplete individual of *Amphorella intumescens*, perhaps of a lorica still unfinished. Fig. 20. *Amphorella pachylocus* n. sp.; $^{350}/_1$. a st. 186, in Salpæ; b st. 26, c st. 25. Fig. 21. *Amphorella trachelium* n. sp.; $^{350}/_1$. St. 206, 1945 m. wire. Fig. 22. *Amphorella ganymedes* (Entz sen.) Dad.; $^{350}/_1$. a and b st. 186, in Salpæ; b var. *bulbosa* (Bdt.). c var. *bulbosa* (Bdt.) st. 26; d *A. ganymedes* f. *acuta*. st. 218. Fig. 23. *Amphorella oxyura* n. sp.; $^{350}/_1$. St. 14. Fig. 24. *Amphorella torulata* n. sp.; $^{350}/_1$. St. 186, in Salpæ. Fig. 25. *Amphorella urceolata* (Ostf.); $^{350}/_1$. St. 187, 945 m. wire. b the supposed side view; not figured by means of camera lucida.

inner lamel” being only an optical delusion, frequently seen in larger forms of the present species and caused by the slightly irregular shape and oblique position of the truncate, triangular antapex, in connection with a strongly protruding longitudinal edge.

The other Mediterranean form (fig. 12) is much smaller, and has a more outward curved orificial rim. Its lorica is narrower at the constriction above, but otherwise of more equal width, or even slightly dilated below the middle, not almost conically narrowing as in the larger form. It is most easily known from the other form by the posterior end lacking the well defined large, triangular, truncate antapex of that form, but obtuse, with a small, truncate end, or often apparently somewhat rounded. It answers well to *Tintinnus amphora* in ENTZ sen. 1884, pl. 24 fig. 20, which he considers the same as *T. quadrilineatus* Clap. et Lachm., only lacking the "furrows".

These two Mediterranean forms do not answer well to the figures in DADAY (1887). The smaller one, var. *minor* n. var., is usually less than 100μ in length, about 80μ to somewhat over 100μ ($76-105\mu$) according to a smaller number of measurements, with a diameter of mouth about $40\mu-46\mu$, and with a secondary, often but slightly pronounced, maximum of diameter about the lower $\frac{1}{3}-\frac{1}{4}$, whilst the larger form usually is $140\mu-170\mu$ ($120\mu-200\mu$, rarely still shorter), by a diameter of mouth = 50μ or more, a more upwards directed rim, with a secondary maximum of diameter slightly below the constriction (above), long and strongly developed plicae and a very conspicuous, truncate and triangular antapex, 15μ broad or more. LAACKMANN (l. c.) has stated the number of nuclei to be two macro- and two micronuclei, whereas DADAY (1887) gave it as four macronuclei.

FAURÉ-FREMIET (1924 pp. 110-112, fig. 111) found that the animalcule, fixed by a short pedicle at the truncate antapex, had when swimming a narrowly oblong shape, a slightly dilated and rather high peristome collar with rounded lobes, "about" 18 membranelles, a high, "moveable" piston and a more or less strongly oblique position of the peristome. The form figured by him is the same as the greater Mediterranean one.

In my opinion this well known form should be considered the main species. At any rate it will be necessary to abandon the *Tintinnus amphora* of CLAPARÈDE et LACHMANN as the type of species, considering that a corresponding form is not yet found, whereas the region in question has been very well explored. BRANDT, it is true, figures a great Atlantic form, identifying it, without an explanation, with the obscure species in question. I know this Atlantic form, which is very well figured (BRANDT l. c. fig. 6); it bears, however, no other resemblance to CLAPARÈDE's species than that of being a more lengthened form than the usual forms of *Amphorella quadrilineata*. It differs from the figure in CLAPARÈDE et LACHMANN in having a broader and much more strongly outward bent oral rim, a pronounced thickening of wall (above), a different shape in consequence of the secondary maximum of diameter being situated much farther down, and a different length, being proportionately great ($145\mu-190\mu$), but not yet great enough. I should propose to name this form var. *brandti* (of *Amphorella quadrilineata*).

In regard to the figures in DADAY (1887) LAACKMANN has already pointed out that the "var. *brasiliensis*" answers very well in shape to the fig. 5 in DADAY, his *Amphorella quadrilineata*. Having seen the material of the Thor, I agree absolutely with BRANDT in abandoning the name *Amphorella dadayi*, the figure in DADAY being very misleading as to details (no thickening above, evenly rounded posterior end etc.). BRANDT lists it as a special variety; it is, however, obviously a merely accidental form, differing from the larger of the two Mediterranean forms in its strikingly small dimensions (length 72μ) and a more pronounced constriction above. I have seen such a form or individual (st. 38), only 71μ in length, but generally answering to the larger Mediterranean form as well as to the fig. 5 in DADAY (see fig. 13).

The other figure (4) in DADAY is somewhat similar to var. *minor*, the dimensions (in DADAY) and the more erect orificial border answer, however, better to the larger form.

Both Mediterranean forms were present in winter as well as in summer, the var. *minor* chiefly in the inner regions as well as in the northern and north-western, the larger predominant or present alone outside the Mediterranean. During the summer cruise, the species being very rare at the surface, but frequent in deeper layers, var. *minor* was always apparently the only superficial form, while the larger, the main species, was found partly alone in the deeper waters, partly together with v. *minor*.

On this account it seems to me possible that the smaller form, v. *minor*, is a special warm-water form, indigenous in the Mediterranean and perhaps wholly or partly (i. e. originally) developed from invading larger forms, as particularly adapted for life in the surface. The larger forms, probably to a great extent only recently immigrated into the Mediterranean from the Atlantic, are in summer only present at deeper levels, particularly in the Eastern Mediterranean where they were found at nearly all stations where deep water samples were taken.

This species has a wide distribution in northern temperate waters, though generally occurring in very small numbers; the German "Plankton-Expedition" (1889) found it, however, abundantly in the Eastern Irminger Sea, south-southeast of Iceland. Otherwise it is known from numerous localities of the warmer and temperate Atlantic regions, all the way from 24° S, exceptionally 42° S, until far to the north. It is recorded for the Indian and the Pacific Oceans, but not for their cooler regions. It was already reported for the Mediterranean by ENTZ sen. (1884).

2. AMPHORELLA LAACKMANNI n. nom. (Fig. 14 p. 17).

Lorica beautifully urn-shaped, somewhat protracted, slightly and gradually dilated towards the mouth, with maximum of diameter about at the lower $\frac{1}{3}$; at the posterior end truncate. Lorica acutely quadrangular on account of four alary plicae, partly extending along the whole length, partly consisting of a longer portion, extending from the lower end up towards the constriction above, and a shorter upper, from the orificial border downwards, these two portions, apparently, not running exactly over into each other (see fig. 14a). On the optical cross-section (fig. 14c) the sides of lorica appear concave (outwards); in side view, two strong inner ribs or lines, with double outlines, appear, corresponding to the optical longitudinal section.

Length 66 μ , diameter of mouth 20 μ .

Only a couple of individuals seen, in stomachs of Salpae from st. 186 (Ionian Sea).

This species is so strikingly similar to the so-called *Tininnus amphora* var. *dadayi* LAACKMANN (1911 p. 486, pl. L fig. 12) that I must provisionally consider them synonymous, in spite of several noticeable differences, according to LAACKMANN'S description and figure. He finds 8 plicae, distinctly running from mouth to posterior end, but "not exactly straight", and describes the end of the lorica as obtusely pointed. By the very few individuals seen it is very well possible that the number of plicae may become greater on account of intermediate ones being developed, or perhaps the two groups of upper and lower plicae may pursue their ways without merging into each other.

LAACKMANN'S species is somewhat smaller than the Mediterranean (length 54 μ). It was found in plankton from St. Helena (German South-Pole Exp., $\frac{1}{9}$ 1903).

3. AMPHORELLA TETRAGONA n. sp. (Fig. 15 p. 17).

As to habitus very similar to the preceding species, but different in having a strongly dilated and outward curved mouth, as well as a lorica, not distinctly urn-shaped and with a very short posterior point, truncate at the very end. The "ribs" appearing on the optical longitudinal section, as well as the four alary plicae, are so similar to those in the preceding species that the present immediately gives the impression of being only a larger form of the same. Nevertheless, the difference is so considerable that they must provisionally be considered different species.

Length 123 μ , diameter of mouth 47 μ . As in the preceding species a (distinct) thickening of wall is lacking.

I believe also to have seen a lorica with 6 alary plicae.

St. 206, 1945 m. wire (Balearic), singly.

4. AMPHORELLA STEENSTRUPI (Clap. et Lachm.) Dad. (Fig. 16 p. 17).

Daday 1887 p. 537, pl. 18 figs. 9, 21. *Tintinnus steenstrupi* Claparède et Lachmann 1858 p. 200, pl. 8 fig. 5.

Sts. 12, 18, 25, 26, 27, 28, 29, 31, 33, 38, 39, 40, 55, 60, 66, 68, 69; 79, 80, 95, 96, 97, 109, 122, 126 (275 m. wire), 137, 140, 152 (250 m. wire), 186 (in *Salpæ*), 190, 204, 206 (1945 m. wire), 210, 213, 229, 231 (0 m. and 1145 m. wire), 234 (0 m., 25 m.—0 m., 100 m.—25 m.), 235, Lisbon.

Wall of lorica, as in *Amphorella quadrilineata*, more or less strongly thickened above. Length remarkably varying, which is also emphasized by BRANDT (1907); the Mediterranean specimens are throughout much shorter than the northern, longer lorica being, however, occasionally met with also in the Mediterranean. Otherwise a rather constant species, particularly as to development of the lower end, which is short and broadly conical, with the lateral outlines nearly perpendicular to each other, the extreme end rounded.

During the winter cruise it was very rare and scarce in the Eastern Mediterranean, only noted for two stations; in the Tyrrhenian Sea it was, however, frequent, being present at nearly all stations, though but singly or in very small numbers, only at st. 31 somewhat more numerous. Farther to the west it was (apparently) lacking until some few stations near the south coast of Spain, whilst outside the Straits it was present at 3 of 5 stations in Bay of Cadiz. No immigration into the Mediterranean from the west seems traceable in February (nor in January).

During the summer cruise it proved to be very rare everywhere in the Mediterranean, in all only present singly at 4 stations in the Eastern Mediterranean and at 8 in the Western. In Bay of Biscay it was met with in greater numbers in June at sts. 79, 80, but in Bay of Cadiz (in June) scarce, whilst in September it was present here at both stations. Along the coast of Africa it was only taken at st. 109 (in June), so that there is only a faint trace of immigration into the Mediterranean from the Atlantic in June.

The lorica figured belongs to the shorter form; its length was 117μ , diameter of mouth 40μ . The northern forms are on an average about 50% longer, up to 200μ and more.

The longer form, more answering to that occurring in northern waters and in the Atlantic, was seen from st. 152, 945 m. wire, and is otherwise only noted for st. 31, here together with the short form, and for st. 206, 1945 m. wire.

This species must very probably be considered indigenous in the Mediterranean; remains of the animalcule in the lorica were occasionally seen. Presumably it gets in occasionally from the Atlantic (in late autumn?), may keep alive in the Mediterranean for some time and perhaps multiply, giving rise to the development of the shorter forms, which are predominating. But it does not seem to thrive easily in the Mediterranean waters, at any rate in summer, being generally very scarce.

It was first reported from the Mediterranean by DADAY 1887, from Naples, later from the Alboran Sea in February (CLEVE 1903 b), from Syracuse (LOHMANN 1903, 1908) and from the northern Adriatic (ENTZ 1909, LAACKMANN 1913, THEODORO 1922).

Otherwise it has a wide distribution in the Atlantic and in the Indian Oceans, in the former from 46° S. to the Barents Sea, seems, however, always to occur sparsely.

5. AMPHORELLA PYRAMIDATA n. sp. (Fig. 17 p. 17).

A small species with a thin-walled lorica, a proportionately wide, semi-erect mouth, distinctly offset from the lorica and forming a sort of collar, yet without an inward protruding rib at its base. Wall somewhat thickened from this base in an upward, as well as in a downward, direction. Lorica slowly narrowing in the lower half to an offset, low conical and very thin-walled portion, at the very end with slightly protruding mamilla. Length 54μ , diameter of mouth 28μ .

From stomachs of *Salpæ*, st. 186, singly.

6. AMPHORELLA INTUMESCENS n. sp. (Fig. 18 p. 17).

Lorica long and narrow, thin-walled, with exception of a shorter middle portion which is thickened, merging slowly and very gradually into the thin-walled parts above and below. Above, towards the mouth, the lorica is more rapidly dilated, but without a distinctly offset collar and without a thickening of the wall. Below the median thickening of wall the lorica is slowly narrowing, showing a few — presumably four — long and not very conspicuous longitudinal plicae or striae. At the posterior end (apparently) rounded and very thin-walled (perhaps unfinished).

The figured individual was $198\ \mu$ in length, diameter of mouth = $37\ \mu$.

I only saw two loricae; the second, not figured, was open below, not very far below the characteristic median thickening, which was identical with that in fig. 18. This lorica gave the impression of being broken or unfinished.

St. 156, 250 m. wire (fig. 18); st. 152, 250 m. wire.

This species and the preceding one being only observed as empty loricae, it is not altogether certain that they really belong to the Tintinnids. The latter species recalls *Stichotricha inquilinus* Entz sen. (1884, pl. 24 fig. 22), *Amphorella inquilina* Dad. (1887). Somewhat answering in shape is also *Tintinnus amphora* Clap. et Lachm.

I have not tried to identify my species with ENTZ's, the latter being figured with a thickened, double oral portion (perhaps after fission?, compare fig. 79 below).

7. AMPHORELLA GRACILIS n. sp. ad int. (Fig. 19 p. 17).

Is probably an unfinished lorica belonging to the preceding species. I will, however, designate it by a special name, in order to draw attention to it. It is perfectly similar to the upper $\frac{1}{3}$ of the lorica in the preceding species; there is, however, (still) no trace of the peculiar median thickening of wall. The lower end was apparently exceedingly thin-walled; in such a case it is very difficult to decide whether the lorica is really open below or not. The two striae figured may answer to those in the preceding species; it is again very difficult to make out whether they are situated on one or both sides (the foremost or the hindmost),

If this really is an unfinished lorica of the preceding species, it will prove that the formation of the lorica takes place from the upper to the lower end.

St. 187 (Ionian Sea) 945 m. wire, one lorica.

8. AMPHORELLA PACHYTOECUS n. sp. (Fig. 20 p. 17).

Sts. 25, 26; 186 (in Salpae). Everywhere singly.

Lorica beautifully calyciform, below acuminate and ending in a solid, spine-like caudal prolongation. Wall thick, with rather well developed limiting lamellae; it is particularly thick at the base of the dilated oral portion, then decreasing in thickness downwards to the posterior end. On one lorica fine longitudinal striae (or plicae) were seen (fig. 20 c), equi-distant as in *A. ganymedes*.

The thickness of wall is considerably varying; specimens from stomachs of Salpae had often a rather thin wall and a lesser thickening of wall below the mouth.

Total length $98\ \mu$ — $104\ \mu$, length of caudal prolongation up to $12\ \mu$; diameter of mouth $32\ \mu$ — $34\ \mu$.

At first I mistook the proportionately thin-walled individual figured in fig. 20 a for *Amphorella acuta* Schmidt (1901 pp. 184, 185, fig. 2), a species which is different from the similar *A. quadrilineata* in having a pointed posterior end. Later I found the more thick-walled individuals, which as to constitution of wall strikingly recall species of *Undella*. This latter genus has, however, much thicker lamellae, separated through a layer which BRANDT reported as showing a fine primary structure. The corresponding layer in

the present species gives the appearance of being of firmer texture, not so different from the lamellae, which also are less distinctly limited inwards, whilst in the genus *Undella* this intermediate layer — if really always filled by a solid substance — seems to be much less consistent, the inner lamellae in some cases easily becoming detached. A very fine "primary" structure between the lamellae must be difficult to distinguish from a similar structure of the lamellae themselves.

This species is as yet otherwise unknown.

9. AMPHORELLA TRACHELIUM n. sp. (Fig. 21 p. 17).

Lorica of a striking shape: above a collar-like oral rim, distinctly set off, at its base strongly spreading, then ascending. Lorica proper is slowly narrowing downwards, then more rapidly passing into a rather long, acute caudal prolongation. Wall apparently simple (single) and rather thin (but rigid), at the collar not or very slightly thickened, showing on its outside fine longitudinal striae (or plicae?), nearly parallel and equidistant.

Total length 96μ , of collar 15μ ; diameter of mouth 42μ , at the base of collar 25μ ; caudal prolongation about 26μ .

On one lorica a few agglutinated foreign bodies were seen.

St. 206, 1945 m. wire.

May be synonymous to *Tintinnus conicus* Bdt. (1907 p. 413, pl. 69 fig. 10), from the Guinea Current and the South Equatorial Current.

10. AMPHORELLA GANYMEDES (Entz sen.) Dad. (Fig. 22 p. 17).

Daday 1887 p. 539, incl. var. *cylindrica* p. 540. *Tintinnus ganymedes* Entz sen. 1884 p. 409, pl. 24 figs. 17, 18; Brandt 1907 p. 412, pl. 70 fig. 2. *T. bulbosus* Brandt l. c. figs. 4, 5, incl. var. a, p. 413, fig. 3.

a. tenuicauda: sts. 68, 69; 126 (275 m. wire), 186 (in Salpæ); 199 (200 m.—80 m.), 212, 218.

var. *bulbosa*: sts. 14, Naples, 26, 28, 29, 31, 33, 39, 40; 152 (250 m. wire), 186 (in Salpæ), 194 (1145 m. wire), 204 (945 m. wire), 206 (1945 m. wire), 209 (945 and 1945 m. wire), 246.

Lorica thin-walled, rather narrowly poculiform, usually slightly dilated towards the mouth and here showing 8—12, slightly oblique ribs, running downwards from the border of mouth — where stronger — to upper $\frac{1}{4}$ — $\frac{1}{3}$ or slightly more, where they gradually disappear; sometimes there are fainter and shorter, intermediate, ribs (see fig. 22 c). In a downward direction the lorica is narrowing slowly, below passing over into a very varying caudal prolongation, which may be rather long, of equal breadth and rounded at the end (see fig. 22 a and ENTZ l. c.), or shorter and swollen up to a spherical end (see fig. 22 b, DADAY l. c., fig. 18 and BRANDT l. c. fig. 3), or again evenly attenuated to a narrow and acute caudal prolongation (see fig. 22 d).

Is remarkably varying, partly in regard to the development and number of the thickened striae or supporting ribs in the upper part of lorica, partly and especially as to length and development of the caudal prolongation. BRANDT has two species, *Tintinnus ganymedes* "Entz" (BRANDT l. c. fig. 2), answering to my fig. 22 c, only with a single point at the lower end of the sphere, with var. a BRANDT (l. c. fig. 3), my fig. 22 b, as well as fig. 18 in DADAY (1887).

I have got the impression that there are many forms, not permitting an unconstrained grouping into BRANDT's two species. Taking no regard to the varying of striae one might provisionally arrange the forms mentioned into two varieties (a main species and one variety), *a. tenuicauda*, with two forms, f. *obtusata* (fig. 22 a, answering to the fig. in ENTZ l. c.) and f. *acuta* (fig. 22 d, BRANDT's *T. ganymedes*), and var. *bulbosa* (Bdt.) (fig. 22 b, c).

Amphorella ganymedes proved, on the whole, to be rare in the Mediterranean. During the winter cruise it was taken frequently, but sparsely, in the Tyrrhenian Sea and near to the border of the Ligurian,

otherwise, however, only at st. 14 in the Adriatic. In summer it seemed to be almost exclusively present in deeper layers, to the east as far as to the coast of Barca, only noted for two surface samples (sts. 212, 218, *a tenuicauda*). In the Bay of Cadiz it was only taken in February, sparsely at two stations. In September it was present (as *a tenuicauda*) at the st. 218 near the coast of Africa, which may be suggestive of a very faint immigration into the Mediterranean from the Atlantic of the main species, which also is the form noted from Bay of Cadiz in February. The most frequent form in the Mediterranean was var. *bulbosa*, which perhaps may be a heavier form, adapted for life in deeper layers.

Is probably to be considered endogenous in the Mediterranean, though rare and scarce and passing over into deeper water towards summer. It is probably partly maintained through immigration from the Atlantic into the Mediterranean, as the main species in upper layers and western regions, and possibly in part developing the var. *bulbosa* (by intermediate forms) farther in.

Is one of the delicate species which seem more closely confined to the surrounding water and are easily washed away with it, appearing relatively rarely and sparsely in the samples. It has a wide distribution in the warmer and warm-temperate regions of the Atlantic, all the way from 21° S as far as off the south coast of Ireland, being particularly frequent across the Atlantic between 39° N and 50° N (CLEVE 1901 d). Also known from Bay of Aden, Arabian Gulf and Bay of Bengal.

11. AMPHORELLA OXYURA n. sp. (Fig. 23 p. 17).

St. 14 (Adriatic, Decbr. 1908), singly.

Lorica hyaline, campanulate, not or very slightly dilated towards the mouth, which shows a double rim, a narrow, outward directed one, and a similar, erect inner. Wall apparently single, rather thin. Lateral outlines of lorica almost parallel or very slightly converging in a downwards direction, somewhat above the lower $\frac{1}{3}$ rapidly converging into a short and very acutely pointed caudal prolongation. No structure seen.

Length 40 μ , diameter of mouth 28 μ .

Considerably similar to *Amphorella*(?) *antarctica* Cleve (1901 a, p. 921 fig. 1), presumably synonymous to *Cyrtarocylis parva* (Laackm. 1907) Laackm. 1911, both of which are nearly allied to *Cyrtarocylis obscura* Brandt (1906 pl. 62, figs. 1, 5). These species, from the sea south of Africa, from the Antarctic and from the coast of Brazil, are all of them larger.

12. AMPHORELLA TORULATA n. sp. (Fig. 24 p. 17).

St. 186 (Ionian Sea), in Salpae.

Lorica recalls that of the previous species, but has a higher (broader) inner rim of mouth, somewhat less protruding outer rim, and is below short conical with a very obtuse, almost rounded end.

Length 28 μ —31 μ , diameter of mouth 23 μ .

One lorica seemed to be coarsely uneven outside, having alternately elevated and depressed parts, appearing darker or brighter. *Cyrtarocylis obscura* Bdt. has perhaps a similar structure (see BRANDT 1901 p. 201).

13. AMPHORELLA URCEOLATA (Ostf.) (Fig. 25 p. 17).

Tintinnus urceolatus Ostenfeld 1899 b, p. 439 fig. 2 f; *Undella*(?) *urceolata* Cleve 1901 d p. 126.

St. 187 (Ionian Sea), 945 m. wire, singly.

Wall of lorica (apparently) structureless, hyaline and single, but proportionately thick. At the upper $\frac{1}{4}$ the lorica is provided with a strongly marked, protruding annular rib (or edge); above it, the lorica is rapidly narrowing to an erect mouth of considerably smaller diameter, below the rib it is also

narrowing, at first slowly, then, at the lower $\frac{1}{4}$, more rapidly to a short and broad posterior portion, ending in a low and rounded mamilla.

Length 43μ , diam. of mouth 32μ , maximum diameter 42μ .

Not quite answering in shape to the figure in OSTENFELD, seems, however, to be the same or a nearly allied species.

OSTENFELD's species has been observed at several localities in the northern Atlantic, from 45°N (15°W) to $56^\circ 39' \text{N}$ ($27^\circ 24' \text{W}$) and to 34°W (51°N).

Tintinnus urceolatus var. α BRANDT 1907 p. 408, pl. 62 fig. 3 does not belong to the present species; see *Metacyclis mediterranea* below.

PTYCHOCYLIS Brandt.

BRANDT 1896 p. 59; 1907 p. 273 p. p.

Wall of lorica (apparently) simple (single), without distinctly developed or separated outer and inner lamellae, outside reticulated with irregular small meshes of finer or coarser elevated plicae, otherwise only with a fine "primary" structure. The optical section of wall shows an apparently homogeneous wall, only with the fine "primary" structure mentioned. No collar, nor any helicoidal portion of wall above, but frequently denticulated at the oral aperture. Loricae broadly campanulate, with or without a caudal prolongation.

The animalcule is proportionately large, short and broad, fixed at the posterior end by a strong, rather thick, pedicle, in a swimming state about as long as the lorica, with 16 powerful membranelles and 4 macronuclei.

This is a very natural genus, comprising nearly allied, northern temperate and arctic species. BRANDT 1907 included in it a great number of quite different species, only on account of their loricae having elevated plicae outsides. (See genera *Rhabdonella* and *Epiptocylis* below).

No species of this genus was met with in the material of the "Thor".

HELICOSTOMELLA n. gen. (ad int.).

Wall of lorica below apparently simple, above evenly and imperceptibly passing over into an "annulated" portion, cylindrical and formed by a single, narrow, closely twisted helicoidal band with numerous, superposed turns, in contact with each other and coalescent at their lower and upper edges, which form a single, spirally twisted line on the outside of the cylinder, right to the mouth, or, properly, from the mouth downwards, where it gradually becomes indistinct. (This very frequent structure in the Tintinnidae I will in the following simply call "annulated", for the sake of brevity. The term "annulus" means a single turn of the band). The upper "annuli" are usually a little overlapping in an upward direction, and frequently dentate. Only a fine, "primary" structure, in well developed specimens mostly visible above, where also two lamellae may be more or less distinctly discernible.

The animalcule of the following species is cylindrical, in a swimming state (obliquely) protruding, with long and narrow membranelles and, outside them, long, supporting setae (FAURÉ-FREMIET 1924 p. 109 fig. 35). 2 macro- and according to LAACKMANN (1906), 2 micronuclei; the animalcule is fixed by a long and narrow pedicle to the lateral wall, about where the lorica narrows into the caudal prolongation.

To this new genus may provisionally be referred a series of thinwalled loricae, as *Cyrtarocylis annulifera* Ostf. et Schm. (1901) and similar species. The very variable *Favella azorica* seems to form a transition between the present, provisional genus and the genus *Favella* (or *Undella*?).

HELICOSTOMELLA SUBULATA (Ehrb.) (Fig. 26).

Tintinnus subulatus Ehrenberg 1834 p. 274, 1838 pl. XXX fig. III. *Amphorella subulata* Daday 1887 p. 536, pl. 18 fig. 7; Fauré-Fremiet 1924 pp. 108–110, fig. 35 ("var. edentata").

Sts. Naples; 84, 169, 170 (20 m.—0 m., 80 m.—20 m.), Constantinople, 171 (0 m.), 172 (17 m.—0 m., 50 m.—17 m., 200 m.—51 m.), 175 (350 m. wire, 1150 m. wire), Barcelona, 212.

This species, rather common in northern waters, was very rare in the material of the "Thor", from the Mediterranean. It usually occurred only as a small form, rather similar to var. *kiliensis* LAACKMANN (1906 p. 17, pl. I, figs. 1, 2). In the winter samples I saw it only from off Naples, and in the summer samples from the Mediterranean proper I only found it in two samples from the Catalanian Sea, everywhere but singly. In the region of the Black Sea it was frequent, though also there not very numerous.

Is a neritic species which seems to be widely distributed also in more southerly waters, but in deviating forms. Whilst the northern form may become over 500 μ long, the specimens seen (by myself) from the Mediterranean proper were but 120 μ or shorter; DADAY states 108 μ —195 μ . The diameter of mouth is 20 μ —26 μ . The specimens from the Black Sea region are generally somewhat more similar to the northern form; the figured individual from the Sea of Marmora was 340 μ long \times 23 μ wide at the mouth.

Was first reported from the Mediterranean by GRUBER (1884), from Genoa. It is sometimes confounded with *Tintinnopsis radix*, which is, however, almost twice as wide (conf. LAACKMANN 1913).

I have also seen specimens from the east coast of Arabia (21° 50' N 59° 25' E) and from the Red Sea (18° 10.5' N, HANDEL-MAZZETTI, Octob. 1910).

In the northern forms of this species one may sometimes find loricae distinctly showing a later prolongation by new helicoidal portions at the mouth, off-set from the older growth. The same is to be seen in fig. 26 b, with an earlier oral aperture near the upper end of the lorica.

FAVELLA n. gen.

Wall of lorica with well developed and distinctly separated lamellae, and usually a single, sometimes, or in parts, two or more intermediate layers of "prismatic elements" the lateral walls of which appear on the optical (longitudinal) section of the lorica as short cross-lines, connecting the outer and the inner lamellae ("*Cytlarocylis*-structure").

No "collar" (as in *Cytlarocylis*); nor helicoidal structure, save in certain forms of the two species *F. ehrenbergi* and *F. azorica*. Frequently a dentate mouth.

The structure described is usually a more or less coarse "secondary" structure, accompanied by a very fine "primary" one. In some species only a single structure, of relatively coarse "primary" elements, has been observed.

The animalcule seems always (in a normal or resting stage) to possess 2 macronuclei, and probably 2 micronuclei; the number of membranelles is in several cases stated to be 18.

Here belong the rest of the old-established genus *Cytlarocylis*, after the separation of *Nystonella*. *Nystonellopsis*, *Coxliella* and the genus *Cytlarocylis* proper. *F. serrata* may be considered the type-species.

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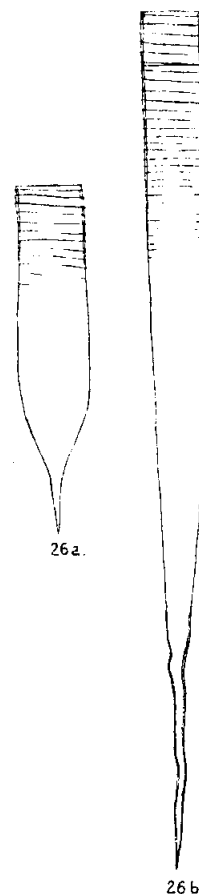


Fig. 26. *Helicostomella subulata* (Ehrb.); ^{350/1}.
a Barcelona Harbour;
b st. 170, 20 m.—0 m.

1. FAVELLA SERRATA (Möb.) (Fig. 27 p. 27).

Möbius 1887 p. 120, pl. VII fig. 40. Cytarocylis serrata Bdt. 1896 p. 60, 1907 p. 204, pl. 39 figs. 1-6. Fauré-Fremiet 1924 pp. 102-105, fig. 33.

Sts. 84 (0 m., 25 m.—10 m.), 85 (abundant), Cadiz, 113 (several specimens), Barcelona, Lisbon, 239, Brest. Scarce, when not otherwise mentioned.

Lorica large, pallid, somewhat below the mouth more or less distinctly swollen, not or only slightly narrowing in the upper half, then more rapidly and below abruptly or more evenly passing into a shorter or longer, mostly thick, very thick-walled and obtuse, rarely acutish, caudal prolongation, showing a narrow channel inside. Lamellae of the wall thick and approximated. At the mouth numerous, triangular denticles. Structure of pallid meshes, varying in size, near the mouth very small.

Length of lorica proper 183μ — 306μ , of the caudal prolongation 26μ — 77μ ; diameter of mouth 85μ — 96μ , number of teeth 60—70, broad and short.

In northern specimens the dilation below the mouth may be indistinct or wholly lacking (var. a Bdt. l. c.); sometimes there is no denticulation. Has in some cases been confounded with *F. ehrenbergi*, which, however, is usually larger, has no denticles, nor any dilation above, has a solid caudal prolongation (without inner channel) and a thicker wall (of lorica).

Favella serrata is a neritic, meroplanktonic species, very scarce and rare in the material of the "Thor" from the Mediterranean, only noted from Barcelona and st. 113, in the latter locality but two, small individuals seen.

Otherwise known from the coasts of the German Ocean and thence to the Western Baltic, the Norwegian coast as far as Tromsø, the west coast of Scotland, the Channel, the Bay of Biscay, the west coast of Portugal and the Bay of Cadiz. Farther to the south, along the west coast of Africa a variety (var. a Bdt.) is occurring, as well as a very closely allied form or species, *Favella arcuata* (Bdt., p. 207, pl. 40, figs. 2-7).

Was first reported from the Mediterranean by EXTZ jun. 1909 (from Naples); his figure (pl. X fig. 10) and description of the animalcule (p. 133) are, however, different. FORTI (1913) reports it from the coasts of the Sea of Marmora. I did not see it in the material of the "Thor" from the Black Sea region.

2. FAVELLA AZORICA (Cl.) (Figs. 28-30 p. 27).

Undella azorica Cleve 1900 d p. 974. *U. campanula* Schmidt 1901, p. 190 fig. 6.

Sts. 160 (0 m.), 167, 179, 182 (0 m.), 190, 195, 202, 206 (0 m., 1945 m. wire), 210, 217, 218, 220, everywhere only singly or very few individuals.

Lorica in the upper half nearly cylindrical, not, or but slightly dilated at the mouth, maximum diameter about in the middle, but not much greater than that of the mouth, about the lower $\frac{1}{3}$ with rounded side outlines rapidly narrowing to a conical, usually somewhat protracted posterior point, obtuse or slightly rounded at the very end, or more or less developed into a short and thick, rarely longer and narrower, caudal prolongation. At the mouth a narrow, thin-walled annulus which may develop into an "annulated" thick-walled anterior portion (of lorica), consisting of up to 4, rarely more, rather narrow "annuli", in the optical section of the wall showing short and thick segments (fig. 29). Wall of lorica with thickened and distant lamellae, approximated in the lower part, but separated right to the posterior end, where the inner lamella is rounded off. Structure more or less distinct, consisting of fine, punctiform meshes, of almost equal size all over the wall, at the very end more pallid and perhaps smaller. Caudal prolongation, when present, solid, coarsely punctate inside.

Length of lorica proper 94μ — 96μ , when "annulated", up to 117μ , caudal prolongation of very varying length or absent, diameter of mouth 60μ — 85μ , wall of lorica up to $2\frac{1}{2}$ — 3μ thick (in the upper $\frac{2}{3}$).

The dimensions given by SCHMIDT for his *Undella campanula* are obviously erroneous; by comparing with his fig. 5 (l. c. p. 189) which is drawn under the same magnification we get 120μ (length of

lorica proper) $\times 72 \mu$ (diameter of mouth), instead of $258 \mu \times 141 \mu$ stated by him. His form is a long one, with an extraordinarily developed caudal prolongation (about 34μ) and therefore rather dissimilar to CLEVE's typical form; I think, however, they will prove to belong together.

There are three different forms: the main species, without "annuli" and without caudal prolongation, var. *campanula* (Schm.), with a more or less developed caudal prolongation and with a single annulus, and var. *composita* n. var., with several (4 or more) "annuli", with (or sometimes without?) a caudal prolongation. The latter variety is noted for sts. 206 (0 m.), 210, 217. Also in the Persian Gulf. Was rare, and scarce in the material of the "Thor".

An immigration from the west into the Mediterranean seems to take place in September; certainly, the species was not observed in the Bay of Cadiz; it is, however, present at the Azores in September, and the occurrence at sts. 218 and 220, must therefore, I believe, be due to individuals entering through the Straits of Gibraltar.

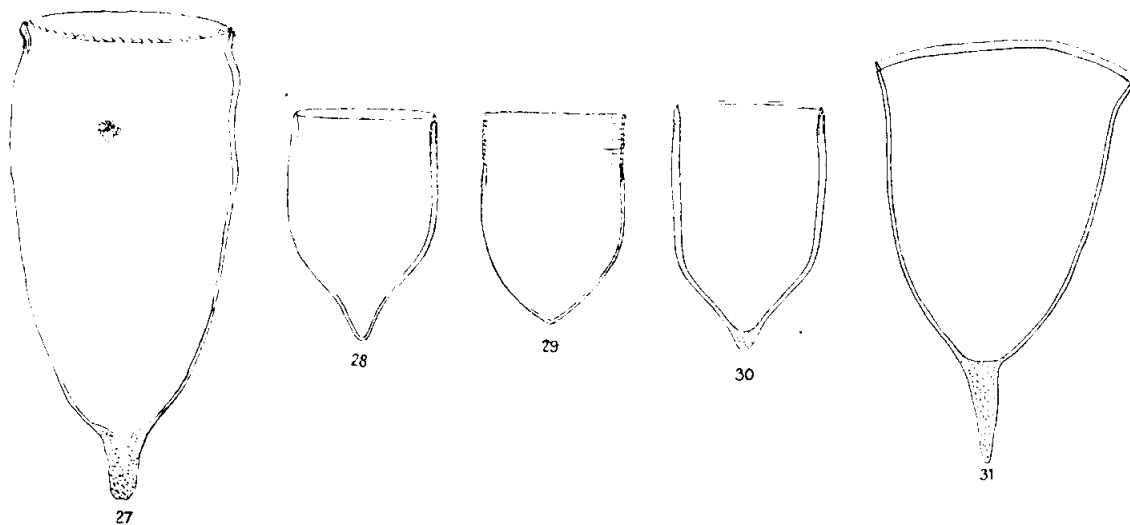


Fig. 27. *Favella serrata* (Möb.); $350/\mu$, Barcelona Harbour. Denticles of mouth only shown in front, optical longitudinal section only shown on the right side, the two lamellae of wall as well as structure of the latter only suggested. (In like manner also in several of the following figures). Fig. 28. *Favella azorica* (Cl.); $350/\mu$, St. 160. Fig. 29. *Favella azorica*, var. *composita* n. var.; $350/\mu$. A thin-walled specimen (with helicoidal prolongation at the mouth). Fig. 30. *Favella azorica* var. *campanula* (Schmidt); $350/\mu$, St. 190. Fig. 31. *Favella adriatica* (Imhof?, Bdt.); $350/\mu$, Gibraltar. A deformed specimen from a slide, showing the relatively thin wall and the narrow and thin-walled ring at the mouth.

Otherwise known from the Azores (Sept. 1898, CLEVE), the Gulf of Siam (SCHMIDT, also recording "*Undella azorica*" from the same region), between Fuchow and the north point of Formosa ($13/7$ 1903, in a sample in possession of OSTENFELD) and from the Persian Gulf (HANDEL-MAZZETTI $16/10$ 1910). The species being so scarce in the Mediterranean and not observed there (as yet) in winter, it may be provisionally considered an allogeneous species, occurring as a summer species, most frequent in the west, especially north and south of the Balearic Isles. The loricae seem to be very light, being perhaps not easily caught with nets; the species may therefore be considerably more frequent than the relatively few records show.

3. FAVELLA ADRIATICA (Imhof?, Bdt.) (Fig. 31).

Cyrtarocyelis adriatica Imhof? 1886 b p. 199. *C. ehrenbergi* var. *adriatica* Brandt 1907 p. 211, pl. 41 figs. 9, 10. *C. ehrenbergi* f. *marginata* Meunier 1919 p. 8, pl. XXII fig. 3.

Sts. 84 (0 m.), 113, Tunis, 153 (many), 172 (50 m.—17 m., 200 m.—51 m.), 173, 179, Barcelona, Gibraltar.

Lorica usually widely campanulate, sometimes longer, below with rounded outlines and an offset, short and thick, frequently curved or undulated caudal prolongation, solid, or at any rate only above

hollow, occasionally with three, not very conspicuous lateral alary edges, extending up to the lower part of lorica. Wall of lorica not very thick, but as a rule distinctly double. At the mouth one, or sometimes two narrow "annuli", with a thin or mostly simple (single) wall. Structure consisting of pallid and inconspicuous, rather equal-sized meshes; the oral rim only with a "primary" reticulation.

Length of lorica proper usually 120μ — 145μ , rarely less, down to 94μ , not infrequently more; diameter of mouth 100μ — 113μ , sometimes less. Wall of lorica scarcely more than 2μ — $2\frac{1}{2}\mu$ thick.

Nearly allied to the following species, but different from it in many respects, especially in the narrow and thin-walled oral rim — which may easily be overlooked — the much less thick wall of the lorica and the firmer, not rugose and relatively broader loricae.

Like the following species it is a coast form (meroplanktonic) which was sparsely present in the material of the "Thor", though occurring now and then in several specimens.

It is doubtful whether this species really is the one mentioned by IMHOF. His very imperfect description certainly suggests a form, near to *Favella ehrenbergi*, as seen by BRANDT; if it is different from this species — which is scarcely to be seen from IMHOF's description — it may be either the present species or *F. serrata*, the mouth of which, in the Mediterranean specimens, was not always denticulate.

Seems to be a well defined species, perhaps more nearly allied to *F. serrata* than to the following species. It was first recorded from Brindisi by IMHOF(?) 1886, later by BRANDT (l. c., taken at Naples 1883), by ENTZ jun. (1909 p. p., pl. 10 fig. 9, scarcely figs. 7, 8) and LAACKMANN (1913 p. 28 p. p.) from the Northern Adriatic (as *Cyrtarocyclus ehrenbergi* var. *adriatica*). Otherwise it is known from the south-western region of the North Sea (the Flemish Sea, MEUNIER l. c., who also has detected resting stages of it there).

4. FAVELLA EHRENBERGI (Clap. et Lachm.).

Tintinnus ehrenbergi Claparède et Lachmann 1858 p. 203, pl. VIII figs. 6, 7. *Cyrtarocyclus ehrenbergi* Fol 1884; Daday 1887 p. 583; Entz jun. 1909 pl. 12 fig. 5, pl. 13 figs. 5, 6, 12 (conjugation).

Sts. 84 (0 m.), 85 (rather numerous), Cadiz, 96, 101, 165, 172 (50 m.—17 m.), 178, Naples (predominating), Barcelona, 226, everywhere mostly as an obvious var. *helgolandica* and singly or sparsely.

Lorica generally of the same shape as in the preceding species, but larger, especially longer, at the mouth, usually somewhat narrowed, maximum diameter about in the middle or a little lower, below frequently more rapidly narrowing, at the mouth without a thinwalled annulus (compare f. *claparèdei*). Wall of lorica relatively very thick, 4μ — 5μ , less firm and often unevenly thickened (rugose); structure as in *F. serrata*, of pallid and rather thinwalled meshes of unequal size, towards the mouth generally very small. Caudal prolongation as in the preceding species with or without distinctly visible alary edges, but mostly larger, longer and thicker, generally solid and very obtuse, rarely acutish. Animalcule very large, with two large, oval macro-, and two small, rounded micronuclei (MERKLE 1909 p. 160), according to DADAY (1887) in f. *claparèdei* with 18 membranelles.

Length of lorica proper mostly 300μ — 400μ , rarely but 200μ , diameter of mouth about 100μ , or more, caudal prolongation of very varying length.

Var. *helgolandica* Bdt. (Fig. 32 a p. 29).

Brandt 1906 p. 24, pl. 41 figs. 6, 7, 1907 p. 212.

Differs from the main species in having very conspicuous bladlike wings from the lower part of lorica to near the end of the caudal prolongation, giving the latter a triangular shape, acute below, above more or less evenly passing over into the outlines of the lorica (on one side). The cavity of the lorica may extend somewhat into the upper portion of the caudal prolongation.

In the main species this prolongation is mostly very thick and obtuse, without alary edges, or with indistinct ones, likely to be overlooked. Intermediate forms are met with occasionally.

It is this variety which, in a more or less developed form, occurs in the Mediterranean. The figures in BRANDT (l. c.) show a strikingly irregular outline, above (usually "annulated" and) funnel-shaped, below strongly and coarsely rugose; this is, however, certainly caused by shrinkage in the preserving fluids or in slides. In a natural state the lorica is of the same shape as in the main species, but easily loses this shape in glycerine or alcohol, especially if not "annulated".

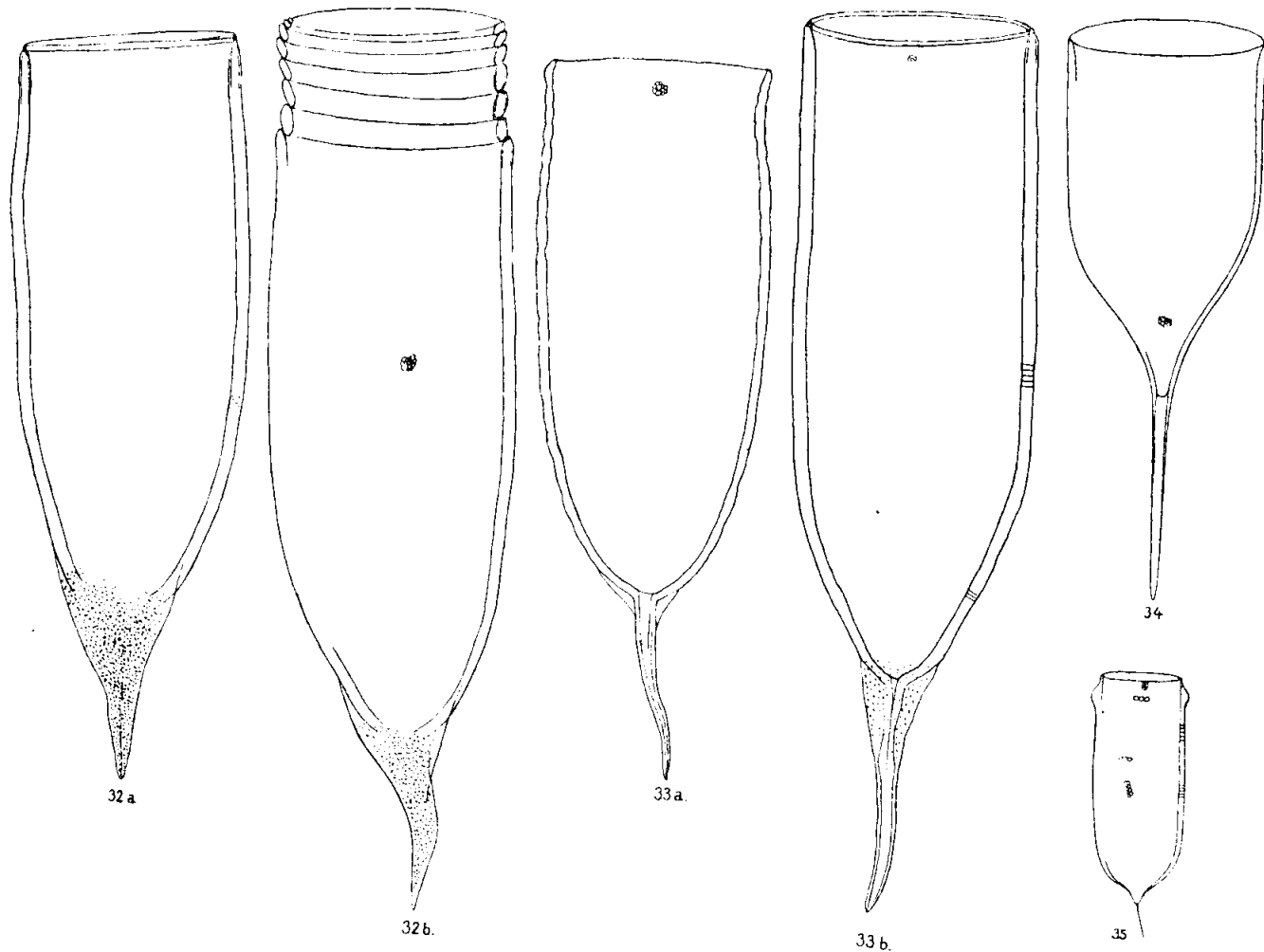


Fig. 32. *Favella chrenbergi* (Clap. et Lachm.) var. *helgolandica* Bdt.; $^{350}/_1$. Naples. b: *F. claparèdei* Bdt.; a: only the lower portion of helicoidal band is finished. Fig. 33. *Favella markusowskyi* (v. Dad.); $^{350}/_1$. Naples. a: suggestive of a helicoidal formation of wall, but no helicoidal line visible. b: a larger specimen with a single, narrow and thin-walled annulus at the mouth. Fig. 34. *Favella fistulicauda* n. sp.; $^{350}/_1$. St. 179. Fig. 35. *Favella aciculifera* n. sp.; $^{350}/_1$. St. 152, 950 m. wire.

The Mediterranean form seems to be smaller than the main species. Length of lorica proper usually about 250μ , of caudal prolongation 70μ — 80μ ; diameter of mouth 95μ — 100μ , maximum diameter (near the middle) 103μ — 107μ , wall up to 5μ thick.

This variety, as well as the main species, both of which apparently merge one into the other without definite limits, occurs frequently in a strikingly deviating form:

f. *claparèdei* (Dad.) Bdt. (Fig. 32 b p. 29).

Cyrtarocyliis claparèdei Daday 1887 p. 582, pl. 21 figs. 5, 16. *C. ehrenbergi* var. *subannulata* Jörgensen 1899 p. 37, pl. 111 figs. 31, 32.
C. ehrenbergi var. *claparèdei* Brandt 1906 p. 24 pl. 41, figs. 1, 5, 8.

Lorica above with a definitely limited "annulated" portion, of the same diameter and thickness of wall as in the rest of lorica, usually with up to 6 "annuli". Otherwise as in var. *heligolandica*, or as in the main species.

This form was in the first instance figured by CLAPARÈDE (1867) as *Tintinnus ehrenbergi* from the coast of Normandy, the "annulated" portion being considered a prolongation of the lorica, which no doubt is correct. From the west coast of Norway I have also seen a specimen with two such "annulated" portions, both of the usual length and 5—6 "annuli", but with a distinct border line, apparently developed at different times. This helicoidal portion presumably acts as a stiffening portion, preventing the mouth of the lorica from collapsing (cf. p. 8).

Instead of introducing a special denomination for the "annulated" form of the main species, or of var. *heligolandica*, I think the same formal name may be used; if necessary for a discrimination, one may write *F. ehrenbergi* f. *claparèdei* and *F. ehrenbergi heligolandica* f. *claparèdei*. In 1899 (JÖRGENSEN l. c.) I believed it necessary to refer DADAY'S *Cyrtarocyliis claparèdei* as a variety to the same author's *C. markusovszkyi*, instead of to *C. ehrenbergi*. This question is still open.

This form, as belonging to var. *heligolandica*, was so frequent in the material of the "Thor" that it may perhaps prove to be the normal state of this variety, when fully developed: sts. 84, 85, Cadiz, 113, 178, Naples.

Otherwise, *F. ehrenbergi* and its varieties are known from the coasts of the North Sea, Skagerrack, Scotland and Western Norway, perhaps or probably also from the Gulf of Bothnia (LEVANDER 1894 p. 88, pl. 3 fig. 6(?), the dimensions according to the figure and the magnification being $333 \mu \times 67 \mu$, not as stated 1045×238).

5. **FAVELLA MARKUSOVSKYI** (Dad.) (Fig. 33 p. 29).

Cyrtarocyliis markusovszkyi Dad. 1887 p. 581, pl. 21 fig. 4; Entz jun. 1904 p. 125, fig. 4. *Tintinnus ehrenbergi* Zacharias 1906 p. 532 fig. 12.

Differs from *F. ehrenbergi* in having a long and narrow caudal prolongation, above with 3 short, but distinct alary edges, extending from the lower part of lorica to the upper of the caudal prolongation. This upper portion is coarsely granulated and apparently separated from the cavity of lorica by the inner lamella which is rounded below. The lower $\frac{2}{3}$ of the caudal prolongation is broadly acicular, with an inner broad channel and well defined, structureless, somewhat thickened side walls, of equal thickness down to the sharp point below.

Otherwise as *F. ehrenbergi*, but the lorica is firmer, and therefore not so easily deformed in glycerine; has perhaps often a somewhat thinner wall. Structure rather regular, of almost equal-sized meshes.

Length of lorica 220μ — 280μ , of the caudal prolongation 82μ — 103μ ; diameter of mouth 95μ — 97μ . BRANDT 1907 considers the species to be synonymous to *F. adriatica* (his *Cyrtarocyliis ehrenbergi* var. *adriatica*) which scarcely can be the case, already on account of the considerable difference in thickness of wall. At the mouth one or two "annuli", as in *F. adriatica*, may sometimes be seen (fig. 33 b), probably later developing into an "annulated" upper portion of the lorica. They are, however, in this species more thick-walled than in *F. adriatica*.

The figure in ENTZ (l. c.) shows a lorica which has shrunk and narrowed in the lower portion; it has also got longitudinal plicae. I have seen the same thing happen in specimens mounted in glycerine.

In the material of the "Thor" this species was present at Malaga Roads and at Naples (in August). DADAY detected it in the latter locality where it was abundant in April. Intermediate forms to *F. ehrenbergi* var. *heligolandica* occurred at Naples; it is therefore most probable that these two forms, the variety just mentioned and the present species, ought to be united. A further question will then arise: are these

two forms to be united into a species, *F. markusovszkyi* s. l., nearly allied to, but different from the more northern species *F. ehrenbergi*, or should they be included under a common varietal name, var. *markusovszkyi* of *F. ehrenbergi*?

Also *F. markusovszkyi* occurs occasionally as an "annulated" form, analogous to f. *claparèdei* of the preceding species. As, however, DADAY describes the caudal prolongation of his *F. claparèdei* somewhat differently, it is not probable that the latter "species" is simply an "annulated" form of *F. markusovszkyi*.

ENTZ jun. found it in the Northern Adriatic. Unknown, as yet, outside the Mediterranean, if not also taken in the Malay Archipelago (CLEVE 1901 c pp. 10, 53, "*Cyrtarocydis markusovszkyi*?, probably a variety of *C. ehrenbergi*"). That he (ibid., note) considers *Undella campanula* Schmidt to be the same species, is undoubtedly due to the great dimensions stated by SCHMIDT (compare above p. 26: either the magnification is erroneously stated and the dimensions correct, or vice versa; in the first case SCHMIDT's species might perhaps be a form near to *F. adriatica*).

6. FAVELLA FISTULICAUDA n. sp. (Fig. 34 p. 29).

Lorica resembles a very short form of that in the preceding species, but is provided with a long and narrow, apparently solid caudal prolongation. It is in the upper half almost cylindrical, or slightly dilated towards the mouth, below the middle slowly narrowing and below rapidly passing into a subulate caudal prolongation which in its upper portion contains a part of the cavity of lorica. At the mouth a very low and indistinct, thin annulus is present, like that in *F. adriatica*, but lower and easily overlooked. Wall of lorica $2\mu-2\frac{1}{2}\mu$ thick; structure of fine meshes.

Length of lorica 153μ , of caudal prolongation 111μ , diameter of mouth 85μ .

I only saw it in the sample from st. 179 (Aegean Sea, at the entrance to the Dardanelles).

7. FAVELLA ACICULIFERA n. sp. (Fig. 35 p. 29).

Sts. 152 (950 m. wire), 187 (945 m. wire), 189 (945 m. wire), 192 (545 m. wire), 194 (0 m., 1145 m wire), 199 (945 m. wire), 206 (1945 m. wire), everywhere but singly.

Lorica swollen below the mouth otherwise on the whole cylindrical to the lower $\frac{1}{3}$, where it is rapidly rounded off to a short, protracted point, obtuse, but carrying a fine, frequently oblique needle or bristle. The two lamellae of the wall well developed and separated down to near the protracted point where they merge into a single, thin wall. At the mouth they are also closer together, at the swollen part, however, more distant; the wall shows about the middle a secondary maximum of thickness. Meshes almost regularly hexagonal, larger and more distinctly visible on the swollen portion, smaller towards the mouth and in the lower $\frac{2}{3}$.

Length of lorica 102μ , of the needle 13μ ; diameter of mouth 37μ ; maximum diameter 45μ .

A singular species, not related to any of the known species. As yet otherwise unknown; there exist, however, a great many small species of Tintinnids which are only exceptionally caught by plankton nets.

POROECUS Cl.

I have been obliged provisionally to use this generic name of Cleve's (1902 b, p. 15) for the following species which as yet is little known.

POROECUS APICULATUS Cl. (Fig. 36 p. 32).

Cleve 1902 b, p. 15. *Porella apiculata* Cleve 1900 d, p. 973; 1901 c, p. 10; 1901 d, p. 117. Scarcely *Cyrtarocydis apiculata* Brandt 1907 p. 203, pl. 32 figs. 3-5.

Lorica cylindrical, below rapidly narrowing into an offset, rather thick, acute, caudal prolongation. Wall not very thick, with distinctly separated lamellae, merging into each other towards the caudal pro-

longation. Structure coarse, of roundish to spherical, almost equal-sized small discs, in the middle showing a dark spot or pore; on the outlines may be seen that these discs are fixed at the outside of the wall. Mouth entire (or in CLEVE'S figure somewhat irregularly wavy).

Length 115μ , including the caudal prolongation (30μ); diameter of mouth 30μ . The round discs about 2μ in diameter.

The agglutinated bodies are probably coccoliths (of Coccolithophora?); they conceal the structure of the wall, the real constitution of which I have not seen. I therefore here list the species under the name, given to it by CLEVE. BRANDT'S species (l. c.) must be a different one; it may, however, prove correct that CLEVE'S species also is a species of "*Cyttarocyclus*" (*Favella*). In the "foreign bodies" it reminds one of the genera *Codonella* and *Codonellopsis*; no species of these genera has, however, a similar appearance.

Only one fully developed and one young(?) lorica were seen: st. 68 (Bay of Cadiz). From st. 14 (in the Southern Adriatic) I saw a single, doubtful, specimen in bad condition, perhaps belonging to this same species.

According to CLEVE known from the South Atlantic (20° S 2° E and 23° S 3° E), the Southern Indian Ocean (42° S 76° E) and from the Azores (in January). The latter record answers very well to the occurrence at st. 68 in February.

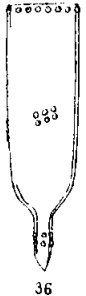


Fig. 36.
Porocetus
apiculatus Cl.:
33m
1
St. 68.

XYSTONELLA (Bdt.) Laackm. (emend.)

Lorica long, protracted, at the mouth broad and channelled, with an outer, more or less spreading, and an inner, erect, oral edge or rim, both separated by a circular groove. Caudal prolongation long and narrow, differently developed, either with a short, annular or umbellate dilation and thickening, dividing it into an upper portion, similar to the lorica proper, only narrower, and a lower, aciculate one, with a simple (single) and structureless, firm wall, — or not dilated, nor thickened, but towards the posterior end provided with a more firmly constituted portion.

Otherwise as in *Favella*.

1. XYSTONELLA TREFORTI (Dad.) Laackm. (Fig. 37 p. 33).

Laackmann 1911 p. 449. *Cyttarocyclus treforti* Daday 1887 p. 579, pl. 21 fig. 1. *C. quadridens* Kofoid 1905 p. 290, pl. XXVII figs. 8—11, pl. XXVIII fig. 18.

Sts. 14, 23, 26, 28, 33, 38, 55, 68; 87, 126 (200 m.—100 m., 275 m. wire), 132 (600 m.—195 m.), 134 (75 m.—0 m.; 125 m.—75 m. numerous), 152 (250 m. wire, common; 950 m. wire), 156 (250 m. wire, 950 m. wire), 160 (100 m.—30 m.; 200 m.—100 m., several; 1000 m.—200 m.), 175 (1150 m. wire), 182 (545 m. wire), 186 (245 m. wire, 1145 m. wire; also in Salpæ), 187 (0 m., 190 m.—100 m., 945 m. wire), 189 (945 m. wire), 194 (0 m.; 1145 m. wire, rather numerous), 199 (200 m.—80 m., many specimens; 945 m. wire), 204 (945 m. wire), 206 (1945 m. wire).

Lorica very similar to that of *Xystonella acus* var. *lohmanni*, but with a different caudal prolongation; below a sharply outlined subula with a simple, structureless wall, as in *X. acus*, but above this subulate portion an umbellate dilation, usually with four acute equidistant denticles.

Lorica at the mouth usually slightly dilated, then slowly narrowing a little to about the upper $\frac{1}{4}$, then cylindrical, or mostly very gradually and slightly dilated to the same width as at the mouth. In the lower part it is rapidly narrowing, passing imperceptibly into a narrow caudal prolongation, in the middle or somewhat lower thickened into the umbellate, cup-shaped apophysis mentioned, again embracing a rather short, subulate point. Wall everywhere, save in this subulate point, with distinctly developed

and separated lamellae, very thick at the mouth and at the secondary maximum of diameter, here up to $7\mu-8\mu$ thick, below much narrower, at the apophysis again thicker and coarsely granulated. Structure consisting of large and rather regular hexagonal meshes, much smaller towards the mouth and in the narrowing lower part, reaching their greatest size at the secondary maximum diameter of lorica.

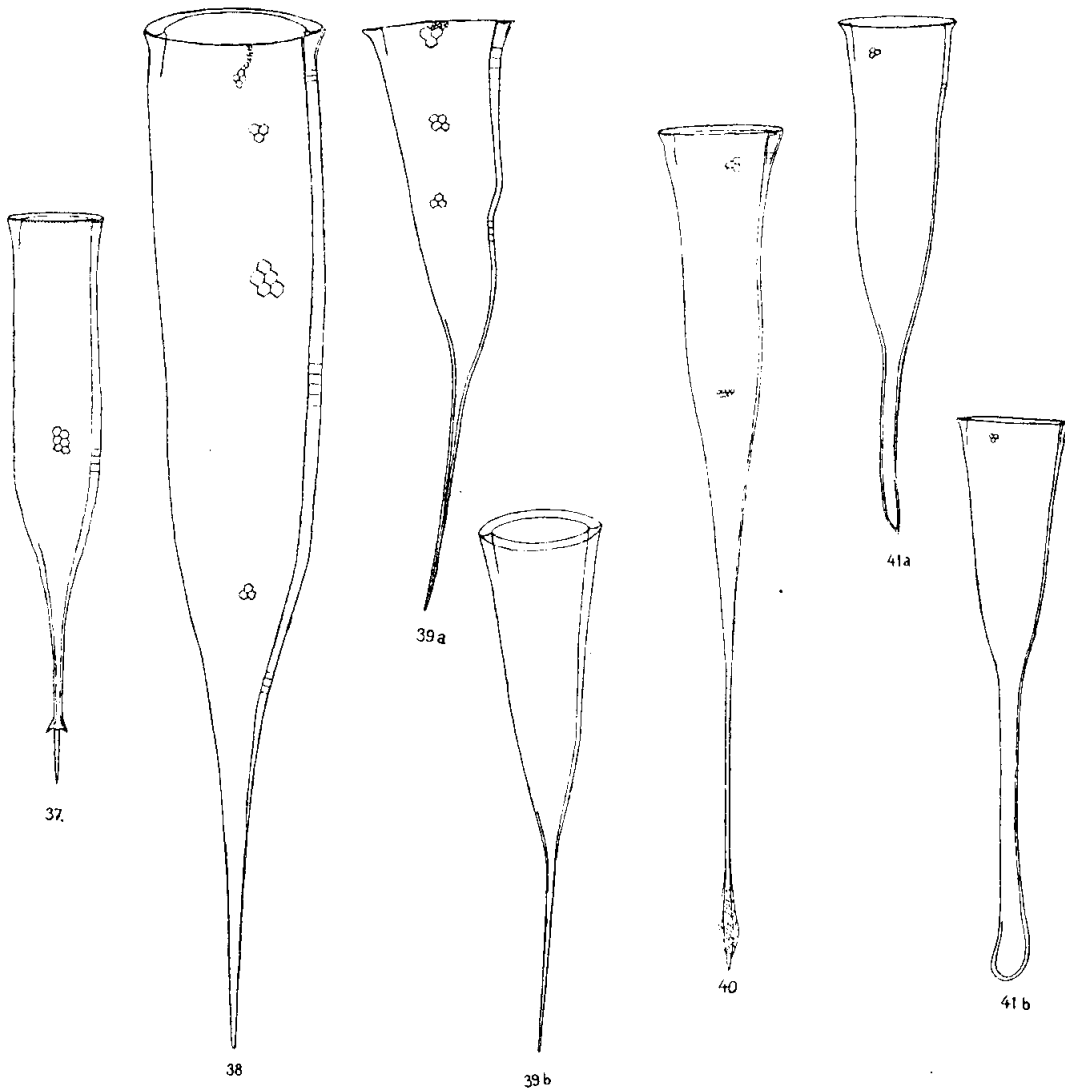


Fig. 37. *Nystonella treforti* (v. Dad.) Laackm.; $^{350}/_1$. St. 26. Fig. 38. *Nystonella (acus* (Bdt.) var.) *lohmanni* (Bdt.); $^{350}/_1$. St. 234. Fig. 39. *Nystonella longicauda* (Bdt.) Laackm.; $^{350}/_1$. a: a somewhat deformed specimen; st. 28. b st. 145. Fig. 40. *Nystonella longicauda* (Bdt.) Laackm. var. *clavata* n. var.; $^{350}/_1$. St. 152, 250 m. wire. Fig. 41. *Nystonella lanceolata* (Bdt.) Laackm.; $^{350}/_1$, a st. 187, 945 m. wire. b *f. clavigera* n. f.; st. 182, 545 m. wire.

The mouth appears sometimes indistinctly denticulate from protruding walls of meshes, e. g. in specimens mounted in glycerine.

Total length $360\mu-470\mu$, length of subula $34\mu-43\mu$, outer diameter at the mouth $80\mu-90\mu$, inner $62\mu-83\mu$.

Was frequent in the material of the "Thor", especially in that from the summer cruise, when it was taken from off the south-western corner of Portugal all the way to Euboea. In winter it was rare

and only found singly, especially present at many stations of the Tyrrhenian Sea. In summer it was only exceptionally met with in the surface of the Mediterranean, only noted for two stations, 187 and 194, being in both localities much more plentiful at lower levels; below the surface it was taken at 14 of the 22 stations in the Mediterranean (proper), sometimes numerous (sts. 134, 194 and 199 in the Tyrrhenian Sea, and st. 152 near the coast of Barca), apparently most so between 200 m. and 100 m.

It was detected at Naples by DADAY (1887) and was later reported from the Alboran Sea by CLEVE (1903 b). Otherwise it is known from numerous localities in the Atlantic, from 32° S, west of the south point of Africa, to 42° N, partly in greater numbers. Also known from the Indian Ocean (Red Sea and Arabian Gulf, Mascarene Current) and from the Pacific (New Pomerania and New Zealand). All according to OSTENFELD and SCHMIDT 1901, BRANDT 1907, LAACKMANN 1911 and samples of my own.

2. XYSTONELLA ACUS (Bdt.) Laackm. (Fig. 38 p. 33).

Laackmann 1911 p. 451. *Cyttarocyclus* (*Xystonella*) *acus* Brandt 1906 p. 6, pl. 45 fig. 4, 1907 p. 244. *C. treforti* Cleve 1901 p. 113 p. p.(?), not *C. treforti* Daday (1887).

Lorica very long-protracted, widest at the mouth, then narrowing, but frequently again somewhat dilated farther down, then gradually narrowing to a more or less protracted caudal prolongation which, towards its end, is subulate, hyaline and structureless, in water much more conspicuous than the otherwise pallid lorica. Wall everywhere double, from well developed, distant lamellae, at the mouth almost cross-cut or with a broad and shallow groove; below the lamellae are gradually approaching each other and finally merge into the subula. Structure of more or less thin-walled and distinctly hexagonal meshes, especially large and conspicuous in the upper portion of lorica, mostly very small at the mouth as well as towards the subula below. The animalcule with two macro- and two micro-nuclei.

This frequent warm-water species includes in BRANDT (l. c.) two varieties, var. *lohmanni* and var. *longicauda*, both well defined species. BRANDT'S main species seems, however, to be somewhat heterogeneous and vague, and is here only maintained in consideration of priority. According to the figure in BRANDT, quoted above, the main species is a form similar to var. *lohmanni*, but decidedly shorter (360 μ long), more dilated above (diameter of mouth 71 μ), without a distinct (lower) secondary maximum of diameter, with an almost cross-cut mouth without a distinctly spreading outer, and a distinctly protruding erect inner, rim, with almost equal-sized meshes, save in the lower $\frac{1}{3}$, where they are gradually diminishing towards the subula, and at the upper border where they are very small. The thickness of wall cannot be seen on the figure 4 quoted; to judge from the figures 7 and 9 on pl. 50, by BRANDT referred to the main species, it is, however, greatest at the mouth and of rather equal size in the upper $\frac{2}{3}$, without an intermediary maximum. In short, compared with var. *lohmanni*, the main species is an unprotracted form of this variety, without the intermediate (secondary) maximum of diameter, thickness of wall and magnitude of meshes, the latter only distinctly diminishing above, close to the mouth.

These chiefly negative characters also manifest themselves in the few localities recorded by BRANDT: border of the Labrador Current, Gulf Stream between the Azores and the north-west coast of Spain, west of the north-west point of Scotland, between 450 m. and 650 m. below the surface at a single station in the Sargasso Sea, i. e. all rather abnormal localities for a subtropical species. The so-called main species therefore gives the immediate impression of being a badly developed form of var. *lohmanni*, which latter ought to be considered the true main species. To avoid interference with the laws of priority one might perhaps provisionally write *X. (acus* var.) *lohmanni*.

Var. *lohmanni* Bdt. (Fig. 38 p. 33).

Brandt 1907 p. 246, pl. 50, figs. 5, 6. *Cyttarocyclus* *denticulata* var. *gigantea* f. *edentata* Fauré-Fremiet 1924 pp. 106—108 fig. 34, not *C. denticulatus* (Ehrb.) Fol.

Sts. 55; 79, 80 (numerous), 81 (100 m. wire), 92 (rather numerous), 98 (several), 99 (many), 111, 113, 126 (275 m. wire), 128 (100 m.—0 m.), 129 (1100 m.—0 m.), 132 (600 m.—195 m.), 134 (75 m.—0 m.),

several), 152 (250 m. wire, many; 950 m. wire), 156 (250 m. wire), 160 (100 m.—30 m.; 200 m.—100 m., several), 182 (545 m. wire), 186 (245 m. wire), 194 (1145 m. wire), 199 (200 m.—80 m., 945 m. wire), 206 (1945 m. wire), 209 (80 m.—33 m., 1000 m.—200 m., 945 m. wire, 1945 m. wire), 223 (1950 m. wire, many), 228 (1145 m. wire), 234 (200 m.—95 m., 700 m.—200 m.), 235. (As usual scarce if not otherwise mentioned).

The characters of this "variety" will be apparent from the above: extraordinarily long loricae, almost cylindrical to below the middle, sometimes slightly narrowed in the upper part, but then again slightly dilated, with greater meshes and thicker wall in the middle portion, lorica here sometimes or frequently as wide as, or slightly wider (in upper $\frac{1}{3}$) than at the mouth, where the meshes become smaller. Very small meshes are again only present close to the mouth and below, towards the subulate point. Lorica as in the "main" species not very firm and likely to lose its original shape in glycerine and certain other mounting substances; in water and glycerine it appears very pallid and may be easily overlooked, save for the conspicuous subula.

Length $330\ \mu$ — $510\ \mu$, diameter of mouth $68\ \mu$ — $81\ \mu$, of meshes up to $5\ \mu$ — $6\ \mu$, thickness of wall up to $9\ \mu$.

According to FAURÉ-FREMIET (l. c.) the animaleule is conical, by a long pedicle fixed laterally in the lower part of lorica. It has an erect, almost evenly cross-cut peristome collar, surrounded outside by a multiple wreath of rather short cilia. About 24 membranelles, a long and narrow ciliary field on one side in the upper half, two oval macronuclei, one contractile vacuole near the "piston", a very deep preoral cavity and strongly refractive myoplasm in the pedicle which is supported by a couple of branches to the wall.

As seen from the list of stations this variety is very frequent in the Mediterranean, especially in the Tyrrhenian Sea, and was in summer caught all the way from off Brittany to st. 182 in the Aegean Sea, almost everywhere, however, but singly or sparsely. It is singular that it was only taken at the surface at very few stations in the Mediterranean, all in the western region in June (sts. 98, 99, 111, 113), whereas it was present almost at all stations where samples from deeper layers were taken (present at 16 of 22 stations). According to the data available it was apparently most frequent between 200 m. and 100 m. below the surface.

During the winter cruise it was rare and seemed to be replaced by less characteristic forms, so at sts. 20, Taormina, 59, 62, 66, 68. These forms were noted as *X. acus*; a revision after the experience acquired later would have been desirable; this could not, however, be undertaken.

According to the occurrence stated this "variety" apparently in part comes in from the Atlantic in spring and early summer; it seems, however, to be a true Mediterranean species, occurring chiefly in deeper layers, here and there in somewhat greater numbers.

Xystonella acus was at first reported from the Mediterranean by BRANDT (l. c.) from Messina (taken by LOHMANN). LAACKMANN (1911) reports it from New Amsterdam, Benguela and Brazil Currents.

3. XYSTONELLA LONGICAUDA (Bdt.) Laackm. (Fig. 39 p. 33).

Laackmann 1911 p. 451. *Cyttarocyclus* (*Xystonella*) *acus* var. *longicauda* Brandt 1906 p. 26, pl. 50, figs. 3, 4 (1, 2), 1907 p. 246. *C. inflexa* Brandt 1907 p. 247, pl. 31, figs. 4, 5.

Sts. 10 (many individuals), 11, 14, 15, 28, 55, 60, 66(?), 145, 147, 152 (0 m., 250 m. wire, 950 m. wire), 154, 156 (0 m., 250 m. wire, 950 m. wire), 158, 160 (0 m.), 161, 163 (0 m., 80 m.—0 m.), 165, 179, 180, 181, 182 (545 m. wire), 183 (common), 186 (0 m., 245 m. wire, 1145 m. wire), 187 (0 m., 25 m.—0 m., 945 m. wire), 194 (0 m., 1145 m. wire), 196, 197, 198 (most numerous species), 199 (common in the surface, 30 m.—0 m., 945 m. wire), 200 (predominating), 202, 204 (0 m., 945 m. wire), 229, 231 (0 m., 1145 m. wire), singly, scarce or rather few individuals when not otherwise mentioned.

Lorica protracted, narrowly calyciform; thickness of wall greatest at the mouth, which is provided with a somewhat spreading outer rim and a more or less distinctly erect inner, separated by a broad

groove. Otherwise the lorica is almost evenly narrowing downwards, with evenly diminishing thickness of wall, at the lower $\frac{1}{3}$ more rapidly narrowing and without any definite limit passing into a relatively long and narrow caudal prolongation, $\frac{2}{3}$ to $\frac{3}{4}$, or more, of the length of lorica proper, ending in a long subula like that in the previous species, hyaline and structureless, sometimes slightly bent or laterally deflected. Meshes with stronger walls than in the preceding species, of almost equal size in the upper half of lorica, yet abruptly diminished close to the mouth; in the lower half they gradually diminish, to very small ones towards the subula below.

The more irregular loricae, with strongly spreading outer rim of mouth (see BRANDT l. c., pl. 50 fig. 4) are influenced by shrinkage in glycerine or other fluids (see also BRANDT l. c. figs. 5, 6 of *X. acus* var. *lohmanni*). Small, indistinct denticles, at the inner, as well as at the outer, rim of mouth, may be produced in a similar way, the walls of the meshes or prismatic elements protruding a little on account of the collapsing lumina.

Total length commonly 250μ – 280μ , of which about $\frac{2}{5}$ is the length of caudal prolongation; diameter of mouth about 57μ (outside), with a thickness of wall about 7μ to 8μ .

A remarkably deviating form, or perhaps another species is

var. **clavata** n. var. (Fig. 40 p. 33).

(Cyttarocyclus?) *Xystonella lanceolata* Brandt 1907 p. 258 p. p., pl. 42 fig. 8.

Lorica as in the main species, but in the lower, more narrowing portion strongly protracted, with a longer hyaline and subulate part, towards its end carrying an oval dilation with a broader inner channel and a thickened wall, apparently spongy or coarsely granulated. Structure of lorica otherwise as in the main species, the wall, however, already from the upper $\frac{1}{4}$ rather thin, with correspondingly smaller meshes; in the lower half of total length the wall is exceedingly thin, with minute meshes.

Total length 350μ , of which caudal prolongation takes 140μ ; outer diameter of mouth 55μ , inner 43μ .

I saw this beautiful form only from the following localities: sts. 152 (250 m. wire, 4 individuals; 950 m. wire, 1), 156 (250 m. wire, 1). It seems to have much the same relation to the present species as *Rhabdonella spiralis* var. *elongata* to its main species (see below).

As seen from the list of stations, the main species was very frequent in the Mediterranean, especially in the inner regions in summer. In contradistinction to the closely allied preceding species, it is chiefly a surface-form, occurring at several stations in greater numbers, especially in the Tyrrhenian Sea. It is certainly a true Mediterranean species, indigeneous there, being apparently independent of an immigration from the Atlantic into the western regions.

Its distribution outside the Mediterranean is as yet but imperfectly known. BRANDT (l. c.) records it from the Sargasso Sea and from the vicinity of New Zealand; LAACKMANN (1911) found it very frequent in the samples from the German South-Pole Expedition, from $\frac{15}{5}$ 1903, south-east of Madagascar, in the Mascarene Current, and $\frac{2}{5}$ – $\frac{11}{5}$, at many places in the Brazil Current, west of South-Africa, to St. Helena, $\frac{1}{5}$ 1903. It seems to be a species descending from the preceding species, presumably better adapted to life at the surface.

4. *XYSTONELLA LANCEOLATA* (Bdt.) Laackm. (Fig. 41 p. 33).

Laackmann 1911 p. 454, pl. XLIX fig. 7. Cyttarocyclus (*Xystonella*) *lanceolata* Brandt 1906 p. 7, pl. 42 figs. 4–7 (not 8); (Cyttarocyclus?) *Xystonella lanceolata* Brandt 1907 p. 258.

Very similar to *X. longicauda* save in the caudal prolongation (of lorica) which in the present species does not form a long and narrow subula, hyaline and structureless, but is developed into a narrow, thin-walled tube, similar to the lorica proper, save in the extreme point. In the forms described by BRANDT, answering to the figs. 4–7 quoted, the latter is lanceolate, acute, wider than the rest of the

caudal prolongation, very conspicuous ("shining") in water, and showing a distinct structure of oval meshes.

LAACKMANN (l. c.) found the species very scarce in samples from the German South-Pole Expedition, ²⁷/₄ 1903 (New Amsterdam). He corrects BRANDT's description of the mouth of lorica — see BRANDT (l. c.) fig. 7, with a peculiar, strongly outward curved rim of mouth, also to be seen in the preceding species in slides with glycerine (or glycerine-gelatine) and caused by shrinkage — but maintains the lack of other structure than the fine "primary" one. He mentions the accordance with the preceding species and emphasizes the lack of the large and regular "secondary" meshes, present in that species.

These latter are, however, present in my specimens (from the "Thor"). I therefore at first considered them to be a remarkable form of *X. longicauda*, deviating in another direction than the var. *clavata*, described above.

The lorica has a mouth completely agreeing with that of *X. longicauda*, and is otherwise of the same shape as in that species, but shorter, and narrowed into a more distinctly offset and much wider caudal prolongation, below either ending in a sharp point, or swollen, clavicate and very obtuse, in both cases, however, with a sharply outlined wall, in water much more conspicuous than the rest of the pallid lorica. The structure was faint and not very well visible, but essentially similar to that of *X. longicauda*, in the upper, more thick-walled portion of lorica consisting of rather large meshes, suddenly becoming much smaller near the mouth. The meshes are also small below.

If this species, *X. lanceolata*, had not been already established, I should have referred the Mediterranean forms in question to *X. longicauda* as peculiarly deviating, "monstrous" forms. The larger, oval, meshes of the dilated part below, near the pointed end, were not seen in my specimens; they answer, however, rather well to the structure of the corresponding part, near the posterior end, of *X. longicauda* var. *clavata* (see fig. 40 p. 33).

These forms only occurred singly at the following localities, always accompanied by *X. longicauda*: sts. 163 (80 m.—0 m.), 182 (545 m. wire), 187 (190 m.—100 m., 945 m. wire), 204 (0 m.). They had the appearance of being unfinished as to development of the caudal prolongation.

*Total length 215 μ —234 μ , length of caudal prolongation 77 μ —110 μ , outer diameter of mouth 48 μ —51 μ .

BRANDT's species was taken sparsely in the Florida Current, in the Sargasso Sea and north-east of the Azores. LAACKMANN found it sparsely in a sample from New Amsterdam in the Indian Ocean (German South-Pole Exp., ²⁷/₄ 1903).

UNDELLA Dad.

Lorica of varying shape (in different species), oval to roundish, or cylindrical, short to moderately long, below rounded to acuminate or provided with a strongly developed caudal prolongation. No "collar" proper, nor helicoidal ("annulate") constitution of wall; the latter always with very well defined and separated lamellae, only merging into each other towards the posterior end, and usually approaching each other above, forming an erect, short tubular, oral ring, more thinwalled than the rest of lorica. Structure of lamellae and interstice generally invisible, or a more or less fine "primary" one, sometimes rather conspicuous.

The animalcule is as yet imperfectly studied, very few records being at hand, and then partly contradicting.

This genus shows connection with several of the others (with *Amphorella*, through *A. pachylocus*, with *Favella*, through *F. azorica*, with *Epiploeylis* and *Xystonellopsis*), but is generally very easily known.

I. Subgenus **UNDELLA** n. subg.

No caudal prolongation of lorica, or only a rudimentary one. Structure of (outer) wall very fine or indistinct; both lamellae frequently or mostly visible also at the posterior end.

The animalcule seems to have no distinct pedicle.

1. UNDELLA CLAPARÉDEI (Entz sen.) Dad. (Fig. 42 p. 39).

Daday 1887 p. 566, pl. 19 fig. 1. *Tintinnus claparèdei* Entz sen. 1885 p. 202, p. 14 figs. 10, 11. *Tintinnus* sp.? Claparède et Laackmann 1858 p. 210, pl. 9 fig. 5 a. *Undella claparèdei* Brandt 1907, incl. varr. c, e, f (*f. fastigata* n. nom.), g (*f. ovata* n. nom.), excl. var. b.

Lorica oval, with its maximum diameter in the middle, above or below. Wall of least thickness below, where the lamellae approach each other; thence the thickness is gradually increasing to somewhat below the mouth, where the inner lamella bends rapidly inwards before uniting with the outer lamella at the very border of mouth. The cavity of lorica therefore shows a very characteristic urn-like shape, being somewhat constricted below the mouth.

Length 65μ — 87μ , diameter of mouth 40μ — 45μ , maximum diameter 65μ — 72μ .

Is highly varying in shape and dimensions, apparently without a special geographical distribution of the different forms.

A relatively well defined form is

var. **angustior** n. nom. (Fig. 42 d).

Undella claparèdei var. d Brandt 1907 p. 364, pl. 64 figs. 9, 8, 33; var. a p. 363, pl. 64 fig. 3. Not *U. subacuta* Cl.

Lorica smaller and proportionately narrower than in the main species, towards the posterior end showing a slight indication of being pointed, but in the very end distinctly obtuse to rounded, with closely set lamellae.

Length 57μ — 64μ , diameter of mouth 28μ — 30μ , maximum diameter 46μ — 48μ .

BRANDT's fig. 3 shows a specimen somewhat obliquely, so that the pointed shape cannot be seen (compare LAACKMANN 1911 p. 471).

This common warm-water species was very frequent in the material of the "Thor", especially in winter, when it was taken at the great majority of stations, very frequently in greater numbers and often abundantly. It was found, indeed, from the most western station in the Bay of Cadiz — being there, at st. 69 in February, the predominating species (of Tintinnids) — all the way to st. 18 in the Bay of Aegina, most numerous in the Tyrrhenian Sea, present there everywhere and very numerous or dominating, save at a few more shallow stations near Naples. It was less numerous in the east, and especially in the most western regions, in the Alboran Sea, where it was absent at half the number of stations and otherwise scarce.

An immigration into the Mediterranean through the Straits of Gibraltar seems to take place (and succeed) in January and February, most easily in the former month — causing the occurrence at all stations along the African Coast in the Balearic — less in the latter, the species being plentiful in the Bay of Cadiz, but only noted for 3 out of 6 stations in the Alboran Sea, at two of these as var. *angustior*.

During the summer cruise the species was much scarcer and had mostly passed over into deeper layers. It is noted for the following summer stations: Sts. 81 (100 m. wire), 87, 89, 92, 95, 99, 106, 120, 126 (200 m.—100 m.; 500 m.—120 m., common; 275 m. wire, numerous), 128 (100 m.—0 m.), 129 (600 m.—0 m., 1100 m.—0 m., in both layers numerous), 132 (600 m.—195 m., common; 1090 m.—57 m., rather common), 134 (125 m.—75 m.; 200 m.—125 m., numerous; 350 m.—185 m.), 152 (250 m. wire, var. *angustior*; 950 m. wire, this variety and *f. fastigata*), 156 (250 and 950 m. wire, var. *angustior* and *f. fastigata*), 160 (1000 m.—200 m., these same forms), 170 (200 m.—85 m.; 1000 m.—195 m., *f. fastigata*, common), 175

50 m. wire, mostly *f. fastigata*; 1150 m. wire), 182 (545 m. wire, *f. ovata*), 184 (945 m. wire, the same), 185 (the same singly), 186 (245 m. wire, 1145 m. wire), 187 (945 m. wire), 189 (945 m. wire, numerous), 192 (545 m. wire), 194 (0 m., singly; 1145 m. wire, several), 196 (singly), 199 (200 m.—1000 m.; 945 m. wire, *f. ovata*), 204 (945 m. wire), 206 (1945 m. wire, numerous), 209 (200 m.—85 m.; 1000 m.

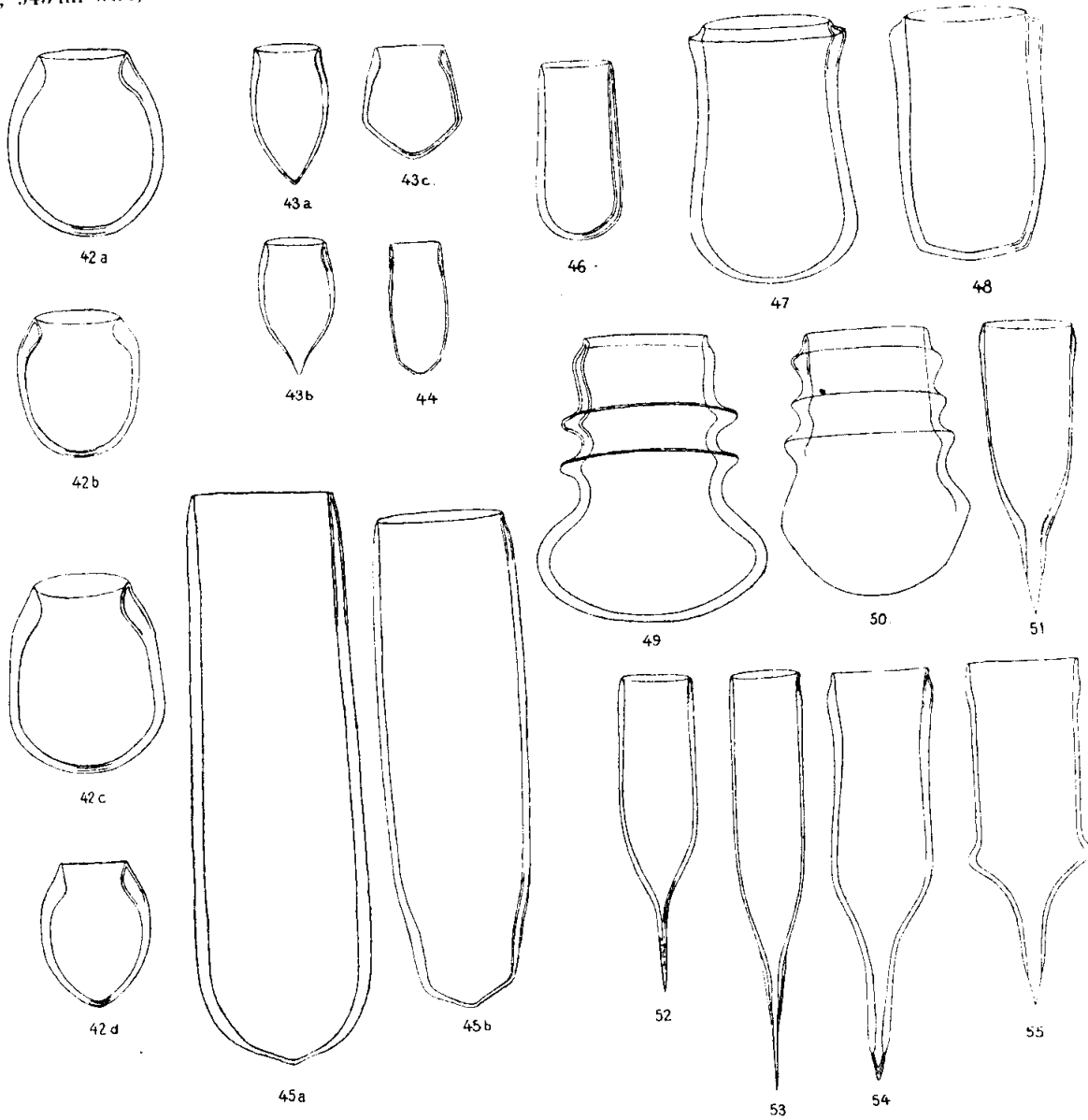


Fig. 42. *Undella claparèdei* (Eutz) Dad.; ^{350/1}. a: main species, Naupaktos. b: *f. fastigata* n. nom.; st. 152, 950 m. wire. c: *f. ovata* n. nom.; st. 184, 945 m. wire. d: *var. angustior* n. nom.; st. 16. Fig. 43. *Undella subacuta* Cl.; ^{350/1}. a: *f. acuta* n. f.; st. 206, 1945 m. wire. b: *var. subcaudata* n. var.; st. 68. c: *var. pentagona* n. var.; st. 156, 250 m. wire. Fig. 44. *Undella clevei* n. sp.; ^{350/1}. a: the main species; Straits of Messina, ^{20/3} 1911. b: *f. attenuata* n. nom. St. 186, in Salpæ. Fig. 45. *Undella hyalina* Dad.; ^{350/1}. a: the main species; Coast of Arabia near Ras Dshibsh, Handel-Mazzetti ^{20/30} 1910. St. 152, 250 m. wire. Fig. 46. *Undella dohrni* Dad.; ^{350/1}. forma?; ^{350/1}. Coast of Arabia near Ras Dshibsh, Handel-Mazzetti ^{20/30} 1910. St. 152, 250 m. wire. Fig. 47. *Undella marsupialis* Bdt.; ^{350/1}. St. 23. Fig. 48. *Undella marsupialis* Bdt., *f. subangulata* n. f.; ^{350/1}. St. 152, 250 m. wire. Fig. 49. *Undella collaria* Bdt.; ^{350/1}. St. 152, 250 m. wire. Fig. 50. *Undella tricoloraria* Laackm.; ^{350/1}. St. 11. The inner lamel detached below. Fig. 51. *Undella caudata* (Ostf.) Jörg.; ^{350/1}. Coast of Norway off Bergen, Decbr. 1901, 5 m.—8 m. Fig. 52. *Undella aculeata* n. nom.; ^{350/1}. St. 28. Fig. 53. *Undella aculeata f. longa* n. f.; ^{350/1}. St. 228, 1145 m. wire. Fig. 54. *Undella lohmanni* n. sp.; ^{350/1}. St. 28. Fig. 55. *Undella messinensis* Bdt.; ^{350/1}. St. 33.

—200 m., abundant and predominating; 945 m. wire, common; 1945 m. wire, rather numerous), 210, 211, 212, 213, 223 (1950 m. wire, singly), 228 (1145 m. wire, var. *angustior*, singly).

This list shows that the species is only apparently less frequent, having practically disappeared from the surface, whilst present everywhere below it. It is really absent only at a single station for deep water samples, 163. The only sample taken here from below the surface, was from 80 m.—0 m; the species being, however, as a rule found in considerably deeper layers, 200 m.—100 m. or even deeper, its absence at st. 163 is not astonishing.

It is remarkable that *Undella claparèdei* is very numerous or even common in several of these samples from deeper water, especially in those from the Tyrrhenian and the Catalonian Seas, as well as from very deep water in the Sea of Marmora.

A species of so wide a distribution as the present one is as a rule rich in different forms, at least partly caused by reaction against or adaptation to varying natural conditions. This was also to be seen in the material of the "Thor". The main species (Entz l. c.) was in the inner and deeper localities wholly or partly replaced by certain other forms, f. i. f. *fastigata* n. nom. Exact investigations in this regard, of this and other species with a wide distribution, will presumably add considerably to our knowledge as to how new forms and species arise by the action of varying surrounding conditions.

The variety *angustior*, which is a form leading over towards the two next following allied species, was noted from the following stations:

11, 14, 16, 18, 58 (alone; i. e. main species absent), 60 (much more numerous than the main species), 64 (alone), 66, 68, 69, 87 (more numerous than the main species), 134 (200 m.—125 m., rare), 152 (250 m.; 950 m. wire, alone), 156 (250 m. and 950 m. wire, more numerous than the main species), 160 (1000 m.—200 m.), 186 (245 m. wire), 187 (190 m.—100 m., without the main species; 945 m. wire), 189 (945 m. wire), 190 (alone), 209 (1000 m.—200 m., 1945 m. wire), 234 (100 m.—25 m.; 700 m.—200 m., numerous and alone).

Undella claparèdei is certainly indigeneous in the Mediterranean, but is probably partly renewed every year through immigration into the Mediterranean from the Atlantic, (from late autumn? to) in January and February, disappearing almost completely from the surface in summer. It was recorded from the Mediterranean already by ENTZ sen. 1885, from Naples (in Salpæ), by BRANDT (1907, from Messina, LOHMANN), by LOHMANN (1908) from Syracuse, by ENTZ jun. (1909) from the Northern Adriatic and by FORTI (1913) from the coasts of the Sea of Marmora.

Otherwise commonly distributed in the Atlantic, from about 41° S (6° W, CLEVE 1901 d) to 53° N 31° W (in April 1910) and to the south-west coast of Ireland (in April, CLEVE l. c.) and the Channel. It occurs frequently in greater numbers. Also known from numerous localities in the Indian Ocean, from 33° S (97° E) northwards, and from New Pomerania in the Pacific (BRANDT 1907).

2. UNDELLA SUBACUTA Cl. (p. p.) (Fig. 43 p. 39).

Cleve 1901 a, p. 923 fig. 4 a (not 4 b). Not *U. claparèdei* var. a ("subacuta Cleve?") Brandt 1907 p. 363, pl. 64 fig. 3, nor *U. clap.* var. *subacuta* Laackmann 1911 p. 471.

Lorica smaller than in the closely allied preceding species, more thin-walled and with a much less marked thickening of wall towards the mouth. Below it is distinctly pointed or acute, with — in var. *subcaudata* — or without — in f. *acuta* — a very short caudal prolongation.

The two lamellae of the wall close together in the lower portion of lorica or in the point below; in f. *subcaudata* the point is thin-walled, the inner lamella ending before the point.

There are several forms of loricae — belonging to Tintinnids — leading on the one hand over to the greater and more thick-walled preceding species, especially to its var. *angustior*, on the other hand to the following, which is very different from *U. claparèdei* in habitus. I have here provisionally tried to gather these forms under a common denomination, have, however, got the impression that there is more

than a single species with intermediate characters. CLEVE's species is described from his fig. 4 a; he has himself (l. c.) designated the fig. 4 b as a slenderer form of that species. As to the dimensions, there is no (essential) difference between his figures and his statements (compare LAACKMANN l. c. p. 472). Cleve has only avoided establishing another new species, answering to the "slenderer form."

A species or form, perfectly answering to CLEVE's fig. 4 a, has not yet been seen; however, to judge from the figure quoted, the lorica seems to have had a slightly oblique position, causing the maximum of diameter to be apparently somewhat displaced in a backwards direction (and the lorica to appear less acute at the posterior end?). To avoid incertitude I have given the forms observed by myself special denominations.

f. **acuta** n. forma (Fig. 43 a p. 39).

Lorica rather narrowly oval, the maximum diameter in the middle or slightly above (in CLEVE's fig. 4 a below the middle). The inner lamella visible to the posterior, distinctly acute, end of lorica.

Length 57μ — 60μ , diameter of mouth 28μ — 32μ , maximum diameter 33μ — 42μ , thickness of wall (above) up to 3μ — 4μ .

Sts. 11; 152 (950 m. wire, several), 156 (250 and 950 m. wire), 163 (80 m.—0 m.), 182 (545 m. wire), 187 (190 m.—100 m.), 189 (945 m. wire), 206 (1945 m. wire), 223 (1950 m. wire); everywhere, except at st. 152, singly.

var. **subcaudata** n. var. (Fig. 43 b p. 39).

Very similar to the preceding form, chiefly differing from it only in having a somewhat protracted, narrowly conical, acute lower end, thin-walled, because of the inner lamella not following to the extreme point, where the two lamellae are replaced by a single, thin wall.

Length 60μ — 62μ , diameter of mouth 30μ , maximum diameter 32μ — 38μ .

Sts. 28, 29, 33, 39, 68; 152 (250 m. and 950 m. wire), 156 (250 m. wire).

var. **pentagona** n. var. (Fig. 43 c p. 39).

Lorica mostly more or less distinctly pentagonal (in optical view), the greatest diameter below the middle. Thickness of wall very small, its maximum below the mouth distinctly visible, but not very conspicuous; the two lamellae apparently merging into another at or below maximum of diameter (of lorica). In optical view the lower end is obtuse-angled.

Length 51μ — 53μ , diameter of mouth 29μ — 32μ , maximum diameter 39μ — 42μ .

Considerably similar to CLEVE's fig. 4 a, but generally greater and proportionately broader.

Sts. 152 (250 m. wire), 156 (250 m. wire), 182 (545 m. wire), 189 (945 m. wire), 192 (545 m. wire), everywhere singly.

This form makes the impression of being a separate species. It is — as seen from the list of stations — only taken in deeper layers of the Eastern Mediterranean, where so many species of *Ceralia* and *Dinophysiacae* of markedly subtropical (or even tropical?) character are found occurring singly. I have also seen it from the Indian Ocean (about 12° N 58° E, $7/4$ 1912, S/S Scharnhorst, capt. TEXTOR) and from the south-eastern corner of Arabia ($23/10$ 1910, HANDEL-MAZZETTI).

The variety *subcaudata* is the most easily known of these forms, on account of its protracted, thin-walled, posterior end, and might very well be considered a separate species. I have, however, the impression that it may not always be safely distinguished from the forma *acuta*, which again is closely allied to *Undella claparèdei* var. *angustior*.

3. **UNDELLA CLEVEI** n. sp. (Fig. 44 p. 39).

Undella subacuta forma Cleve 1900 p. 923 fig. 4 b. *U. Dohrni?* DADAY 1887 p. 566, pl. 18 fig. 22.

Sts. 14, 26, 28, 29, 33; 152 (250 m. wire), 182 (545 m. wire), 186 (in Salpæ), 187 (945 m. wire), 206 (1945 m. wire), 209 (80 m.—33 m.), everywhere singly.

Lorica almost cylindrical, generally slightly wider at or below the middle, below short and broadly conical and slightly acute. Wall rather thin, below the mouth slightly or imperceptibly thickened, the two lamellae distinct and distinctly separated down to near the end, where they merge into each other. The mouth sometimes slightly dilated.

Length $55\ \mu$ — $71\ \mu$, diameter of mouth $23\ \mu$ — $31\ \mu$, maximum diameter $25\ \mu$ — $32\ \mu$.

Is much more closely allied to *Undella hyalina* than to *U. claparèdei*.

This species seems to be rather widely distributed in deeper layers of the Mediterranean in summer. On account of its narrow loricae it presumably slips easily through the net.

It answers in dimensions to *Undella dohrni* Daday, save in diameter of mouth, this being stated by DADAY as only $14\ \mu$. It was, however, remarkably varying in shape (and thickness of wall); therefore, it is not quite impossible that DADAY'S species may be a similar form. BRANDT considers it to be a form of *Undella claparèdei*, which seems to me very improbable. (See below p. 43).

4. UNDELLA HYALINA Dad. (Fig. 45 p. 39).

DADAY 1887 p. 564, pl. 18 fig. 17; BRANDT 1907 (incl. var. a, b, excl. var. c).

Sts. 10, 11, 12, 14, 15, 16, Naupaktos (many), 18, 20, Taormina, Naples, 23, 24, 25 (several), 26, 28 (several), 29, 31, 33, 38, 39, 40, 42, Galita, 45, 46, 50, 53, 55, 57, 59, 60, 64, 66, 68, 69; 92, 95, 96, 98, 126 (500 m.—120 m., 275 m. wire), 128 (100 m.—0 m.), 129 (80 m.—0 m., 1100 m.—0 m.), 132 (600 m.—195 m.), 134 (75 m.—0 m.), 125 m.—75 m., 200 m.—125 m., 350 m.—185 m.), 152 (250 m. and 950 m. wire), 156 (250 and 950 m. wire), 160 (30 m.—0 m., 100 m.—30 m., 200 m.—100 m., 1000 m.—200 m.), 163 (80 m.—0 m.), 185, 189 (945 m. wire), 192 (545 m. wire), 194 (0 m., 1145 m. wire), 199 (30 m.—0 m., 945 m. wire), 203, 204 (945 m. wire), 206 (1945 m. wire), 209 (80 m.—33 m., 1000 m.—200 m., 1945 m. wire), 216, 217, 220, 221, 223 (1950 m. wire, many), 224, 225, 228 (0 m., 1145 m. wire), 229, 231 (0 m., 1145 m. wire), 234 (25 m.—0 m., 700 m.—200 m.), singly or sparse, if not otherwise mentioned.

Lorica large, almost cylindrical, sometimes slightly narrowing towards the mouth, usually narrowing slowly in the lower $\frac{1}{5}$, then abruptly, to a rounded or low conical and very obtuse end. Frequently the lorica is almost exactly cylindrical down to the posterior end, which is short and broadly conical or rounded. The two lamellae of the wall well developed (thickened) and well separated, at the mouth approaching each other, below more distant, at the posterior end merging into a single, thin wall, or in contact with each other, or slightly separated. Wall of lorica accordingly thinnest towards the mouth and at the posterior end, thickest about at the lower $\frac{1}{6}$.

Length $180\ \mu$ — $255\ \mu$, diameter of mouth about $60\ \mu$. Sometimes considerably shorter individuals are found (sts. 231, 234, outside the Mediterranean); the diameter is, however, only slightly varying.

The animalcule is fixed at the posterior end of lorica by the attenuated end of the body, or — as also in *U. claparèdei* — by 2 or 3 short branches (DADAY 1887, ENTZ jun. 1909). The peristome collar has rounded lobes (see DADAY l. c.). Two oval macro- and two rounded micronuclei (DADAY l. c., ENTZ jun. l. c.).

The most common form, also in the Mediterranean is

f. *attenuata* n. f. (Fig. 45 b p. 39).

U. hyaline var. a Brandt 1907 p. 359, pl. 63, figs. 1—3, pl. 64 fig. 17.

This is the form with the gradual conical narrowing in the lower part of lorica.

BRANDT considers as the main species the long and almost completely cylindrical form (fig. 45 a), founded on DADAY'S figure quoted, which, however, is scarcely exact enough to be used for identification of special forms. In this case the great length, stated by DADAY to from $220\ \mu$ up to $240\ \mu$, decides the question; the commoner form, *attenuata*, being generally considerably shorter. This greater form I have noted from sts. 16; 132, 185, 189, 192, i. e. from the Eastern Mediterranean and the Tyrrhenian Sea.

Undella hyalina was very frequent in the Mediterranean. In winter it was present almost everywhere along the route, as a rule sparsely, in a few places nearer the coast more numerous (sts. 28, Nau-paktos, off Naples). In summer it was noted from 18 of the 22 stations where deep-water samples were taken, from somewhat less than 100 m. to more than 200 m.; at the surface it was absent everywhere east of Sardinia, save at st. 185, whilst it was frequently met with also in the upper layers of the most western regions, the western Balearic and the Alboran Sea, though always more sparsely than in deeper layers. At st. 223 it was rather numerous at a greater depth (1950 m. wire), a fact, suggestive of an emigration from the Mediterranean through the Straits of Gibraltar into the Atlantic. These "wire-samples" may, however, in regard to microplankton easily lead to false conclusions, having caught material also during the hauling in of the net.

This species is certainly indigeneous in the Mediterranean, but is also partly renewed every year by immigration into the Mediterranean from the Atlantic, in winter (January and February) causing an increase in numbers in the western regions, in June apparently failing, in September again succeeding. Very probably a successful invasion takes place from autumn to late winter; I have seen f. *attenuata* from the Straits of Gibraltar in Decbr. 1908 (S/S "Sevilla", capt. J. RÖD).

It was first recorded from the Mediterranean by DADAY 1887, as a new species (from Naples). Later it was mentioned by BRANDT 1907 from Messina (taken by LOHMANN), by ENTZ jun. 1904 from the Northern Adriatic, and by LOHMANN 1908 from Syracuse.

Otherwise known from the Atlantic, from 30° S 9° W (the "Fram", July 1911) to about 39° N in the Florida Current (BRANDT l. c.) and to the Azores — where present January to March, as well as October and November (CLEVE 1901 d) — as well as to the west coast of Portugal. Generally only scarce, more numerous in the Sargasso Sea (BRANDT l. c.). Also taken at many places in the Indian Ocean between South Africa and Australia (according to LAACKMANN 1911 and to samples in my possession). In the Pacific taken at the Tonga Isles (BRANDT 1907).

5. UNDELLA DOHRNI Dad.

Daday 1887 p. 366, pl. 18 fig. 22.

This species, taken at Naples by DADAY in few specimens in March, was not with certainty seen by myself in the material of the "Thor". According to DADAY's description and figure it should answer to *U. clevei*, only being much more narrowed above, to 14 μ diameter of mouth, and correspondingly bulging below.

I have seen another species (east coast of Arabia, HANDEL-MAZZETTI, ²⁰/₁₀ 1910), similar to a very small specimen of *Undella hyalina*, below somewhat dilated and rounded, which also in part answers to *U. dohrni*, but has a much wider mouth: length 74 μ , diameter of mouth 31 μ , maximum diameter 36 μ (fig. 46). It is considerably more thick-walled than *U. clevei*. This is probably the same form which BRANDT (1907 p. 359) lists as *U. hyalina* var. c from the North Equatorial Current ("Pl. 66"), if there might be some mistake as to the length stated (155 μ). No magnification is quoted for the corresponding figure (pl. 64 fig. 19); if we suppose it to be 550 — which is used for many other figures of the same plate, instead of 225, used in figs. 16—18 — the dimensions are 62 μ (length), 23 μ (diameter of mouth), 28 μ (maximum diameter), answering tolerably well to those in DADAY (63 μ , 14 μ , 36 μ), only the mouth is again much too wide.

OSTENFELD and SCHMIDT (1901 p. 182) record DADAY's species — as *U. claparèdei* var. *dohrni* — from the Gulf of Arabia, without figure or description.

6. UNDELLA MARSUPIALIS Bdt. (Figs. 47, 48 p. 39).

Brandt 1906 p. 8, pl. 63 figs. 7, 8, pl. 64 fig. 20.

Sts. 14, 20, 23, 24, 25, 26, 28, 29, 31, 33, 36, 38, 39, 40, 42, 55, 59, 60, 68, 69; 81 (100 m. wire), 87, 89, 126 (200 m.—100 m., common; 500 m.—120 m.; 275 m. wire, common), 128 (100 m.—0 m.), 129

(600 m.—0 m.; 1100 m.—0 m., many), 132 (600 m.—195 m., 1090 m.—57 m.), 134 (75 m.—0 m., 125 m.—75 m.), 152 (250 m. wire, many; 950 m. wire, many), 153, 156 (250 m. wire, 950 m. wire), 160 (200 m.—100 m., 1000 m.—200 m.), 175 (350 m. wire, 1150 m. wire), 179, 182 (545 m. wire), 186 (245 m. wire, 1145 m. wire), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), 192 (0 m., 545 m. wire), 194 (0 m.; 1145 m. wire, many), 195, 199 (200—80 m., many; 945 m. wire), 200, 202, 204 (0 m., 945 m. wire), 206 (1945 m. wire), 209 (200 m.—85 m., 1000 m.—200 m., 945 m. wire; 1945 m. wire, many), 210, 223 (1950 m. wire), 234 (100 m.—25 m., 700 m.—200 m.). Scarce, if not otherwise mentioned.

Lorica short and wide, in side view almost rectangular, slightly swollen just below the mouth, then of almost equal width to the middle. In the lower half, it is either somewhat widened towards the abruptly and broadly rounded end, or of almost equal width, or in the lower $\frac{1}{3}$ narrowing by convex lateral outlines towards a slightly polygonal lowest portion, showing (on the optical section) more or less marked lateral corners. The two lamellae of the wall strongly developed (thickened) and distant, closer at the lower end and particularly at the mouth, where both lamellae are in contact or fused, forming a proportionately thin, obliquely upward an inward directed upper rim, protected and supported by a lower outer one, more or less distinctly protruding on the swollen part mentioned.

Length $102\ \mu$ — $128\ \mu$, diameter of mouth $51\ \mu$ — $54\ \mu$, upper maximum diameter $68\ \mu$ — $71\ \mu$, lower $64\ \mu$ — $71\ \mu$, maximum thickness of wall (at the swollen part above) about $7\ \mu$.

The first above quoted figure in BRANDT, pl. 63 fig. 7, is according to my own experience, an uncommon form — it is much wider below than above — and should therefore be avoided as representative of the main species, whereas his fig. 8 shows a common form. This may be taken to represent the main species, no other being chosen before.

This main species, showing a secondary maximum of diameter more or less far below the middle, was in the material of the "Thor" present at the following stations: 153, 175 (350 m. wire, 1150 m. wire), 179, 192 (0 m., 545 m. wire), 194 (0 m., 1145 m. wire), 199 (200 m.—80 m.), 204 (0 m.), 206 (1945 m. wire), 209 (1100 m.—200 m., 945 m. wire; 1945 m. wire, many), 210, 234 (100 m.—25 m., 700 m.—200 m.), always singly or very sparsely, save at st. 209, 1945 m. wire. Also present in winter.

The most frequent form taken during the summer cruise, and the only one occurring in greater numbers, was the following,

f. *subangulata* n. f. (Fig. 48 p. 39).

Differs from the main species in the absence of a marked secondary maximum of diameter below, and in showing more or less distinctly angular corners between the lateral and the posterior outlines.

Undella marsupialis is otherwise rather constant; frequently, however, particularly in summer samples from deeper water, a form with only a faintly pronounced or lacking lower maximum of diameter is met with, similar to f. *subangulata*, but without the angular corners below. This form, f. *subcylindrica* n. f., passes, however, apparently without a definite limit over into the form mentioned.

This species was very frequent in the Mediterranean, also in winter, though in that season always very scarce. In summer it was taken all the way from the north-western coast of Portugal as far as into the Sea of Marmora, in the Mediterranean, however, almost exclusively in deeper water, only at 8 stations — 7 of them in the Western Mediterranean — at the surface, and at all of these singly or very scarce, whilst below it was not seldom rather plentiful. It is also noteworthy that it was the main species which was generally met with in the surface, whereas this same form usually or mostly was lacking in deeper layers, or, at any rate much rarer there than f. *subangulata* (and f. *subcylindrica*). Forms intermediate between the main species and the other two mentioned, were not rare.

All this seems to me to suggest that the main species in the Mediterranean gives rise to the two deviating forms mentioned, particularly where the latter are present in greater numbers.

Direct indications of an immigration from the Atlantic into the Mediterranean are lacking; the distribution in winter might, however, be suggestive of such an immigration in late autumn. I have seen

8. UNDELLA TRICOLLARIA Laackm. (Fig. 50 p. 39).

Laackmann 1911 p. 470, pl. XLIX figs. 18, 19.

Very near to the preceding species, but much less swollen below, and with a more pronounced annular and somewhat acutely projecting widening below the mouth. Also, the distance between the first and the second annular widenings is but slightly greater than between the two following.

Also in this species forms with less pronounced or obsolete upper (1st) or lower (4th) annular widenings are met with; they were, however, not observed in the Mediterranean.

Length 118 μ , diameter of mouth 55 μ , maximum diameter (at the 4th widening) 84 μ . Diameter of 1st annular widening 65 μ , situated at a distance of 9 μ —10 μ below the mouth, diameter of 2^d widening 67 μ , at a further distance of 19 μ , diameter of 3^d widening 75 μ , distance 17 μ ; the 4th widening (at its maximum) 32 μ farther down, usually much less acute or sometimes even lacking (see LAACKMANN l. c. fig. 19).

I saw this species only in the sample from st. 11 in the Jonian Sea in Decbr. Otherwise only known from the Brazil Current, west of South Africa (German South-Pole Exp., 18th—22^d of Aug. 1903, LAACKMANN l. c.).

II. Subgenus PARUNDELLA n. subg.

Loricæ more or less elongated, with a well developed, simple caudal prolongation. Structure of (outer) wall generally very well visible, frequently rather conspicuous, though only a "primary" simple one. Lamellæ generally rather approximated, though as a rule distinctly separated, save at the posterior end where they are merging into each other, forming a single-walled lower and generally firmer part of the caudal prolongation.

Is nearly allied to the genus *Xystonellopsis* (see below).

9. UNDELLA CAUDATA (Ostf.) Jörg. (Fig. 51 p. 39).

Jørgensen 1900 p. 95. *Tintinnus caudatus* Ostenfeld 1899 b, p. 438 fig. 2 e (p. 437). *Undella pellucida* Jørgensen 1899 p. 41, pl. I figs. 7, 8. *U. lachmanni* Brandt 1907 p. 367, pl. 64 fig. 26, incl. var. a, p. 368, pl. 64 figs. 25, 27 (not var. b caudata).

Lorica in the upper half cylindrical, frequently slightly dilated somewhat below the mouth, in the middle sometimes slightly narrowed, but then again dilated to a somewhat greater width than in the upper half; below it is narrowing more rapidly, by convex lateral outlines, merging imperceptibly into a rather short, narrowly conical and acute caudal prolongation, thin-walled and with a rather broad, conical cavity. Both lamellæ of the wall well developed and distinctly separated for about the upper half of the caudal prolongation, then merged into a single thin wall. Thickness of wall, or distance of lamellæ, greatest above, slightly below the mouth, as well as below, about where the lorica proper passes over into the caudal prolongation. Alary ribs or plicæ from the upper portion of this prolongation up to the lower one of lorica, may be present.

Total length usually 110 μ —125 μ , exceptionally down to 90 μ , or up to 179 μ , length of caudal prolongation usually 34 μ —42 μ ; diameter of mouth usually about 40 μ , up to 46 μ . Length of the conical, single-walled, lower part of caudal prolongation usually 17 μ —20 μ .

In my quoted paper of 1899 the diameter of mouth is erroneously stated to be 65 μ and 62 μ (in the two cases mentioned there), which may be a printer's error (for 45 μ and 42 μ).

Only a very fine primary structure.

This species is closely allied to the following; nevertheless it is so different from it in the constitution of the lower (posterior) part of the lorica that they should be considered separate species, at least provisionally. In this subgenus there are several closely allied species, needing further examination before the true limits can be drawn.

the species in a sample from the Straits of Gibraltar in Decbr. 1908 (the Sevilla, capt. J. RÖD). It certainly is, however, a true Mediterranean species, though only in winter frequent at the surface; in summer it is generally present everywhere at some deeper level — noted for 19 out of 22 stations — partly abundant, particularly in the Tyrrhenian Sea.

Was first reported from the Mediterranean by BRANDT 1907 (Messina, taken by LOHMANN), later by LOHMANN 1908 from Syracuse, and by ENTZ jun. 1909 from Naples (in December).

Otherwise the species is as yet only known from rather few localities: Off the south-western coast of Africa, in the Brazil Current (LAACKMANN 1911), frequent and partly present in somewhat greater numbers in the North Equatorial Current, west of Africa, and sporadically, as well as very scarce, in the Sargasso Sea and the Gulf Stream, as far as west of the Straits of Gibraltar (in October, BRANDT l. c.). I have also seen it in a sample from the Pacific (off the coast of Mexico, 21° N 106° 25' W, the Alden, capt. KARS, 14/2 1910).

These, relatively few, localities, compared with the wide distribution in the Mediterranean, seem to indicate that the species properly belongs to deeper layers. The exact depth of these in the Mediterranean cannot easily be determined; it seems, however, generally to answer to the depth where the density of water grows more constant (σ_t about 28.9 to 29.0 for the stations where the species was occurring in greater numbers). This may, however, be interpreted in two different ways; the species may require this density, to be able to keep floating, or the dead individuals (or loricae), may sink into and gather in this layer. Loricae with remains of the animalcule were sometimes, it is true, found at a considerable depth (f. i. at st. 223, 1950 m. wire); the animalcule may, however, have been dead. Besides, empty loricae are always greatly in the majority.

Nevertheless, both the present and several, or even many, other species of Tintinnids certainly (when alive) chiefly belong to deeper layers, at any rate in the Mediterranean in summer.

7. UNDELLA COLLARIA Bdt. (Fig. 49 p. 39).

Brandt 1906 p. 8, pl. 63 fig. 12, pl. 64 fig. 21; 1907 p. 361 (incl. var. a).

Sts. 152 (250 and 950 m. wire), 156 (950 m. wire), 160 (200 m.—100 m.), 182 (545 m. wire), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), always singly or very sparse.

Lorica similar to one of the preceding species, strongly swollen below; it is, however, in the middle and above provided with two, strongly pronounced and very prominent annular dilations.

Length 122 μ —130 μ , diameter of mouth 55 μ , maximum diameter (below) 96 μ —100 μ .

In this and the closely allied following species there are four, more or less strongly pronounced annular widenings, of which in the present species the two median, more approximated ones, are acutely prominent. The upper one is in this species obsolete and situated near the mouth, as in *U. marsupialis*; its outer (and upper) border is showing as a faint or indistinct line parallel to the orificial rim, 9 μ —10 μ below the latter. The distance from the same to the next widening of the lorica, an acutely projecting annular rib, is about 25 μ , maximum diameter of the latter = 72 μ —77 μ , the distance farther on to the next annular rib, similar to the preceding, about 21 μ , diameter of the rib = 77 μ —83 μ , i. e. slightly greater than the preceding. The fourth annular widening is much broader (higher) and rounded off; its maximum diameter is 96 μ —100 μ , and is situated at a distance of 45 μ —47 μ below the third dilation. Thickness of wall up to 7 μ , only less at the mouth and at the broadly rounded posterior end.

This beautiful species seems not to have been observed before in the Mediterranean.

In the material of the "Thor" it was only noted for deeper layers in the Eastern Mediterranean, 200 m.—100 m., perhaps also deeper.

Otherwise only known from the Sargasso Sea (at many places, BRANDT l. c.). Allied forms or species are rather widely distributed in the southern Atlantic, between South-Africa and South-America (the "Fram" 1911).

Is a northern Atlantic, cold-temperated species, distributed from 38° N off the coast of North America (the "Texas", April 1910, capt. PEDERSEN) northwards to Iceland (OSTENFELD 1899 and 1900) and to Lofoten (JØRGENSEN 1905), to the south perhaps as far as the Azores (CLEVE 1901 d and 1902 b). More southerly situated localities (CLEVE l. c., LAACKMANN 1911) require further confirmation.

In the material of the "Thor" I saw this species only in stomachs of *Salpæ* from st. 80 (Bay of Biscay). (Length of lorica varying). It is not known from the Mediterranean, but has been confounded with the following warm-water species.

10. UNDELLA ACULEATA n. sp. (Fig. 52 p. 39).

U. lachmanni var. *b caudata* Brandt 1907 p. 368, p. 64 figs. 24, 24 a, 14; Laackmann 1911 p. 474. Not *Tintinnus caudatus* Ostf.

Sts. 28, 55, 59, 60, 68; 81 (100 m. wire), 132 (600 m.—195 m.), 134 (125 m.—75 m., 200 m.—125 m.), 152 (950 m. wire), 182 (545 m. wire), 194 (0 m., 1145 m. wire), 199 (200 m.—80 m.), 206 (1945 m. wire), 223 (1950 m. wire) 228 (1145 m. wire), 234 (100 m.—25 m., 200 m.—95 m.), always singly or very few individuals.

Very near to the preceding species; lorica, however, with a longer and narrower caudal prolongation, in the lower part subulate or needleshaped, with a thickened, single and homogeneous wall and a narrow inner cavity or channel, or sometimes apparently wholly or partly solid. Lorica almost cylindrical as far as or to somewhat below the middle, then conically protracted in a downward direction, with almost perfectly straight or somewhat convex lateral outlines passing over into a rather offset, narrow caudal prolongation. Thickness of wall generally somewhat less than in the preceding species, only slightly greater above and below. The two lamellæ of the wall everywhere distinctly separated down to the narrow caudal prolongation, where they merge into each other about in the middle. This lower half of the caudal prolongation is very firm in consistence and more conspicuous in water than the rest of the lorica, recalling the corresponding lower spine-like part in *Xystonella acus*. The channel-like cavity inside generally distinct in the upper part of the subulate end, frequently also visible to the very end, but seems sometimes to be lacking. Alary edges or ribs from the upper portion of caudal prolongation, up to the lower part of lorica, may be present, but are generally narrow and inconspicuous.

Total length 130μ — 187μ (*f. longa*), of lorica proper 100μ — 128μ ; diameter of mouth 31μ — 40μ . Length of subulate part below up to 35μ or sometimes more; thickness of wall about 2μ only.

f. longa n. f. (Fig. 53) has a more protracted lower part of lorica, and a longer caudal prolongation than usual.

Sts. 228 (1145 m. wire), 234 (700 m.—200 m.), singly.

Undella aculeata is rare and scarce in the Mediterranean, during the winter cruise only met with in the Alboran Sea and near Naples, in summer sporadically in deeper layers, again particularly between 100 m. and 200 m., or deeper, all the way from the Alboran Sea as far as to Euboea, but only at a single station present at the surface (at st. 194 where many species, otherwise only noted for deeper layers, were met with at surface, probably on account of the submarine ridge in the Straits of Messina).

Otherwise it is as yet only known with certainty from scattered localities in the Atlantic, from about 28½° S in the Benguela Current, west of southern South-Africa (German South-Pole Exp., 11/8 1903, see LAACKMANN l. c.), to the meeting of the Florida and the Labrador Currents, far south-east of Nova Scotia (BRANDT l. c.). I have seen a species or form very similar to the *f. longa* from the Indian Ocean (43° S 99° E, S/S Akershus, March 1911, capt. MARTIN).

We should probably also include here the *Undella caudata*, by CLEVE (1901 c) reported from the southern Indian Ocean, and by OSTENFELD (1907) from the Benguela Current, as well as most of the localities south of the Azores reported by CLEVE (1901 d and 1902 b).

"*Undella lachmanni*" is in the first instance recorded for the Mediterranean by LOHMANN (1903 and 1908) from Syracuse, and later by ENTZ jun. (1909) from Naples, in both instances without figure or description.

In the material of the "Thor" there is a faint indication of immigration into the Mediterranean from the Atlantic in February (and perhaps in May (?), presence at st. 134), but none in June, nor in September. The very scarce occurrence at the surface in winter may perhaps indicate that the species has some difficulty in keeping alive in the Mediterranean for a longer time, and that it is maintained by a faint immigration into the Mediterranean from the west (in winter and spring?), passing over to deeper level in the inner regions.

11. UNDELLA LOHMANNI n. sp. (Fig. 54 p. 39).

U. messinensis BRANDT 1906 p. 9 p. p., pl. 64 fig. 29, 1907 p. 369 p. p. *U. lachmanni* DADAY? 1887 p. 568, based on CLAPARÈDE & LACHMANN 1858 p. 210, pl. IX fig. 5 b.

Sts. 28, 33, 68; 87, 126 (275 m. wire), 132 (600 m.—195 m.), 134 (200 m.—125 m., 350 m.—185 m.), 152 (950 m. wire), 182 (545 m. wire), 187 (945 m. wire), 189 (945 m. wire), 192 (545 m. wire, several), 194 (0 m., 1145 m. wire), 200, 204 (945 m. wire), 206 (1945 m. wire), 209 (1000 m.—200 m., 1945 m. wire), 210, 223 (1950 m. wire), 228 (1145 m. wire), 234 (200 m.—95 m.), scarce or even singly except at st. 192.

Lorica on the whole cylindrical, below the mouth somewhat dilated — the outer lamella curving outwards — then slowly narrowing by concave lateral outlines to a minimum diameter slightly above the middle of lorica proper, then again widened to a secondary maximum of diameter near the end of lorica proper, here by rounded lateral outlines passing over into a large and broad caudal prolongation, the cavity of which in the lower portion is narrowly conical, very acute, with a somewhat thickened, but single wall. The two lamellæ of wall everywhere well developed and separated, save in the pointed end, where they merge into each other. The outer lamella is particularly well developed (thickened) at the lower maximum diameter of lorica, the distance of the lamellæ greater at the widening below the mouth, as well as in the caudal prolongation, above the single-walled lower part of it. At the mouth a well-developed, rather thin-walled, but firm rim, formed by the two adjacent lamellæ; this rim is found by many species of *Undella* and allied genera. Alary plicæ rare or lacking.

Length of lorica proper 111 μ —137 μ , of caudal prolongation 45 μ —53 μ ; diameter of mouth 40 μ —43 μ , at the upper maximum diameter 45 μ —47 μ , at the lower 43 μ —47 μ . The posterior, single-walled point narrow and short, 12 μ —15 μ in length \times 3 μ —4 $\frac{1}{2}$ μ in breadth at its base. In concentrating watery glycerine the lorica contracts easily and considerably above the middle.

Is very similar to *Undella caudata* (*U. pellucida*), but obviously specifically different from it.

In regard to the name *Undella lachmanni* I should like to point out that DADAY, when establishing this species, only knew it from the quoted figure in CLAPARÈDE et LACHMANN, giving this figure a special denomination. Later on, several similar species were found to exist; most of them were already known to BRANDT (1906). These forms he grouped under two different species, *Undella lachmanni* and *U. messinensis*. He has obviously not seen the true "main" form of the former species, but only more or less "similar" ones. A form exactly answering to the figure in Claparède et Lachmann is also as yet unknown, very probably because this, and other figures in older works were not intended to serve as a means for distinguishing a series of very similar forms, these being still unknown. These old figures should never be used for determining special forms.

In this case there are two different species or forms answering to the figure quoted, the present species and the northern *U. caudata*. The latter was, however, by BRANDT considered identical with the above described warm-water species *U. aculeata*, which in any case deserves a special name, to distinguish it from the true northern species. In my opinion, however, the present species, which BRANDT confounded with his *U. messinensis* (or referred to this species without a special denomination or mention), is more

probably that of CLAPARÈDE et LACHMANN. They agree as to shape of lorica, but the last mentioned species shows no offset caudal prolongation. They agree also as to length, this being in CLAPARÈDE'S figure about $180\ \mu$, whilst *U. caudata* in the open Atlantic is generally much shorter. Besides, CLAPARÈDE'S species was taken together (?) with *U. claparèdei*, which is a warm-water species, whilst *U. caudata* is a cold-temperate one.

CLAPARÈDE'S species can hardly be the same as *U. lachmanni* above, both differing considerably, in shape as well as in development of the posterior end. If this older name should be kept, it must be used instead of the well-established name, *U. caudata*, if not transferred to the present species. On account of this intricate state of things I should propose to drop the older name, considering also the improbability of any certain identification in future.

This new species proved to have a wide distribution in the Mediterranean. In winter it was only met with at two stations in the Tyrrhenian Sea in addition to one in Bay of Cadiz, in summer, however, it was present all the way from the south-western corner of Portugal as far as Euboea, but generally in deeper layers, from 100 m. to 200 m. or more. It was taken at the surface only at three stations (in summer), but in deeper layers at 14 of the 22 Mediterranean stations where deep-water samples were taken; it must therefore be frequent at deeper levels, though always very scarce.

It was first recorded for the Mediterranean by Brandt (l. c.), as taken at Messina by Lohmann.

12. UNDELLA MESSINENSIS Bdt. (Fig. 55 p. 39).

BRANDT 1906 p. 9, pl. 64 figs. 13, 30 (excl. fig. 29 and var. a).

Sts. 33, 35; 129 (600 m.—0 m., 1100 m.—0 m.), 132 (600 m.—195 m.), 134 (200 m.—125 m., 350 m.—185 m.), 170 (200 m.—85 m., here the predominant species of Tintinnidæ; 1000 m.—195 m., rather numerous), 175 (350 m. wire, predominant), 194 (1145 m. wire), 199 (945 m. wire), 204 (945 m. wire, several), 206 (1945 m. wire), 209 (1000 m.—200 m., 1945 m. wire), 234 (700 m.—200 m.). Only very scarce, if not otherwise mentioned.

Lorica of a very characteristic shape; above, at the mouth, rather thin-walled and erect, with closer set lamellae of the wall, then somewhat swollen, then again cylindrical or very slowly narrowing, by almost perfectly straight lateral outlines, to near the lower end of lorica proper, where rapidly dilated and then almost abruptly constricted, by concave lateral outlines passing rapidly over into a broad and strong caudal prolongation, similar to that of the preceding species, but with a broader and longer, single-walled point.

At the lower maximum diameter the outer lamella is still more thickened than in the preceding species, being strong enough to maintain the special shape of the lorica — at any rate in its lower part — even in concentrating glycerine-water.

Length of lorica proper $107\ \mu$ — $111\ \mu$, of caudal prolongation $38\ \mu$ — $45\ \mu$; diameter of mouth $50\ \mu$ — $52\ \mu$, upper maximum diameter $51\ \mu$ — $53\ \mu$, lower $52\ \mu$ — $53\ \mu$. The single-walled point at the posterior end rather thin-walled, $17\ \mu$ — $20\ \mu$ in length by $5\frac{1}{2}\ \mu$ — $6\frac{1}{2}\ \mu$ broad at its base.

Several or many alary plicæ from lower end of lorica to upper of caudal prolongation, generally rather narrow.

I have reserved the specific name *messinensis* for this form, being the first figured (l. c.) under this name, in BRANDT.

This species was very rare in the winter samples, probably on account of its being rare at the surface, as is the case with many species of *Undella*. During the summer cruise it proved to be considerably rarer than the preceding species. It was not observed to occur in the Eastern Mediterranean, though recorded from deeper layers of the Sea of Marmora, at two stations, where it even proved to be the predominant species of Tintinnids.

As yet only known from the Mediterranean, first taken by LOHMANN at Messina (BRANDT l. c.).

U. messinensis "var." Brandt (l. c. p. 369, pl. 64 figs. 15, 28) is probably also a new species, different from the true *U. messinensis*, as defined above. To judge from my notes it was perhaps seen in the sample from st. 60, different from the two preceding species; I did not, however, meet with it in the summer plankton.

XYSTONELLOPSIS n. gen.

Loricæ elongated, at the mouth with a thin-walled, but firm, more or less developed, short rim, formed by the closer-set lamellæ and not offset from the rest of the lorica. A similar rim is present in many or most species of *Undella*. Wall otherwise as in the latter genus, showing two well developed and limited, and well separated lamellæ, with a more or less fine "primary" structure without greater, "secondary" meshes. Caudal prolongation provided with a similar annular or umbellate (cup-shaped) thickening as in certain species of *Xystonella*, frequently also with longitudinal plicæ and a coarse structure near this thickening, where the caudal prolongation is abruptly narrowed to a more or less subulate point.

This genus is closely allied to *Undella*, as well as to *Favella* and *Xystonella*. From the two latter genera it is easily known by the quite different mouth, with a rather thin, single rim or border, instead of a broad mouth, with an outer and inner rim (border).

1. XYSTONELLOPSIS SCYPHIUM n. sp. (Fig. 56 p. 51).

Sts. 68; 129 (1100 m.—0 m.), 132 (600 m.—195 m.), 152 (950 m. wire), 156 (950 m. wire), 184 (945 m. wire), 185, 186 (0 m., 245 m. wire, 1145 m. wire), 187 (945 m. wire), 189 (945 m. wire), 199 (945 m. wire), 204 (945 m. wire), 206 (1945 m. wire), 209 (1945 m. wire), 234 (700 m.—200 m.). Generally very scarce; at st. 186, 1145 m. wire, in somewhat greater numbers; at st. 184 (Bay of Corinth) abundant.

Lorica as in *Xystonella favata* BRANDT (1906 p. 7, pl. 44 fig. 2, pl. 47 fig. 5), but much smaller and with a shorter upper part (i. e. above the sudden narrowing) of caudal prolongation. Lorica at the very mouth slightly dilated, a little lower faintly, but distinctly, swollen, then with gradually more converging lateral outlines beautifully poculiform (see fig. 56 a), below passing over into a rather short and broad upper part of caudal prolongation, ending as usual cross-cut, but continued through a strong, but single-walled, subula, only half as broad, without visible structure.

Wall of lorica everywhere above this subulate end double, with — at any rate in the upper half — well separated outer and inner lamellæ, at the swollen portion above nearly twice as thick as in the middle, below generally less thick, but just before the upper end of subula again slightly thicker. Sometimes short and narrow plicæ are present, extending upwards from the abrupt narrowing below.

Structure exceedingly fine and inconspicuous.

The form, which was abundant at st. 184, differs slightly from the usual one in being larger and less poculiform, rather evenly and very slowly narrowing in the upper half (in a downward direction).

Total length usually $128\ \mu$ — $147\ \mu$, rarely down to $120\ \mu$, subula $23\ \mu$ — $28\ \mu$, diameter of mouth $45\ \mu$ — $50\ \mu$, at the swollen portion above some $6\ \mu$ greater.

Is so similar to *Xystonellopsis favata* (Brandt) that I first mistook it for this species, which, according to BRANDT, is $276\ \mu \times 87\ \mu$, i. e. about double the size. His figure seems to represent an individual, artificially compressed (squeezed) above; it differs, however, also in having a proportionately much longer upper portion of caudal prolongation, and must belong to a different species.

The present delicate species shows about the same distribution in the Mediterranean as *Xystonellopsis cymatica*; is, however, not noted for the winter cruise, and seems in summer throughout to occur at greater depths. The local abundance at Naupaktos is very remarkable.

Not yet known outside the Mediterranean, save from st. 68 in Bay of Cadiz in February. Seems to be a deep-water species of wide distribution in the Mediterranean, where recorded for 12 of the 22 stations for deep-water samples.

No indication of an immigration into the Mediterranean from outside was to be traced.

The closely allied *Xystonellopsis favata* has only been taken at one locality in the Sargasso Sea, and at one in the South Equatorial Current.

2. XYSTONELLOPSIS CYMATICA (Bdt.) (Fig. 57).

Cyttarocylis (*Xystonella*) *cymatica* Braudt 1906, p. 6, pl. 44 figs. 3, 4; 1907 p. 251, incl. var. a, pl. 44 fig. 5, pl. 45, fig. 2. *Xystonella cymatica* Laackmann 1911 p. 452, pl. XLIX fig. 5.

Sts. 24, 28, 68 (see var.); 86, 87, 89, 129 (600 m.—0 m., 1100 m.—0 m.), 132 (600 m.—195 m.), 134 (200 m.—125 m.), 152 (950 m. wire), 156 (950 m. wire), 160 (1000 m.—200 m.), 182 (545 m. wire), 187

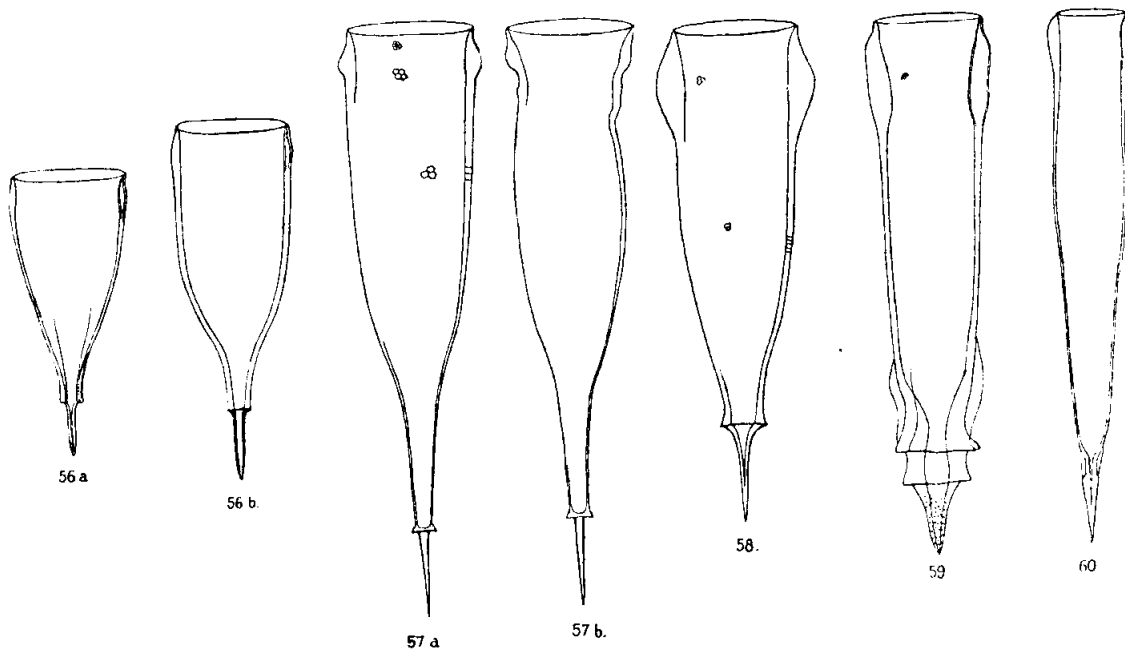


Fig. 56. *Xystonellopsis scyphium* n. sp.; $^{350}/_1$. a: st. 68, b: st. 184, 945 m. wire. Fig. 57. *Xystonellopsis cymatica* (Bdt.); $^{350}/_1$. St. 28. a: Specimen showing its natural outline. b: The same in concentrating glycerine-water. Fig. 58. *Xystonellopsis cymatica* var. *spicata* Bdt.; $^{350}/_1$. St. 68. Fig. 59. *Xystonellopsis paradoxa* (Cl.); $^{350}/_1$. St. 26. Fig. 60. *Xystonellopsis braudti* (Laackm.) n. sp.; $^{350}/_1$. St. 152, 250 m. wire.

(190 m.—100 m., 945 m. wire), 194 (0 m., 1145 m. wire), 199 (945 m. wire), 200, 206 (1945 m. wire), 209 (200 m.—85 m.), 234 (200 m.—95 m., 700 m.—200 m.), but singly or (sts. 152, 187) very scarce.

Lorica swollen below the mouth, then slowly narrowing about to the middle, then again more rapidly narrowing and below passing over into a slightly offset, broad upper portion of caudal prolongation, which is slowly and evenly narrowing downwards to a slightly dilated, thickened, somewhat umbelate end. From this latter issues a much narrower, subulate, lower caudal prolongation conspicuous in water, and with hyaline, structureless, simple (single) wall. The two lamellæ of the wall otherwise everywhere separated. Thickness of wall greatest at the swollen portion above, where up to 7μ — 8μ , at the very mouth rather small, below the swollen portion 3μ — 4μ , towards the subula below much smaller. Meshes small on and above the swollen portion, below and towards the middle larger and more conspicuous, in the narrower portion near the subula very small.

Total length $180\ \mu$ — $250\ \mu$, length of the subulate posterior part of caudal prolongation $38\ \mu$ — $40\ \mu$, diameter of mouth $53\ \mu$ — $60\ \mu$, maximum diameter (below the mouth) $64\ \mu$ — $74\ \mu$. The different shape of BRANDT'S var. a is obviously due to shrinkage (compare figs. 57 a and b).

This beautiful species was frequent in the material of the "Thor", from the Baleares as far as Euboea, as well as near the southern and south-western coast of Portugal, though everywhere very scarce. In winter it was almost absent, only noted for two stations near Naples (24, 28) and for st. 68 in Bay of Cadiz; in summer it was almost only met with in deeper layers, being only present at the surface at sts. 194, 200. It was apparently chiefly met with in layers from 100 m. to somewhat below 200 m., and was taken at 12 of the 22 stations for deep water samples (in the Mediterranean proper).

A deviating form or perhaps another species is

var. *spicata* Bdt. (Fig. 58 p. 51).

Brandt 1907 p. 252, pl. 47 fig. 4.

The swollen portion of lorica above is longer, less pronounced or localized, but very thickwalled. The upper portion of caudal prolongation — above the constriction — almost undeveloped, the lorica narrowing almost evenly to the annular thickening below where the subulate lower part takes its origin. This lower portion of caudal prolongation is also much broader at its base (in my specimen) than in the main species, and the structure in the upper part of the lorica less coarse. Is shorter than the main species, the difference answering to the difference in lengths of upper portion of caudal prolongation in both forms.

Total length $207\ \mu$, of lower portion of caudal prolongation $42\ \mu$; diameter of mouth $53\ \mu$, maximum diameter $64\ \mu$.

I saw only one specimen from st. 68 (Bay of Cadiz). BRANDT (l. c.) records it from one locality in the North Equatorial Current and from one in the South Equatorial Current, as well as from Ceylon. My specimen is slightly different from the figure in BRANDT.

Xystonellopsis cymatica was first reported from the Mediterranean by BRANDT (l. c.), as taken by LOHMANN at Messina. Otherwise it is known from the Pacific (New Pomerania, BRANDT l. c.), from the Mascarene Current in the Indian Ocean (LAACKMANN 1911), as well as from a large area in the Atlantic, from the Sargasso Sea to the South Equatorial Current, though generally everywhere rare and scarce (Brandt l. c.).

3. *XYSTONELLOPSIS PARADOXA* (Cl.) (Fig. 59 p. 51).

Undella paradoxa Cleve 1900 p. 974 (fig.). *Cyttarocyclus?* (*Xystonella*) *paradoxa* Brandt 1906 p. 25. (*Cyttarocyclus?*) *Xystonella paradoxa* Brandt 1907 p. 256, pl. 48 figs. 3—6.

Sts. 14, 20, 23, 25, 26, 27, 28, 31, 38, 40, 42; 126 (275 m. wire), 132 (600 m.—195 m.), 152 (250 m. wire; 950 m. wire, rather numerous), 156 (250 m. wire, 950 m. wire), 160 (200 m.—100 m., several specimens; 1000 m.—200 m.), 182 (545 m. wire), 186 (245 m. wire), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), 199 (200 m.—80 m.), singly or sparsely where not otherwise mentioned.

Lorica at the mouth slightly dilated and rather thin-walled, then swollen and very thickwalled for a considerable length, then again rather slowly narrowing in a downward direction, frequently somewhat more rapidly from the middle, to a couple of annular thickenings, one above the other, cross-cut at their lower ends and similar to the corresponding parts in the preceding species, only much larger. The lower part of lorica accordingly shows two marked annular constrictions; from the lowest of them the caudal prolongation is continued by a triangular, sharply acuminate point thick-walled at the base. The cavity of lorica stretches down to the very point, but is considerably narrowed above the upper annular thickening by a corresponding thickening of wall. From this upper annular thickening several conspicuous alary plicæ run upwards along the lower portion of lorica. Structure in the lower portion

of lorica and caudal prolongation conspicuous, consisting of rather coarse, strong-walled meshes; otherwise, it is more conspicuous and consisting of larger meshes on the swollen portion above, whilst close to the mouth the meshes are very small, and from below the swollen portion down towards the lower portion mentioned, they become very delicate or indistinct.

Total length $180\ \mu$ — $230\ \mu$, diameter of mouth $45\ \mu$ — $50\ \mu$.

The animalcule is (according to ENTZ jun. 1909) fixed at the lower point of lorica.

This very characteristic species was strikingly frequent in the material of the "Thor". In winter it apparently occurred only in the median regions of the Mediterranean, from Sardinia to the Adriatic, but was remarkably frequent in the Tyrrhenian Sea. In summer it was again only met with east of Sardinia, thence as far as the Levant and the Aegean Sea, but only in deeper layers, nowhere observed in the surface. This species also seems particularly to occur between 100 m. and 200 m. below the surface, or somewhat deeper, where it must be rather frequent, being taken at 10 of the 22 stations (for corresponding samples).

There are no direct indications of an immigration into the Mediterranean from the west; the distribution in winter would, however, apparently answer to such an immigration in late autumn (Novbr.—Decbr.?), compare JØRGENSEN 1920 p. 105). I have seen the species in a sample from the Straits of Gibraltar Decbr. 1908 (the Sevilla, capt. Rõd). As it is so frequent and not always scarce, it is likely to be able to keep alive all the year in deeper layers, though probably it is renewed by an occasional invasion from the Mediterranean.

It was first recorded for the Mediterranean by ENTZ 1909 (from Naples, Decbr. 1902). Otherwise it is known from the Azores (in January, CLEVE l. c.), from the South Equatorial Current frequent to the Florida Current, and from south of Madagascar (BRANDT l. c.).

4. XYSTONELLOPSIS BRANDTI (Laackm.) n. sp. (Fig. 60 p. 51).

Undella heros var. c? BRANDT 1907 p. 373. *Undella tenuirostris* var. *brandti* LAACKMANN 1911 p. 478, pl. L figs. 1, 2.

Sts. 14, 20, 52 (0 m., 250 m. wire, 950 m. wire), 156 (250 m. wire, 950 m. wire), 158, 161, 186 (in Salpæ), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), 194 (0 m.); everywhere but singly or very sparse.

Lorica with an erect, rather thin-walled mouth, below it swollen and thick-walled, then very gradually passing over into a cylindrical, thin-walled portion, but again from above, or at, the middle slowly tapering downwards and almost imperceptibly passing over into a broadly subulate, thick-walled point, very conspicuous in water, frequently somewhat curved or oblique towards its end. Several, more or less short plicæ are present at the upper end of the subulate point, running upwards to the lorica proper. Structure a very fine "primary" one, "prismatic elements" in several layers in the upper thicker portion of wall.

Total length $196\ \mu$ — $225\ \mu$, maximum diameter $30\ \mu$ — $36\ \mu$.

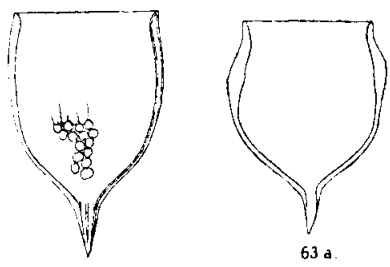
Was rare and scarce in the material of the "Thor": Eastern Mediterranean and st. 194, north of the Straits of Messina.

Is a subtropical species, otherwise (as yet) only known from three localities: Sargasso Sea (Pl. 40, about $30\frac{3}{4}^{\circ}$ N 54° W) and at the Azores (Pl. 121, BRANDT l. c.), as well as in the Mascarene Current (German South-Pole Exp. $15\frac{1}{5}$ 1903, LAACKMANN l. c.) Such a narrow species may easily slip through the nets; it is therefore probably much more frequent, in the Mediterranean as well as outside.

EPIPLOCYLIS n. gen.

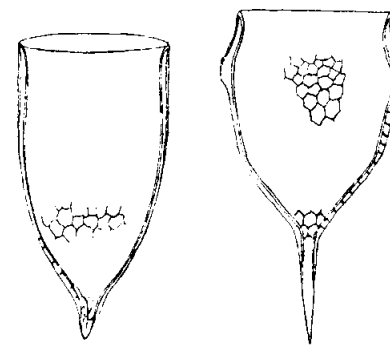
Wall of lorica above as in *Undella*, with strongly developed and separated lamellæ. Below, the outer lamella shows a very coarse and irregular reticulation, consisting of meshes with elevated walls, but otherwise sunk, partly to contact with the inner lamella. Otherwise only a "primary" structure, frequently rather conspicuous, sometimes also a rather coarse "secondary" one, in addition to the much coarser reticulation in the lower half of lorica, just mentioned. The animalcule is as yet almost perfectly unknown. It seems to have two macronuclei.

BRANDT (1907) refers these species to his earlier established genus *Ptychocylis*, on account of the elevated plicæ of the outer lamella; they are, however, so different from the cold-water species which originally constituted that genus that they ought to be separated generically from them. The species of *Rhabdonella* being already removed, the rest of the genus *Ptychocylis*, answering to its original extent, make a very natural group of species. The same is the case with the present genus, comprising — in addition to the species described here below — *E. calyx* (Brandt), *E. bruhni* (Brandt), intermediate between *E. undella* and *E. acuminata*, *E. reticulata* (Ostf. et Schmidt) and the more distantly allied *E. nervosa* (Cl.).



61

63 a



62

63 b

1. EPIPLOCYLIS UNDELLA (Ostf. & Schm.) (Fig. 61).

Cyttarocylis Undella Ostenfeld & Schmidt 1901 p. 181, fig. 30. *Ptychocylis undella* Brandt 1907 p. 292, incl. var. a p. 294, pl. 59 fig. 1, var. c p. 295, pl. 59 fig. 2, var. e p. 295, pl. 61 fig. 1, var. f p. 296, pl. 61 fig. 4, var. h p. 297, pl. 61 fig. 5, var. i(?) p. 297, pl. 60 figs. 2, 4, var. k p. 297, pl. 59 fig. 4, pl. 61 fig. 6, var. l p. 298, pl. 60 fig. 1. *Tintinnus mucronatus* Zacharias 1906 p. 555 fig. 17.

Sts. 11, 18, 25, 68; 145 (abundant and predominating), 147, 152 (0 m., predominating; 250 m. wire, numerous; 950 m. wire, many); 154, several; 155, 156 (0 m., abundant and by far predominating; 250 m. wire, singly; 950 m. wire), 158 (many); 160 (0 m.; 30 m.—0 m., many; 1000 m.—200 m.), 161 (abundant), 162, 163 (0 m.), 165, 167, 169, 179, 180, 181, 182 (0 m., 545 m. wire), 183 (abundant), 184 (0 m., 945 m. wire), 186 (0 m.), 187 (0 m., 25 m.—0 m., 190 m.—100 m., 945 m. wire), 189 (945 m. wire), 192 (0 m., 545 m. wire), 194 (0 m.). Scarce where not otherwise noted.

Lorica campanulate, somewhat below the mouth generally slightly dilated, then narrowing slowly to about the lower $\frac{1}{3}$, where rapidly narrowed to an offset, narrowly conical caudal prolongation, very acute and with an inner channel. Wall in upper $\frac{1}{4}$ thick, with

distant lamellæ; cavity of lorica slightly dilated at the very mouth, where both lamellæ unite. The wall is still rather thick in the upper part of caudal prolongation, diminishing gradually towards the lower end, which is formed by a thin- and single-walled point. The coarse reticulation in the lower portion of lorica consists of larger and smaller, roundish or polygonal meshes, extending up to lower $\frac{1}{3}$ — or somewhat more — of lorica proper, where the reticulation becomes incomplete and gradually disappears, whilst both lamellæ diverge to the normal greater distance above. Otherwise the structure consists of "primary" meshes generally easily visible.

Total length $105\ \mu$ — $111\ \mu$, length of caudal prolongation $20\ \mu$ — $30\ \mu$; diameter of mouth generally about $60\ \mu$, ($57\ \mu$ — $63\ \mu$), maximum diameter about $63\ \mu$ — $65\ \mu$ ($60\ \mu$ — $68\ \mu$).

Fig. 61. *Epiplocylis undella* (Ostf. & Schm.); $\frac{350}{1}$. St. 152, 250 m. wire. Fig. 62. *Epiplocylis undella* (Ostf. & Schm.), var. *blanda* n. nom.; $\frac{350}{1}$. St. 152, 250 m. wire. Fig. 63. *Epiplocylis acuminata* (Dad.); $\frac{350}{1}$. a: st. 16; b: a form with a long caudal prolongation st. 23.

Is a common and widely distributed warm-water species, considerably varying, partly as to shape, but particularly in length and diameter of caudal prolongation and in structure.

A relatively very well distinguished form, rather constant and likely to be considered a separate species is

var. **blanda** n. nom. (Fig. 62 p. 54).

Ptychocyclus undella var. b Brandt 1907 p. 294, pl. 61 fig. 3, incl. var. *sargassensis* p. 298, pl. 60 figs. 5, 6? and var. o, pl. 60 fig. 3?

Sts. 14, 16; 152 (250 m. wire, 950 m. wire), 156 (250 m. wire, 950 m. wire), 160 (100 m.—30 m.: 200 m.—100 m., numerous; 1000 m.—200 m., several), 163 (0 m.; 80 m.—0 m., many), 164, 167, 179, 181, 182 (545 m. wire, abundant), 183, 184 (0 m.), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), 192 (545 m. wire), 194 (0 m.).

Lorica longer than that of the main species, above cylindrical, below the middle more conically and acutely narrowing into a less distinctly offset, broader and shorter caudal prolongation. Primary structure rather conspicuous and coarse.

Total length 120 μ —136 μ , length of caudal prolongation 20 μ —25 μ ; diameter of mouth 60—68 μ . Wall of lorica of more even thickness than in the main species.

The Mediterranean distribution of *Epiptocyclus undella* was remarkable. In winter it was only taken at three stations in the Mediterranean, one far off Naples, the two others in the Eastern Mediterranean, everywhere singly. In summer it was first met with near the south-western coast of Sicily, here, however, at once abundantly, and was afterwards very frequent throughout the Eastern Mediterranean as far as the entrance to the Dardanelles and back again to the Straits of Messina, at several stations present in greater numbers or even abundant and predominant (among the Tintinnidæ). Here, in the Eastern Mediterranean, it was present at all stations where deep water samples were taken, generally at the surface, where often in greater numbers, as well as in deeper layers. In the Western Mediterranean it was only taken in small numbers at the first station north of the Straits of Messina, st. 194.

The variety had its special distribution — which is in favour of considering it a separate species — though on the whole it was confined to the same area as the main species in summer, from st. 152 as far as the entrance to the Dardanelles and back again to the Straits of Messina and st. 194. In this area it was chiefly present only at deeper levels — in contradistinction to the main species — present at all stations for deep water samples and generally in greater numbers than the main species, though only at one station (near Euboea) common.

In the Bay of Cadiz, *Epiptocyclus undella* was only taken singly at st. 68.

It is certainly an indigeneous Mediterranean species, apparently belonging to the Eastern Mediterranean, where it is strongly increasing in numbers at many places in the warmer season. An immigration into the Mediterranean from the west seems not to take place, judging from the material in question, at any rate not in summer, though there may be an occasional one in Novbr. (?) and Decbr. In this latter month the species was present in the Straits of Gibraltar (the Sevilla, Decbr. 1908, capt. RÖD).

It was first recorded for the Mediterranean by BRANDT (1907) from Messina, taken by LOHMANN, then by LOHMANN (1908) from Syracuse, by ENTZ 1909 from Naples and the Northern Adriatic (?; compare LAACKMANN 1913 p. 34). Otherwise it is widely distributed or rather common in the Atlantic, from the south point of Africa in the east, and from Rio de Janeiro in the west, as far as 38° N in the Florida Current, and north of the Azores; in the Sargasso Sea, at the Cape Verde Islands and in the South Equatorial Current also in greater numbers. Also known from many places of the Indian Ocean, where apparently frequent from 32° S in the Agulhas Current to the Red Sea, the Arabian Gulf and the Bay of Bengal. In the Pacific taken at New Zealand, together with v. *blanda*, at New Pomerania, on the west coast of South America, about 23° S (the Melderskin, Aug. 1909, capt. JACOBSEN), at 4° N 94° W and at 16° N 103° W (S/S Alden, Febr. 1910, capt. KARS). According to BRANDT l. c., LAACKMANN 1911 and my own samples).

2. EPIPOCYLIS ACUMINATA (v. Dad.) (Fig. 63 p. 54).

Cyrtocyclus acuminata v. DADAY 1887 p. 578, pl. 20 fig. 33. *C. semireticulata* BIEDERMANN 1892 p. 23, pl. 1 fig. 3. *Ptychocyclus acuminata* BRANDT 1907 p. 289, incl. var. *semireticulata* p. 290, pl. 58 fig. 9, var. b p. 291, pl. 58 fig. 10 and var. c p. 291, pl. 58 fig. 11.

Sts. 10, 14, 15, 16, 23, 24, 25, 26, 28, 29, 31, 33, 35, 36, 38, 39, 40, 42; 115, 116, 117 (common), 118, 123, 126 (0 m.; 200 m.—100 m., several; 500 m.—120 m.; 275 m. wire, common), 127, 128 (0 m.; 100 m.—0 m., common), 129 (0 m., 80 m.—0 m.; 600 m.—0 m., many; 1100 m.—0 m., abundant), 132 (600 m.—195 m., numerous; 1090 m.—57 m.), 134 (75 m.—0 m., 200 m.—125 m.), 152 (250 m. wire, 950 m. wire), 186 (245 m. wire, 1145 m. wire and in *Salpæ*), 187 (945 m. wire), 189 (945 m. wire), 192 (0 m.; 545 m. wire, several), 194 (0 m.—1145 m. wire), 199 (30 m.—0 m.; 200 m.—80 m., common; 945 m. wire), 202, 204 (1145 m. wire), 206 (1945 m. wire), 209 (80 m.—33 m.; 200 m.—85 m., several; 1000 m.—200 m., numerous; 945 m. wire, several; 1945 m. wire, many), 210, 211, 229, 237, 238. Scarce, if not otherwise mentioned.

Lorica on the whole very similar to that of the preceding species — its main form — short and widely campanulate, also varying in a corresponding manner. The main differences are that the lorica in the present species, somewhat below the mouth, is swollen and thick-walled and that the coarse reticulation extends much farther up, considerably past the middle of the lorica proper, up to or even beyond the swollen portion, where it disappears in fainter or incomplete meshes, formed by indistinct or law plicæ, not in parallel or slightly anastomosing striæ, as usual in the preceding species.

Otherwise as in that species.

Total length varying, $86\ \mu$ — $140\ \mu$, the caudal prolongation being from $17\ \mu$ to $45\ \mu$ in length. Length of lorica proper $70\ \mu$ — $90\ \mu$ or somewhat more, diameter of mouth $53\ \mu$ — $64\ \mu$, maximum diameter $54\ \mu$ — $77\ \mu$.

The winter form (see fig. 63 a) answers very well to DADAY'S figure (total length $63\ \mu + 18$), but has a shorter caudal prolongation; it corresponds to var. c in BRANDT. Forms with a longer caudal prolongation also occur (see fig. 63 b).

In winter this species was present at all stations of the median and northern regions of the Mediterranean, but was absent everywhere in the southern Balearic and farther west. It was not taken east of Corfu. In summer it was very frequent in the same regions, in the central regions of the Tyrrhenian Sea also very frequent, often common or even abundant, but absent at the surface in the Eastern Mediterranean — only present near the Straits of Messina, sparsely — and also farther west present in much greater numbers in deeper layers, whilst frequently but singly in the surface. Now, in summer, it was also taken in the Balearic and the Catalonian Seas, but was lacking in the Atlantic Current near the north coast of Africa.

Compared to the rather nearly allied preceding species it occurs at the surface rather as a winter species and has an area, on the whole more westerly situated — though not comprising the most western regions — with an optimum over a greater area in the Tyrrhenian Sea, whereas the preceding species has its optimum east of Greece and near the eastern north-coast of Africa.

Is otherwise widely distributed in the Atlantic, from the south point of Africa in the east, and from Rio de Janeiro in the west, up to 45°N (44°W , April 1910), at any rate in the southern regions rather common (the "Fram", July—Aug. 1911). Also known from the vicinity of New Amsterdam in the Indian Ocean (German South-Pole-Exp., $27/4$ 1903, LAACKMANN 1911) and from the Agulhas Current (BRANDT l. c), as well as from the west coast of South America ($45\frac{1}{2}^{\circ}\text{S}$, the Alden, capt. KARS, Jan. 1910) and off Antofagasta, about $23\frac{1}{2}^{\circ}\text{S}$ (the Melderskin, capt. JACOBSEN, Aug. 1909).

It was detected at Naples by DADAY (1887) and is later reported from the Mediterranean by LOHMANN (1903) from Syracuse and by LAACKMANN (1913), who found it to be frequent in the northern Adriatic. As he remarks (l. c) it is probably this species which ENTZ (1904 and 1909) reports as *Cyrtocyclus* or *Ptychocyclus reticulata* from Quarnero.

Is certainly indigeneous in the Mediterranean and — together with the preceding species — one of the more important species there, in summer chiefly occurring in deeper layers. Some invasion of this species from the Atlantic perhaps or probably takes place late autumn, though no indications of an immigration into the Mediterranean from the west are to be seen in the material in question.

PROTORHABDONELLA n. gen. ad int.

Lorica short and wide, more or less acute below; wall apparently simple (single), with few and distant, or more numerous longitudinal ribs or elevated plicæ, otherwise apparently without structure or with only the usual fine "primary" one. No caudal prolongation. Mouth simple.

Small species, intermediate between the following genus, *Rhabdonella*, and the more primitive genus *Amphorella*; they might as well be referred to this latter genus, but seem to be naturally allied to *Rhabdonella*, as representing the ancestral form of this genus.

1. PROTORHABDONELLA SIMPLEX (Cl.) (Fig. 64).

Cyttarocyclus simplex Cleve 1900 d, p. 972. *Rhabdonella amor* var. *simplex* Brandt 1907 p. 331 p. p.?, Laackmann 1911 p. 463, pl. XLIX fig. 15.

Sts. 18?, 26; 156 (250 m. wire), 186 (in Salpæ).

Lorica of greatest diameter at about the upper $\frac{1}{3}$, acuminate in a downward direction, but at the very end obtuse, above slightly narrowing towards the mouth which has an abruptly, though very slightly outward curved border. Wall everywhere thin or very slightly thickened, at the mouth not thicker than below. On the outer lamella about 9 (7 to 10?) narrow longitudinal ribs, not perfectly straight, but somewhat twisted (to the left), very rarely showing up to three intermediate, fainter ribs between every two of the stronger ones. Border of mouth frequently almost erect, or indistinctly curved outwards.

Length 52μ — 58μ , diameter of mouth 32μ — 38μ .

In appearance similar to a species of *Rhabdonella* without caudal prolongation; wall of lorica is, however, simple (single) and there is no broader and double-rimmed mouth, as in the latter genus. I have seen no structure of the wall (save the plicæ). LAACKMANN (l. c.) found the animalcule to have two rounded macro- and two micro-nuclei.

This species is quite different from *Rhabdonella amor*; in the Mediterranean it was very rare and scarce. It is reported from the Adriatic by ENTZ jun. (1909), as *R. amor* var. *simplex*.

I have seen it from the south coast of Arabia (near Ras Ekab, HANDEL-MAZZETTI, $\frac{28}{10}$ 1910) and from the coast of Chile (the Alden, capt. KARS, Jan. 1910). Otherwise it is known from scattered localities in the warmer regions of the Atlantic, from 20° S to the Azores and up to 56° N (CLEVE l. c.), as well as from 39° S to 41° S, 13° W to 6° W (CLEVE 1902 b). Also reported from the Red Sea and the Arabian Gulf (OSTENFELD and SCHMIDT 1901, CLEVE 1903 b) and from the Gulf of Siam (SCHMIDT 1901).

2. PROTORHABDONELLA CURTA (Cl.) n. sp. (Fig. 65).

Cyttarocyclus striata β *curta* Cleve 1901 a, p. 922 (fig.).

Sts. 58; 186 (in Salpæ).

Similar to the preceding species, but smaller, diameter of the mouth slightly greater, as great as the maximum diameter below, sometimes even slightly greater, with a mouth more outward curved, but

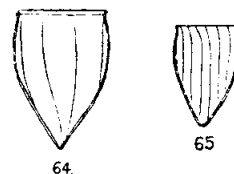


Fig. 64. *Protorhabdonella simplex* (Cl.); $\frac{350}{1}$. St. 26.
Fig. 65. *Protorhabdonella curta* (Cl.); $\frac{350}{1}$. St. 186.

not so abruptly, as well as with more approximated striæ (plicæ), about 18 to 24, above more strongly curved on account of the mouth being curved outward for a slightly longer distance. In this species the lorica is also less acuminate in a downward direction, and the wall is less thin.

It is very similar to small species of *Rhabdonella* and is perhaps in part synonymous with *R. amor* var. *simplex* BRANDT (1907 p. 331, without a figure), is, however, smaller than stated by him.

Length $38\ \mu$ — $44\ \mu$, diameter of mouth $23\ \mu$ — $28\ \mu$.

A similar, but larger form occurred (in stomachs of *Salpæ*) at st. 80: length $57\ \mu$, diameter of mouth $32\ \mu$, maximum diameter $34\ \mu$.

I have also seen it from the Red Sea, 18° N (HANDEL-MAZZETTI, ²⁸/₁₀ 1910). If the form figured in CLEVE (l. c.) is the same, it occurs in several places of the southern Atlantic and the southern Indian Ocean (41° S 6° W; 41° S— 45° S, 29° E— 76° E).

RHABDONELLA (Bdt.) Laackm.

Laackmann 1911 p. 460. Ptychocylis subgen. *Rhabdonella* Brandt 1906/7.

Lorica more or less elongate and narrow, with a more or less protracted caudal prolongation — seldom only rudimentary — not or but vaguely offset from lorica proper. Wall outwards with numerous and long longitudinal, raised, plicæ, simple or branched, or distantly anastomosing, almost straight or frequently somewhat twisted, always in the direction of a left-handed screw. Lamellæ distinctly developed and separated, particularly towards the mouth which is broadly dilated and double-rimmed, with an outer, more or less spreading border and an inner erect one, both very narrow and separated by a broad, but shallow groove. Denticles and collar are failing, caudal prolongation nearly always long or distinct, sometimes with a very fine opening at the end of the inner channel. Structure in part only a "primary" one, in part also a "secondary" coarser one ("*Cyttarocylis*-structure"); in addition, more scattered, greater, rounded "windows", generally in longitudinal rows alternating with the plicæ, are frequent.

The animalcule has two macronuclei (DADAY 1887, BRANDT 1906/7, LAACKMANN 1911) and presumably in a normal state two micronuclei, at any rate recorded for two species (LAACKMANN l. c.).

This is a very natural genus, comprising closely allied and easily known species, with a wide distribution in warmer seas.

1. RHABDONELLA AMOR (Cl.) Laackm. (Fig. 66 p. 59).

Laackmann 1911 p. 463, incl. var. *indica* p. 464, pl. XLIX figs. 12—14. *Cyttarocylis amor* Cleve 1900 d, p. 972 (fig.). *Ptychocylis* (*Rhabdonella*) *amor* Brandt (1906/7 p. 327, pl. 54 figs. 4, 5, 12, 13, 15 (excl. varieties).

Sts. 11, 12, 14, 18?; 80, 147, 187 (190 m.—100 m.), 189 (945 m. wire), 192 (0 m.).

Lorica in upper half almost cylindrical, only slightly dilated from the middle in an upward direction, in the lower $\frac{1}{3}$ or $\frac{2}{5}$ more rapidly narrowing towards an acute or acuminate posterior end, without a caudal prolongation. Wall with approximated, though distinctly separated lamellæ, at the mouth with a distinct annular groove and somewhat spreading outer border, though frequently not very prominent. Striæ (plicæ) numerous, about 32—36, not, or only occasionally, anastomosing.

Length $88\ \mu$ — $105\ \mu$, diameter of mouth $37\ \mu$ — $51\ \mu$.

Is a rather rare species, somewhat varying in size and shape, though on the whole easily distinguished from the allied species. In the winter material of the "Thor" I only saw it from four stations of the Eastern Mediterranean, everywhere very rare. During the summer cruise it was still rarer, being only noted for four stations, again in the Eastern Mediterranean, everywhere singly, in deeper layers save close to the Straits of Messina (st. 192).

Probably enters occasionally from the Atlantic, apparently being able to keep alive in the Eastern Mediterranean, particularly in deeper layers.

Otherwise very widely distributed in the warmer regions of the Atlantic, from 39° S (10° E) to 45° N and 50° N. Also known from many localities in the Indian Ocean. BRANDT, strange to say, records it from the Karajakfjord, which must, I think, be due to some error.

Already recorded for the Mediterranean — again the Eastern — by CLEVE (1903 b).

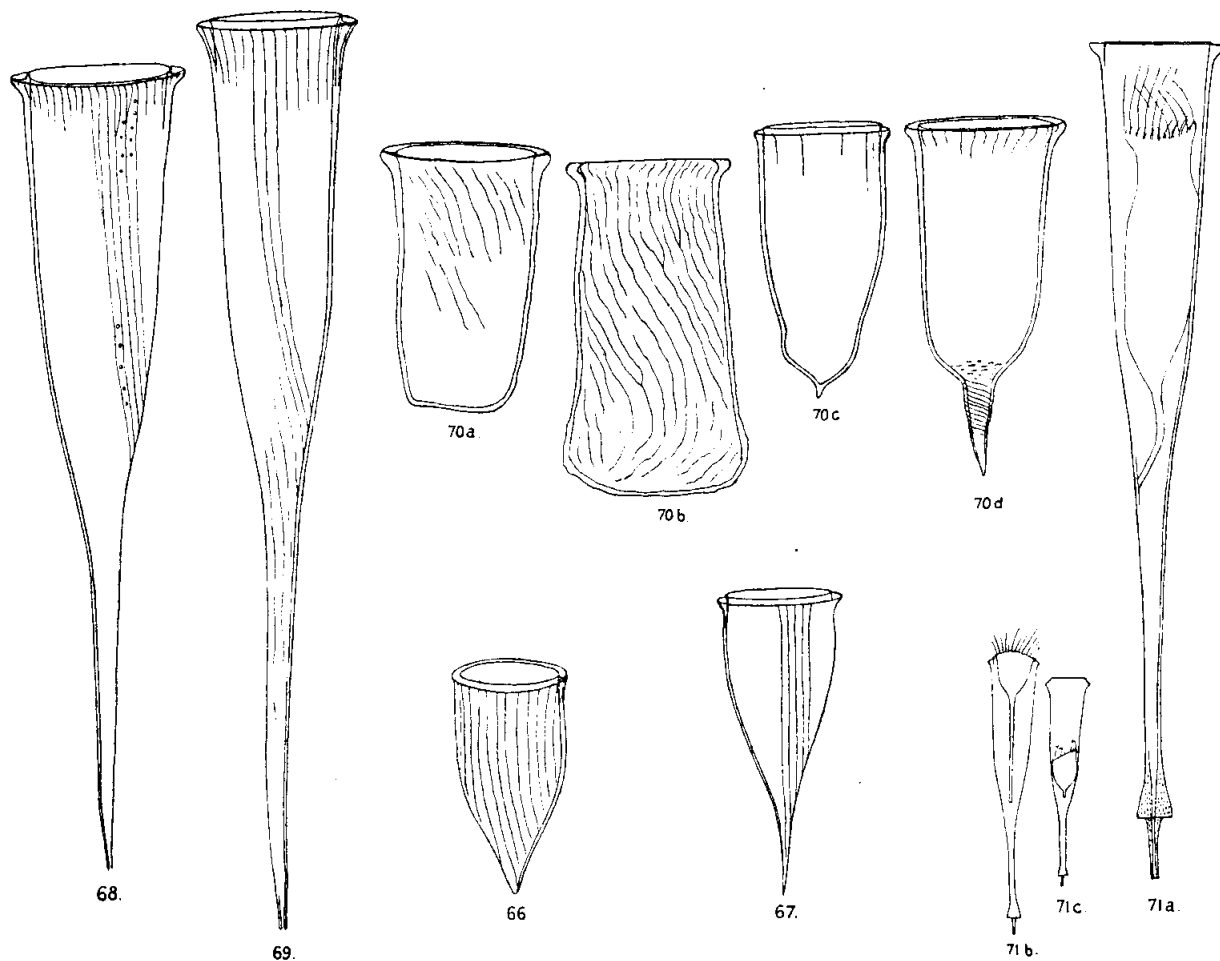


Fig. 66. *Rhabdonella amor* (Cl.) Laackm.; ³⁵⁰/₁. Tortugas ²²/₅ 1910. Optical section of wall only shown on the right side. Fig. 67. *Rhabdonella elegans* n. sp.; ³⁵⁰/₁. St. 160. Optical section of wall shown on the left side. Striae (plicae) but partly shown. Fig. 68. *Rhabdonella spiralis* (Fol) Laackm.; ³⁵⁰/₁. Monaco. Fig. 69. *Rhabdonella spiralis* (Fol) Laackm., var. *elongata* n. var.; ³⁵⁰/₁. St. 158. Fig. 70: *Rhabdonella spiralis* (Fol) Laackm., f. *hydria* n. f.; ³⁵⁰/₁. a: st. 95; b: st. 152, 250 m. wire; c and d: two unfinished loricae, the latter evidently of *R. spiralis* (var. *elongata*?); c: st. 187 (0 m.), perhaps of *R. apophysata*, d: st. 156 (0 m.). Fig. 71. *Rhabdonella apophysata* (Cl.) Bdt. Tortugas, May a. June 1910. a: Sketch of a lorica containing a withdrawn animalcule, ³⁵⁰/₁. b and c: two rude and small sketches of the living animalcule in its lorica, b extended, c completely withdrawn.

2. RHABDONELLA ELEGANS n. sp. (Fig. 67).

Undella spiralis Daday 1887 p. 565 p. p. *Ptychoecylis* (*Rhabdonella*) *amor* var. *cuspidata* Brandt 1906/7 p. 331, pl. 54, figs. 3, 10, 11.
Not *Tintinnus cuspidatus* Zacharias (1906, see the following species).

Sts. 10, 11, 14, 20, 25; 145, 147, 148, 152 (0 m., 250 m. wire, 950 m. wire), 154, 156 (0 m., 250 m. wire, 950 m. wire), 158, 160 (0 m., 1000 m.—200 m.), 161, 163 (0 m.), 165, 179, 180, 181, 182 (545 m. wire),

3, 184 (0 m.), 187 (0 m., 25 m.—0 m., 190 m.—100 m., 945 m. wire), 189 (0 m., 945 m. wire), 192 (0 m., 545 m. wire), 194 (0 m., 1145 m. wire).

Similar to a larger form of the preceding species, with an elongated caudal prolongation. It is so constant as to shape and size that — in my opinion — it should be considered a separate species. It is varying in shape, length, number of striæ and in structure, like the preceding and the following species, but is easily distinguished from them.

Length 110μ — 122μ , diameter of mouth 50μ — 53μ .

This species was very rare in the winter material of the "Thor", being only noted for 4 stations in the Eastern Mediterranean, and for one in the Western (off Naples), everywhere but singly. During the summer cruise it proved to be frequent, and not seldom present in greater numbers (sts. 145, 147, 152, 158, 160 (0 m.), 187 (0 m., 25 m.—0 m.), 189 (945 m. wire), 192 (0 m., 545 m. wire)) in the Eastern Mediterranean, particularly in the inner regions, yet only as far as st. 179, before the Dardanelles. In the Western Mediterranean it was only taken at st. 194, somewhat north of the Straits of Messina.

Accordingly, no indication of an immigration into the Mediterranean from the Atlantic was to be found. This species is certainly indigeneous in the Mediterranean, apparently thriving well in the Eastern Mediterranean in summer, increasing strongly in numbers, whilst in winter, apparently, it is decidedly decreasing. It was first found in the Mediterranean by DADAY, who (l. c.) referred it to the following species.

According to BRANDT (l. c.) it is known from most of the main currents in the warmer regions of the Atlantic, from 7° S (15° W) to 41° N (in the Florida Current). BRANDT also records this species from the Karajakfjord, which needs a further statement. He records it from Borneo, and I have myself seen it from the Red Sea (HANDEL-MAZZETTI, $18^{\circ} 10.5'$ N, October 1910).

3. RHABDONELLA SPIRALIS (Fol) Laackm. (Figs. 68, 69 p. 59).

Laackmann 1911 p. 461. *Tintinnus spiralis* Fol. 1881 p. 21, pl. 1 fig. 4; *T. anadyomene* Entz sen. 1884 p. 409, pl. 24 fig. 19. *Undella spiralis* Daday 1887 p. 565 (p. p.), pl. 18 fig. 8. *Tintinnus striatus* Biedermann 1892 p. 29, pl. 3 fig. 13. *Cyttarocyclus hebe* Cleve 1900 d, p. 971 p. p., right fig. *Tintinnus cuspidatus* Zacharias 1906 p. 519 fig. 7. *Ptychocyclus* (*Rhabdonella*) *spiralis* Brandt 1906/7, p. p., varr. a *hebe*, b *chavesi*, d *striata*, pp. 325, 326, pl. 52 figs. 2, 10, pl. 53 figs. 3—5.

This common warm-water species is very varying in length, numbers of striæ, structure, length of caudal prolongation and partly in shape of lorica.

The latter generally is narrowly poculiform, at the mouth frequently somewhat dilated, with a generally somewhat spreading, outer border; below it is rather rapidly or more gradually passing over into a long and narrow caudal prolongation, frequently open at the very end. Wall of lorica distinctly double, at the mouth with very distant lamellæ, all along the outside with numerous, partly branched and anastomosing, low, longitudinal ribs or plicæ, very similar to simple striæ, usually about 30, but varying from 20 to about 40. Otherwise a more or less fine or distinct "primary" structure, sometimes accompanied by a coarser "secondary" one, showing on the optical section one to very few layers of short "prismatic elements", connecting both lamellæ. Also frequently rather larger, roundish to oval, meshes ("window"s, BRANDT) present, with or without a thickened circumference, scattered between the ribs, connecting both lamellæ. Finally, there is often also an irregular thickening of the caudal prolongation, near to its end ("Spindel" BRANDT), generally thick-walled or spongy, sometimes with very strong and close, as well as very oblique striæ.

This species was in the first instance described by FOL (1881) from Villefranche, later under a new name — on account of its peculiar and complicated structure — by BIEDERMANN (1892), and still later, for similar reasons, under a third name by CLEVE (1900), his specimens being destitute of "windows", already stated to occur in the main species by FOL. BRANDT has then tried to keep these different names by dividing the species in a corresponding series of varieties.

In the Mediterranean a very long and narrow form was found having a particularly long caudal prolongation with a more or less distinct, thickened "spindle" of varying appearance. The other forms, though varying as above mentioned, generally answer very well to the figure in FOL. They should therefore be considered typical for this species, if necessary in connection with a series of "forms", which, however, will probably be hard to distinguish one from another.

This main species was quite common and plentiful in the Mediterranean. It does not answer exactly to any of the figures in BRANDT, having more oblique plicæ and a simple caudal prolongation, without a "spindle", and, on the whole, better agreeing with the quoted figure in DADAY.

The other Mediterranean form mentioned above I have named

var. *elongata* n. var. (Fig. 69 p. 59).

Lorica much more elongated and more evenly, or almost imperceptibly, passing over into a long caudal prolongation, as long as, or frequently longer than, the lorica proper. The longitudinal plicæ but slightly oblique or almost straight, only on the lower, narrower portion of the lorica proper more distinctly oblique, on the caudal prolongation, however, again straight, parallel to the longitudinal axis. Close to the end of caudal prolongation nearly always a more or less developed thicker "spindle" is seen, mostly with a much coarser structure than usual, sometimes with coarse and close, strongly oblique plicæ (see BRANDT l. c. pl. 53 fig. 3). The posterior end of caudal prolongation very narrow, but cross-cut and apparently as a rule open. Plicæ close together, about 40—50¹.

Length 370 μ —470 μ ; diameter at the mouth 66 μ —70 μ .

This form BRANDT (l. c. p. 323, pl. 52, figs. 4, 7, 8, 9) considers the main species; it is, however, so different from the figure in FOL and from the form which — according to the material of the "Thor" — is likely to be the common one at Villefranche, that, in my opinion, it should be considered a special, well distinguished variety, instead of the main form.

The distribution of this variety in the Mediterranean is very interesting. During the summer cruise it was present singly at sts. 80, 87, then in greater numbers but frequently without the spindle, at sts. 89, 91, 92, 94 (singly), 95, 96, 97 (singly), and outside the Straits; then again singly at sts. 98, 99, just inside the same. Throughout this region, from outside the Mediterranean to just inside the Straits, this variety was the only form (of *R. spiralis*) occurring. Farther on, a few individuals were taken at sts. 112, 113 on the coast of Africa, at the first station together with the main species; later, however, it does not appear during the eastward journey until the Eastern Mediterranean, where singly and very rare in deeper layers: sts. 152 (950 m. wire), 160 (100 m.—30 m., 1000 m.—200 m.), 163 (80 m.—0 m.), 182 (545 m. wire), 184 (945 m. wire), 185. Then sporadic and rare, mostly only present in deeper layers: sts. 197, 206 (1945 m. wire), 209 (200 m.—85 m., 945 m. wire), 215, 216 (several individuals), 217, 218, 223 (1950 m. wire), 228, everywhere, save at st. 216, singly or sparsely. Farther west it becomes more frequent and plentiful: sts. 229 and 231 abundant, at the latter station also several individuals in deeper layers, st. 234 (in all catches, in greater numbers down to 100 m.), st. 235 and scarce at st. 241. Farther northwards it is gradually replaced by a shorter form without spindle, answering to forma *striata* (BIEDERMANN) BRANDT, synonymous with f. *hebe* (CL.), with "windows" and above almost straight striæ, perhaps less close together than in the common Mediterranean form: sts. 237, 238, 239, 241, 242.

Inversely, the form which I consider the main form was mostly just present, frequently also in greater numbers, where var. *elongata* was absent or very scarce. It appeared during the summer cruise

¹ The striæ being difficult to count directly, I have mostly counted on the figure — drawn by means of ANBE's drawing apparatus — the number of interstices on a median distance equal to the radius, and have multiplied this number by 6. In this way the number may be too great, owing to compression of lorica (i. e. increase of diameter).

at st. 112, near the African coast, together with var. *elongata*, but was particularly abundant from st. 114 (in the Balearic) farther on, almost continually present and predominant (among the Tintinnids) throughout the Balearic, the Ligurian and the Tyrrhenian Seas, still predominant at the border-line of the Eastern Mediterranean, between Tunis and Sicily. In the Eastern Mediterranean it immediately became much more scarce, though present at nearly all stations and frequently the predominant species of tintinnids, especially in the northern regions of the Aegean Sea and the Jonian Sea, in the latter partly again very numerous. On the return voyage it was still rather plentiful through the Tyrrhenian and the Balearic Seas, varying greatly in numbers, but on the whole less numerous than on the eastward journey. The same was the case in the Balearic where it was scarce at st. 217 and rather suddenly disappeared near the African Coast. Only a few individuals were seen at st. 228 in the surface, just inside the Straits of Gibraltar.

Accordingly, the main species must be supposed to be a true and indigenous Mediterranean species, during summer increasing strongly in numbers here and there, to become abundant and predominant in the median regions of the Mediterranean, the Balearic and the Tyrrhenian Seas, but otherwise frequent and present in greater numbers all the way from about the border-line between the Alboran and the Balearic Seas as far as the entrance to the Dardanelles. An immigration from the Atlantic into the Mediterranean seems not to take place directly; it may, however, be considered probable that the main species has originally developed in the Mediterranean from forms immigrated into it from the west. From the material in question it cannot be certainly seen whether such a development from invading forms to modified, Mediterranean ones is still going on, the sudden or very uneven development of masses on the way from st. 113 to Genoa, greatest in the south (at sts. 114--118) where a branch of the Atlantic Current is protruding northwards, seems to indicate some stimulating influence of this current. Directly, it seems, however, that the var. *elongata*, numerous in Bay of Cadiz in June as well as in September, was not able to get very far inside the Straits before disappearing. The question is whether this disappearance is partly connected with a transformation into and reappearance as the other form, more adapted to the conditions of life in the Mediterranean.

We may have here a similar case to that of *Ceratium candelabrum* and *C. pulchellum* (see This report vol. II J. 1).

Very remarkable is a presumably monstrous form of this species or of its var. *elongata*,

f. *hydria* n. f. (Fig. 70 a, b p. 59).

Lorica with a similar characteristic mouth to that of the present species, but strikingly different in shape, being short and saccate, below slightly or not narrowed or even dilated, with a cross-cut or rounded lower end. Also in structure apparently very different from the present species; at the mouth, however, the same characteristic plicæ are seen, only they are very oblique and mostly cannot be traced farther than to a small distance in a downward direction.

I have shown, for comparison, two unfinished (?) loricae of *Rhabdonella*, fig. 70 d at any rate of *R. spiralis*, probably of var. *elongata*. On the caudal prolongation the same strong and very oblique plicæ, sometimes present on the spindle of this variety, are seen. Fig. 70 c represents perhaps an unfinished lorica of *R. apophysata*, on account of the plicæ which are distant, and above straight. Similar loricae are here in regard to dimensions and localities counted together with f. *hydria* (proper). Sometimes the outside of the lorica in the lower portion is rugose or wrinkled, instead of plicate; sometimes the bottom of the lorica is replaced by a circular hole of great diameter, approximately as wide as the lorica itself in its lower portion.

Diameter of mouth (outside) 66μ — 70μ ; length varying, 107μ — 144μ , number of plicæ at the mouth 36μ — 42μ , oblique on the upper portion of lorica, or, in loricae of greater length, almost straight.

These remarkable forms were only found singly or very sparsely, but at a remarkably great number of stations: sts. 87, 95, 98, 99, 115, 117, 129 (0 m.), 134 (125 m.—75 m., 200 m.—125 m.), 139, 140, 152 (250 m. wire), 156 (0 m.), 160 (100 m.—30 m.), 187 (0 m.), 204, 209 (0 m.), 228 (0 m.), 229.

In some of the loricae remains of the animalcule were seen, which for some time caused me to consider these forms a separate species. This view soon, however, proved to be untenable, the variations being so extraordinarily great and pointing to an accidental development. A very important feature is the regular mouth, very exactly answering to that of *Rhabdonella spiralis*, particularly of the var. *elongata*.

It seems to me probable that we have here loricae, developed during, or immediately after, a fission, for some or other reason not passing normally on to full development of the newly created loricae, perhaps suddenly killed or left. One might also imagine that — by a conjugation between individuals with such very long loricae as in *Rhabdonella spiralis* — similar short provisional loricae were formed, later to be finished or left. In this latter case the phenomenon — these remarkable modifications as rare specimens among abundant normal ones — would be easily comprehended, though based on mere conjecture, nothing being actually known to support this supposition. There are, however, different facts at hand — particularly the large and regular aperture at the bottom in some cases, but also the incomplete, not always oblique, or, inversely, straight, striae, as well as the early development of a caudal prolongation, seen in several cases — supporting the hypothesis that these short and apparently abnormal loricae represent young and newly formed ones stopped in evolution. If this be correct, we should here have a proof that the loricae are developed from the mouth backwards, and not in the shape of helicoidal bands; further, that the double wall and its different accessories — e. g. the double-rimmed mouth and the two lamellae — are formed simultaneously, or only successively in so far as they are situated at different distances from the mouth or are undergoing a final completion. Moreover, that a later stretching of the wall, when still far from being finished, takes place to some — considerable? — extent, or a process, apparently giving the same result as if the different parts (or levels) of the young lorica continue growing (developing in size) for some time after being excreted from the animalcule.

I should like to recommend these questions for thorough examination in a place where *Rhabdonella spiralis* is present in plenty.

It seems natural to suppose a connection between these "abnormal" loricae and the occurrence of var. *elongata*. In the Bay of Cadiz they were present together with the latter variety, not together with the main species, whilst farther into the Mediterranean they occur partly together with the same variety, partly where the latter had just disappeared.

During the winter cruise *Rhabdonella spiralis* was taken at the following stations, in small numbers if not otherwise noted: 10, 11, 12 (in greater numbers), 14 (abundant), 15 (several individuals), 16, 20, 23 (several), 24 (several), 25, 26, 28, 29, 31 (in greater numbers), 33 (several), 35, 36, 38 (rather numerous), 39, 40, 42.

As I only later arrived at the conception of the species above stated, and a later revision of the material became impossible, I dare not definitely decide whether the var. *elongata* was present in winter, or not. However, loricae with a very long caudal prolongation, as well as others with a shorter one, answering to var. *hebe* Brandt, occurred, with, or without, a spindle. This variety in BRANDT (l. c.) is founded on *Cyrtarocyclus hebe* CLEVE (l. c.), but is different from the latter in having the greater "windows"; CLEVE (l. c.) emphasizes that his species is similar to FOL'S *spiralis*, but has not this structure. BRANDT'S var. b *Chavesi* (l. c. p. 326), without "windows", is therefore the true species of CLEVE. I have, however, got the impression that these two forms, as well as the fourth variety in BRANDT, var. *striata* (BIEDERMANN, not CLEVE), are only unnatural varieties, without definite morphological or geographical limits, and therefore of no greater use or importance. They may, of course, very well be maintained as "forms", perhaps as geographical varieties, if later investigations should make this possible. The var. *striata* is

similar to the common Mediterranean form — the main species above — but has “straight” striae (plicae) in upper half of lorica.

Rhabdonella spiralis was lacking at coast stations with shallow water. It was generally also present beneath the surface where such samples were taken, but was, as a rule, scarce in deeper layers. At st. 134, however, it occurred down to 200 m. in almost as great numbers as at the surface.

This species is a true Mediterranean one, in summer — perhaps especially at an early season — present abundantly, being mostly the predominant species of Tintinnids. In summer also abundant in the Bay of Cadiz, as var. *elongata*, which, however, disappears (from the surface) just inside the Straits, thus apparently causing no direct immigration from the Atlantic into the Mediterranean, at any rate in June and September. In January and February the species, as well as the variety, were lacking in the Bay of Cadiz. The number of individuals decreases very strongly in winter, but swells strongly up again in early summer, especially in the Balearic where the Atlantic Current gives off a branch towards the Ligurian Sea.

Otherwise rather common in the Atlantic, occurring in different, more or less closely allied forms throughout the warmer and warm-temperate regions, from 26° S (in the east as well as in the west) until 51° N (22° W) and south-west of Ireland (according to CLEVE 1901 d, OSTENFELD and SCHMIDT, BRANDT l. c. and my own samples). Also widely distributed in the warmer regions of the Indian Ocean. I have seen it from the Pacific, 2° S 94° W and 15° N 102° W, at the latter locality abundant, S/S “Alden”, Febr. 1910, capt. KARS).

4. RHABDONELLA APOPHYSATA (Cl.) Brandt (Fig. 71 p. 59).

(Ptychocylis) *Rhabdonella apophysata* Brandt 1906/7 p. 333, pl. 51, figs. 1, 2 (3—7). *Cyttarocylis* Hebe var. *apophysata* Cleve 1900 d, left fig. p. 971; *C. apophysata* (and *C. Hebe*?) Ostenfeld and Schmidt 1901 p. 179, fig. 26?

St. 89 (Bay of Cadiz).

Very closely allied to the preceding species and perhaps not certainly distinguishable from that species in all forms (of both). Is usually easily known by a strongly thickened “lance-bucket” — recalling species of the genera *Xystonella* (f. i. *X. treforti*) and *Xystonellopsis* — on the caudal prolongation, but this thickening may also be wholly or almost lacking. Otherwise similar to long and narrow forms of the preceding species, but differing from the usual, long and narrow conical appearance of these forms in having a more elegant, narrow calyciform (poculiform) shape, but slightly dilated in the lower portion of lorica proper and with a caudal prolongation of almost equal breadth, only below the thickened and usually umbellate “lance-bucket” considerably narrowing. Besides, it has much fewer plicae, about 20—25 or up to 30.

CLEVE has certainly seen the similar forms of the preceding species, f. i. var. *elongata*, with a similar, but far less regularly developed thickening of caudal prolongation, as well as forms of the present species, with badly or not developed “apophysis”, and therefore described this species as a variety (of his *Cyttarocylis Hebe*, answering to the var. *elongata*). BRANDT, on the contrary, makes it a special group of species (“Formenkreis”), coordinate with another, comprising the preceding three (or four) species.

I have seen living specimens at Tortugas (May 1910). The animalcule is campanulate and by a long pedicle fixed about the middle of total length — or somewhat below — to the lateral wall, about where the lorica proper narrows into caudal prolongation (figs. 71 a—c). (Compare the different statements in LAACKMANN 1911 p. 466, from killed specimens).

The figure given by CLEVE (l. c.) answers best to BRANDT's var. b, pl. 51 figs. 1, 2. This form, which also seems to be by far the most common one, should therefore be considered the main species.

I saw this species in none of the Mediterranean samples of the material of the “Thor”, but only from st. 89 outside the Mediterranean (several specimens). I have, however, also seen it from Straits of Gibraltar in Decbr. 1908 (S/S “Sevilla”, capt. RÖD). It was earlier observed in the Adriatic by ZACHARIAS (1906, p. 520 fig. 8, “*Tintinnus Iriton* n. sp.”).

Is still more frequent than the preceding species in the Atlantic, from 31° S 13° W (the "Fram", July 1911) as far as 48° N (26° W—31° W, CLEVE 1901 d). Frequent in the Florida Current; at the Azores present throughout the summer (CLEVE l. c.). Also known from the Red Sea (? if *Cyrtarocydis Hebe* OSTF. and SCHMIDT is this species without an apophysis, which seems probable, to judge from the figure quoted), the Gulf of Aden (OSTENFELD and SCHMIDT) and several places in the Indian Ocean (BRANDT l. c., and from my own samples).

TINTINNOPSIS Stein.

Lorica without caudal prolongation and without posterior aperture, or with both, the latter being a small or irregular opening at the end (or partly side) of the former, often apparently on account of rupture. Wall of lorica — where freely visible — thin and apparently homogeneous, with or without a "primary" structure, frequently in the upper portion "annulate" (helicoïdal) and with agglutinated, shining or opaque, irregularly angular "foreign" bodies, scattered or close, partly or completely concealing the wall.

The animalcule has in a normal state two macro- and two micronuclei, one contractile vacuole and a number of membranelles, varying — in the different species — from 16 to 24. Peristome collar more or less distinctly lobed and in certain species provided with a single circle of stalked "tentaculoids" (see fig. I p. 4).

The numerous "foreign" bodies on wall of lorica cause this genus to be easily distinguished, though in some cases a similar incrustation, only scarcer and mostly consisting of much smaller particles, may be seen in other genera, f. i. in *Coxiella helix* — very similar to *Tintinnopsis* — in *Leprotintinnus* (Jörg., Laackm. p. p.), with a large normal, posterior aperture, and particularly in species of *Codonella* and *Codonellopsis*, as well as in *Stenosemella*, the three latter genera being — in certain species, or in all — quite similar to the present genus in regard to incrustation of "foreign" bodies.

BRANDT (1896), as well as MERKLE (1909) and others, have shown that these "foreign" bodies have a similar "primary" structure to that so generally met with in the walls of loricae. They are therefore by BRANDT considered to be no true "foreign" bodies, but originating from the animalcule itself. ENTZ (1909) considers them to be fæcalia. This seems to me very probable, at any rate in so far as the fæcalia in certain periods of life may contain numerous similar particles, to be used for construction and stiffening of the loricae. Their "primary" structure is in many (or most?) cases much coarser and more irregular than the corresponding, very fine, one of lamellæ.

If this hypothesis of ENTZ be correct it is easily understood that the loricae, in rather rare cases, in addition to the usual, angular and irregular bodies may show shells of diatoms or other "true" foreign bodies (BRANDT), originating from different well-known marine organisms. It is more difficult to explain the very regularly disposed coccoliths seen in many cases by BRANDT, LOHMANN and ENTZ jun. (see also *Codonella galea*, below).

BRANDT has pointed out that the species of *Tintinnopsis*, in contradistinction to most of the other *Tintinnids*, are "hemipelagic" (neritic, in part meroplanktonic), being only met with near the coasts, not in the open sea. This has always proved to be true, and, presumably, is necessarily connected with their "foreign bodies", these probably being captured inorganic or organic particles or parts of organisms. Only in rarer cases is such building material to be had in open sea, e. g. coccoliths and particles from *Radiolaria*.

The helicoïdal, "annulate", structure of the wall is seen more or less distinctly in the upper portion of lorica, in many species generally becoming very indistinct or plainly invisible farther below. This constitution of wall is probably of great advantage in connection with the incrustation, excreted bodies being easily captured and kept together by secretion of a viscous ring-shaped band (from below

the peristome collar), as SCHWEYER (1905, 1909) explains having seen the beginning of lorica-building take place. The gradual disappearing of the border-lines between the successive turns may be due to the above (p. 63) suggested growth or development of the secreted substance, in consequence of which the lines of contact (of successive turns) may be the more inconspicuous, the older they are. A further consequence of this would be that the lorica — when “annulated” above — is formed in an upward, not in a downward direction, as supposed in the case of *Rhabdonella spiralis*, which never shows an “annulated” constitution. On the other hand, there are “annulated” loricae, where the turns (of the helicoidal spire) are undoubtedly formed in an upward direction, as for instance *Favella ehrenbergi* var. *claparèdei*; here, however, there are no obsolete border-lines, particularly not at the lower end of the helix. In this case there are two reasons for the maintenance of the lines of contact, the “annuli” are not formed in immediate connection with the building of the lorica itself, but obviously formed later, for the purpose of lengthening, and then, the double wall in *Favella* will favour the maintenance, the limiting lamellae being of a firmer and, presumably, sooner finished consistence.

Answering to their character of neritic forms the species of *Tintinnopsis* were, on the whole, only scarce and rare in the material of the “Thor”, being generally only found in harbours or at very shallow stations, sometimes in greater numbers. The distinguishing of species is difficult and requires particularly great first hand experience and plenty of material.

1. TINTINNOPSIS BEROIDEA Entz. (Fig. 72 p. 67).

Entz 1884 p. 411, pl. 24 fig. 3 (1—2, 4—9). *T. beroidea* var. *acuminata* Daday 1887 p. 547, pl. 19 fig. 4 (5). *T. karajacensis* var. *acuta* Paulsen 1904 p. 24 fig. 12. Not *T. beroidea* Brandt 1896 p. 56, pl. III fig. 4, nor Laackmann 1906 p. 20, pl. I figs. 6—8, nor Brandt 1906/7 p. 135, pl. 16 figs. 5, 7, 11 (incl. var. a fig. 6). *T. karajacensis* Merkle 1909 p. 152, pl. II fig. 14. *T. acuminata* Meunier 1919 p. 22, pl. XXII figs. 19, 20, not *T. acuminata* (Imhof) Daday 1887 p. 563.

Sts. 55, 58, 60; Falmouth (common), 79, 84, 85, 87, 89; 112, Genoa, 135, 153, 164, 170 (1000 m.—195 m.). Barcelona (in greater numbers); Lishon, Brest (in greater numbers).

Lorica almost cylindrical, or very slightly and evenly narrowing in the upper $\frac{1}{3}$, then slightly dilated to about the same width as at the mouth; below short conically narrowing, somewhat acute or obtuse at the end, rarely with a very short and acute caudal prolongation. Very occasionally the lorica is somewhat dilated at the mouth, not infrequently very slightly conically narrowing in the upper $\frac{2}{3}$ or somewhat more. “Annuli” (always parts of a single helicoidal band) rarely distinctly visible, but seem to be generally present.

This species, having perhaps the most simply constituted loricae of all species of *Tintinnopsis*, is remarkably difficult to limit from allied species. Is very varying in length, which is always the case with the “annulated” species of *Tintinnopsis*; statements of length should therefore always be accompanied by statements of diameter.

I have already earlier discussed the synonymy of this species (JØRGENSEN 1912 p. 2); as it is, however, growing still more complicated, I will here briefly give the chief features. The name *beroidea* derives from STEIN; his species was taken at Wismar (Baltic), was described as having “short, wide, parabolically acuminated” loricae, but was not figured. After STEIN the name was first used by ENTZ for a Mediterranean form; then BRANDT (1896) transferred it to another, much smaller species from the Baltic, as ENTZ’s species has not been found there. Later, however, the Baltic proved to harbour more species, answering to STEIN’s description, in part apparently much better than BRANDT’s species; it seems therefore quite impossible to make certain which species that of STEIN really is.

On the other hand it is very probable, though not quite certain, that ENTZ’s species will never be found in the Baltic, so that he was (certainly) in error, when applying STEIN’s name *beroidea* to it. Nevertheless, it seems unjust to keep BRANDT’s name — though it cannot be said certainly to be wrong — and to drop that of Stein, which undeniably is the more improbable one, considering that the exact

state of things properly is that no other denominations are quite safe than the following: 1. *T. beroidea* ENTZ 1884, the Mediterranean species, 2. *T. beroidea* BRANDT 1896, the Baltic, smaller, species.

Both names may be abandoned, BRANDT's to be replaced by *T. rapa* Meunier 1910, which seems to be the same species, ENTZ's in exchange for *T. karajacensis* Brandt (1896) var. *acuta* Pauls. Though the name *T. beroidea* in ENTZ is due to an error, it may, however, in my opinion be kept as *T. beroidea* Entz, without fear of any complications, unless somehow, by means of unknown figures or manuscripts,

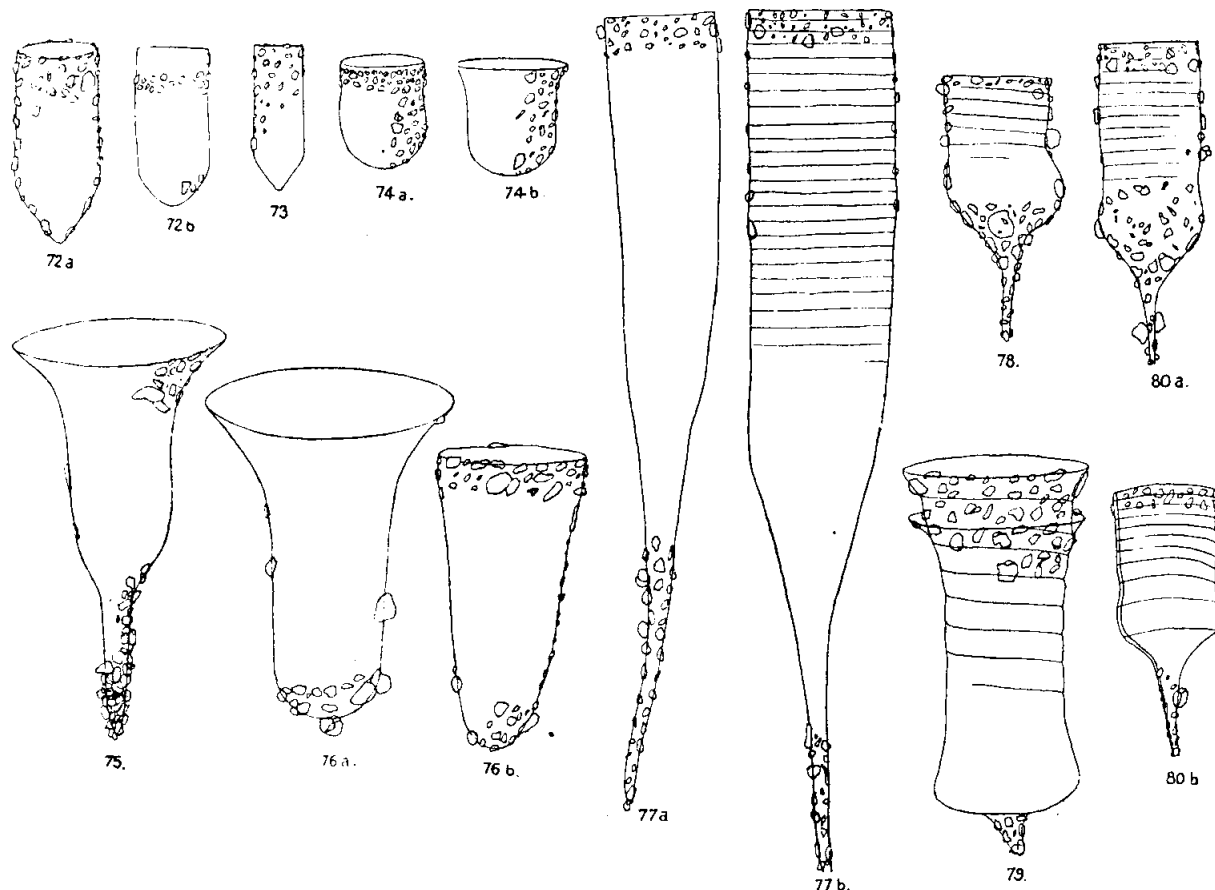


Fig. 72. *Tintinnopsis beroidea* Entz; ³⁵⁰/₁. a: St. 84; b: a more obtuse form from Barcelona. In these and the following figures the "foreign bodies" are only shown on a smaller portion of lorica. Fig. 73. *Tintinnopsis beroidea* Entz, var. *angustior* n. var.; ³⁵⁰/₁. Barcelona. Fig. 74. *Tintinnopsis compressa* (Dad.) Laackm.; ³⁵⁰/₁. a: st. 165; b: Barcelona. Fig. 75. *Tintinnopsis campanula* (Ehrb.) Dad.; ³⁵⁰/₁. Naupaktos. Fig. 76 a. *Tintinnopsis campanula* (Ehrb.) Dad., var. *bütschlii* (Dad.) Jörg.; ³⁵⁰/₁. Naupaktos. b: *Tintinnopsis campanula* (Ehrb.) Dad., var. *cyathus* (?) (Dad.); ³⁵⁰/₁. Naupaktos. Fig. 77. *Tintinnopsis radix* (Imhof) Laackm., ³⁵⁰/₁. a: st. 184, 945 m. wire. b: st. 167; a larger specimen, distinctly "annulate". Fig. 78. *Tintinnopsis angulata* Dad.; ³⁵⁰/₁. St. 184, 945 m. wire. Fig. 79. *Tintinnopsis angulata* Dad., a lorica, with another, unfinished(?) one protruding from its mouth; ³⁵⁰/₁. St. 16. Fig. 80. *Tintinnopsis lindeni*(?) Dad.; ³⁵⁰/₁. a: st. 160. b: st. 184, 945 m. wire; a shorter specimen, with distinctly double wall very similar to *T. angulata*.

the true significance of *T. beroidea* Stein might still be fixed. At any rate it seems unjust to keep *T. beroidea* Brandt and abandon *T. beroidea* Entz, which has the priority (compare MEUNIER l. c. p. 23).

BRANDT, as well as ENTZ, was probably aware of the implied resemblance to Beroë; BRANDT's species recalls the northern *B. forskali* in its lower half, but wants the dilation at the mouth, the figures in ENTZ partly show this dilation — probably only on account of compression in slides — but are in the lower half more similar to the second Mediterranean species, *Beroë ovata*, which is nearly cylindrical

above and rounded below. Certain forms of *T. campanula*, with less developed brim and caudal prolongation, would answer still better to the diagnosis in STEIN (compare MEUNIER l. c. p. 23).

DADAY (l. c.) describes as main species a form with posteriorly evenly rounded lorica, which I myself (1899 p. 24) designated as *T. beroidea* var. *rotundata*. This form is closely allied to *T. karajacensis* BRANDT (1896 p. 57, pl. III fig. 5) and probably not distinguishable from that species. In the material of the "Thor" I only saw this form from Falmouth and have therefore not listed it here.

A form similar to *T. beroidea* Entz, but narrower and probably a separate species, is the following:

Var. **angustior** n. var. (Fig. 73 p. 67).

T. beroidea var. b Brandt 1906/7 p. 138, pl. 16 fig. 15, pl. 19 fig. 22. *T. beroidea* var. *compressa* Fauré-Fremiet 1908 p. 234 fig. 20, not Daday 1887.

Lorica as in the main species, but proportionately and absolutely narrower.

Length 54μ , diameter of mouth 22μ .

Barcelona, in greater numbers than the main species; st. 226.

It should be remembered that such a narrow form will easily slip through the net.

This variety is very similar to *Tintinnopsis fistularis* MEUNIER 1919 p. 23, pl. XXII, fig. 21 — not *T. fistularis* CLEVE 1900 a p. 17 —, but this species (of MEUNIER'S) is smaller, according to the figure quoted 45μ in length, 15μ in diameter. This latter species seems very closely allied to *T. minima* (ENTZ 1909 p. 133, pl. IX fig. 4, as *Tintinnus minimus*), which, however, is stated to be considerably narrower, 8μ — 10μ in diameter. I did not see it in the material of the "Thor".

Otherwise, *Tintinnopsis beroidea* Entz is common on the European temperate coasts, from the coasts of Portugal and Bay of Biscay to the North Sea, Skagerrack and the west coast of Norway.

2. **TINTINNOPSIS COMPRESSA** (Dad.) Laackm. (Fig. 74 p. 67).

Laackmann 1913 p. 14, pl. I figs. 10—15. *T. beroidea* var. *compressa* Daday 1887 p. 548, pl. 19 figs. 7, 8.

Sts. 165, 170 (1000 m.—195 m.), 172 (200 m.—51 m.), 175 (1150 m. wire), 184 (945 m. wire), 190,

Barcelona; everywhere but singly.

This seems to be a well-established species. Lorica almost as wide as long, towards the mouth often considerably and more or less rapidly dilated, frequently with a strongly spreading border; diameter less great in the middle or somewhat above, then again greater. Below the lorica is rounded. Not infrequently the lorica is evenly dilated upwards, towards an obliquely erect or spreading border, and not narrowed in the middle. "Foreign" bodies numerous, particularly towards the mouth; "annuli" very indistinct to invisible, a few near the mouth are sometimes more distinctly visible on less incrustated loricae.

Exceptionally, elongated loricae, distinctly "annulated" above, occur, in shape above like a short, cylindrical "collar", at its base distinctly surrounded by the earlier border of mouth.

Length (normally) 45μ — 54μ , diameter of mouth 34μ — 48μ , minimum diameter (near the middle) 31μ — 38μ .

DADAY caught it frequently at Naples in April; according to LAACKMANN also frequent in the Adriatic.

I have seen it from the Red Sea (Dshedda $1/11$ 1910, HANDEL-MAZZETTI). It is recorded by CALKINS from Woods Hole (Massachusetts), but seems to belong to warmer coasts.

3. **TINTINNOPSIS CAMPANULA** (Ehrb.) Dad. (Fig. 75 p. 67).

Daday 1887 p. 558, pl. 20 figs. 9, 11, 13, 15. *Tintinnus campanula* Ehrenberg 1840.

Sts. 12, 16, Naupaktos (in greater numbers), 23, 27 (in greater numbers), 28, 31, 53, 55, 58, 59, 60, 62, 64 (many individuals), 66, 68; 84, Cadiz, 101, 109 (in greater numbers), Genoa, 164, 170 (80 m.—20 m., 200 m.—85 m., 1000 m.—195 m.), 184 (945 m. wire), Naples, Barcelona, 213, 226, 228 (0 m., 1145 m. wire), Gibraltar, Lisbon, 237, 238, Brest, 249. Singly or sparsely, if not otherwise noted.

Lorica generally of elegant shape, above more or less broadly widened to an obliquely erect or strongly spreading and very broad border or brim. Below, the lorica usually narrows into a shorter or longer, very often oblique, caudal prolongation. "Annuli" not very distinct, but generally visible above, sometimes as far as below the middle.

In a swimming state the animalcule extends considerably beyond the mouth of the lorica, supporting unilaterally on the broad brim of mouth (see fig. I p. 4). It has two macro- and two micro-nuclei; on the inward border of peristome collar are found the peculiar "tentaculoids", already detected by HAECKEL and later seen by SCHWEYER, ENTZ jun. and FAURÉ-FREMIET.

This species, common also on northern temperate coasts, is very varying (compare JÖRGENSEN 1899 p. 22). The brim of mouth is frequently less developed; an extreme form in this respect is

var. *cincta* (Dad.) Jörgensen (l. c.).

T. cincta Daday 1887 p. 557, pl. 20 figs. 6—8, not *Tintinnus cinctus* Claparède et Lachmann. *Codonella campanella* Haeckel 1873 p. 567, pl. 28 figs. 11—14; *C. urniger* Entz 1884 p. 412, pl. 24 fig. 23. *Tintinnopsis annulata* Daday?, 1887 p. 550, pl. 19 fig. 17.

This variety is frequent, also in the Mediterranean, often together with the main species and intermediate forms.

Much more rarely the caudal prolongation — which is very varying as to development — is lacking. Such a form is

var. *bütschlii* (Dad.) Jörg. (l. c. p. 23) (Fig. 76 a p. 67).

T. bütschlii Daday 1887 p. 556, pl. 20 figs. 4, 5.

Sts. Naupaktos, 64; Cadiz.

Closely allied to this latter variety is (apparently) *T. cyathus* Dad., incl. var. *annulata* Dad., l. c., pl. 20 figs. 2, 3, a form with a less developed brim of mouth (see fig. 76 b). *T. infundibulum* Dad. (l. c. p. 559, pl. 20 figs. 17, 18) may, however, be another species. I only saw a single individual of a similar species, below, however, more narrow and rounded, without a caudal prolongation: length 132 μ , diameter of mouth 54 μ , in the middle 30 μ ; indistinct "annuli" (st. Naupaktos).

Tintinnopsis campanula was already recorded for the Mediterranean by FOL 1881 (from Villefranche).

4. TINTINNOPSIS RADIX (Imhof) Laackm. (Fig. 77 p. 67).

Laackmann 1913 p. 17, pl. II figs. 17—31. *Codonella radix* Imhof 1886 p. 103, 1891 p. 4. *Tintinnopsis davidoffi* Dad. 1887 p. 552, pl. 19 figs. 23, 25, 26 (var. *longicauda*); *T. curvicauda* Daday l. c. p. 554, pl. 19 fig. 33. *T. fracta* Brandt 1906/7 p. p., pl. 23 fig. 4.

Sts. 109, 110, Genova, 156 (950 m. wire), 165, 167, 168, 170 (0 m., 200 m.—85 m., 1000 m.—195 m.), Constantinople, 172 (17 m.—0 m.), 174, 175 (0 m.), 185, 186 (0 m., 245 m. wire, 1145 m. wire).

Lorica long and narrow, almost cylindrical in the upper half, then narrowing — or shorter and narrowing from the very mouth — and usually passing over without any limit into a more or less elongated, frequently oblique or flexuose caudal prolongation. "Annuli" usually visible in upper half, or not rarely as far as to the caudal prolongation, on strongly incrustated loricae often apparently lacking (obliterated?).

Total length up to 220 μ , according to LAACKMANN up to 500 μ , diameter of mouth 43 μ —53 μ .

Seems to be common on the Mediterranean coasts, particularly in the innermost regions, as far as into the Black Sea. In the material of the "Thor" it was generally scarce — like species of *Tintinnopsis* on the whole — at sts. 110, 174 and 175, it was present in much greater numbers and the predominant species of *Tintinnida*.

Otherwise it seems to have a wide distribution along the coasts of warmer regions.

In regard to BRANDT's species, *T. fracta* and *T. aperta*, with irregular apertures at the end and partly at the sides of caudal prolongation, it seems to me by far the most probable explanation that these openings are due to fractures in preserved material, perhaps particularly in alcoholic samples. I

several similar cases in the material here dealt with; sometimes nearly the whole caudal prolongation broken off. The two species mentioned also otherwise seem to me to be more artificial than natural ones, the difference between them in part being ruled by a more or less inconsiderable or even indistinct dilation in the lower portion of lorica, whilst the more important width or diameter varies too much and the same "species", at any rate in *T. aperta*.

5. TINTINNOPSIS ANGULATA Dad. (Figs. 78, 79 p. 67).

Daday 1887 p. 561, pl. 20 fig. 22; Laackmann 1913 p. 26, pl. IV figs. 48-53.

Sts. 135, 160 (0 m.), 162, 163 (0 m., 80 m.—0 m.), 164, 165, 167, 181, 182 (0 m., 545 m. wire), 184 (0 m., 945 m. wire), 185, 186 (0 m., 245 m. wire, 1145 m. wire, in Salpæ), 187 (190 m.—100 m.), (0 m., 945 m. wire), 190, 192 (0 m., 545 m. wire), 194 (0 m., 1145 m. wire), Naples, 218, 220, 221, (1950 m. wire), 226, 228 (0 m.), Gibraltar.

Lorica almost cylindrical, slightly and as a rule evenly dilated towards the mouth, more rapidly towards the lower end and frequently to a greater width than above, then rapidly or almost abruptly restricted to a rather short, straight or frequently oblique or curved, very acute, caudal prolongation. Slightly broad (high) "annuli" nearly always distinctly visible from the mouth to below the middle. Foreign bodies mostly rather scattered.

Length $68\ \mu$ — $96\ \mu$, diameter of mouth $40\ \mu$ — $57\ \mu$, caudal prolongation $25\ \mu$ — $37\ \mu$ in length, at the mouth rather broad, but very narrow towards the end.

Very varying. DADAY's species is a form with a conspicuous and abrupt dilation towards the lower end of lorica proper, and then an abrupt constriction to the caudal prolongation. Sometimes the lorica is widest at the mouth, with or without a second widening below.

Is very similar to *Coxliella helix* which, however, is larger, has a thicker wall with distinctly developed and separated outer an inner lamellæ, much more strongly marked border lines between the "annuli", and usually few and scattered foreign bodies, as well as a coarser "secondary" reticulation.

At st. 16 a considerably deviating form was taken, apparently a form of the present species. I have figured it here as an instance of the peculiar looking lorica, having the upper portion of another lorica protruding from the mouth. The older lorica was apparently elongated after being finished, the lower portion being surrounded at its base by the spreading border of the older lorica. (Perhaps the new lorica may have been built by a daughter animalcule not getting loose after fission).

LAACKMANN (1906) figures the same case in *T. campanula* and *T. karajacensis*. Also in loricae having an erect mouth a superposed, new portion may be seen, in rare cases, though not so distinctly offset.

In the material of the "Thor" this species was relatively frequent and sometimes rather plentiful: Sts. 183 (many specimens), 190 (the predominant species of Tintinnids), Naples (several individuals). In the list above forms intermediate to the following, closely allied, species are included.

Was first recorded for the Mediterranean by DADAY (1887) and afterwards by LAACKMANN (1913); is, however, probably the same species which ENTZ jun. mentions and figures (1904) as *Codonella orthoceras* and (1909) as *Cyttarocylix helix* (see LAACKMANN l. c. and the following species).

Otherwise, it seems only observed (as yet) in Gulf of Siam (?) (SCHMIDT 1901 p. 186, as *T. lindeni* Dad.).

6. TINTINNOPSIS LINDENI Dad. (Fig. 80 p. 67).

Daday 1887 p. 560, pl. 20 fig. 23. *Codonella orthoceras* Entz 1904 p. 127 fig. 10 (figs. 12-23?); *Cyttarocylix helix* Entz 1909 pl. 11 figs. 6-8, pl. 12, figs. 10, 11. *Tintinnopsis helix* Laackmann 1913 p. 24, pl. III figs. 37-42? (43-47?).

Sts. 106, 114, 160, 174, 185, 206 (1945 m. wire), 210.

Lorica generally more elongated than in the preceding species, almost cylindrical, but mostly somewhat narrower below the middle and again slightly dilated towards the lower end, which is rapidly

rounded or short conical, with a generally distinctly offset, rather short and frequently oblique caudal prolongation. Wall rather thick, without very distinctly developed or separated outer and inner lamellæ, but with a rather conspicuous "primary" reticulation. Foreign bodies rather scattered. "Annuli" mostly distinct as far as below the middle or towards the end of lorica proper.

Length of lorica proper $132\ \mu$ — $170\ \mu$, of caudal prolongation $28\ \mu$ — $55\ \mu$; diameter of mouth $43\ \mu$ — $49\ \mu$, below somewhat less or somewhat more.

Is very similar to *Coxliella helix* (see below), but has not the thicker wall of the latter species, nor the distinctly developed outer and inner lamellæ and their relatively coarse "secondary" (double) structure. *Coxliella helix* is also mostly a larger species.

The figure of *T. lindeni* in DADAY (l. c.) does not answer very well to the diagnosis, but rather — or as well — to forms of the smaller, preceding species. He states, however, rather different lengths, of *T. lindeni* $180\ \mu$, of *T. angulata* $144\ \mu$ (caudal prolongation included). In the "annulated" species the length is, however, an unstable character; also forms are frequent, apparently belonging to the preceding species, but differing in the same way as shown in DADAY'S figures of both species (chiefly in the more abrupt bulging out below of *T. angulata*). I was only lately aware of the possibility that *T. lindeni* might be another species than *T. angulata*, first on account of the difficulties which LAACKMANN (l. c.) found in distinguishing between his *T. helix* and the latter species, then on account of the plentiful occurrence of both forms together at st. 185, without any disturbing intermediate forms.

BRANDT has also referred species, apparently belonging to *Tintinnopsis*, to his *Coxliella helix*; see f. i. BRANDT 1906—7 pl. 29 figs. 4—12 and pl. 30 fig. 2, from Naples, this latter being apparently the present species.

At present, I find a difficulty in believing that there really exist intermediate forms passing imperceptibly over into species of *Tintinnopsis* on the one hand, and into *Coxliella helix* on the other.

In LAACKMANN'S figures the optical section of wall is generally not to be seen, but will in this case be decisive; the chief question is whether in fully developed — not in young — lorice of the above "*T. lindeni*" the outer and inner lamellæ are developed in a way or to a degree, not too inferior to that in *Coxliella helix*. That the typical *T. angulata* does not possess this character, having only the usual simple wall of *Tintinnopsis*, seems to be certain. I should wish to recommend this rather important question for special investigation, having never seen any doubtful forms of *Coxliella helix* in our northern waters, where this species, however, is scarce. The material of the "Thor" was, as mentioned above, only poor in corresponding material.

It is very probable that the present species also comprises forms of lesser length, and that these above have been listed together with the preceding species. An essential difference between both seems to be the ordinary thin wall in *T. angulata*, as against the thicker, indistinctly double one in the present species, which in any case seems to be a noteworthy connecting link between the genera *Tintinnopsis* and *Coxliella*.

COXLIELLA (Bdt.) Laackm.

Laackmann 1911 p. 454. *Cyttarocyelis* subg. *Coxliella* Brandt 1906 p. 7.

Wall of lorica always nearly double and with well developed and separated lamellæ, rarely — in the first species below — apparently single or with two, imperfectly separated, lamellæ. Structure very fine and indistinct or mostly a coarse, double ("secondary") one, similar to that of *Favella* ("*Cyttarocyelis*-structure"). Wall throughout the lorica formed by a single, helicoidal band, with superposed turns of varying height. No regular denticles at the mouth.

Animalcule possessing two macro- and two micronuclei.

Loricæ generally very similar to those in *Favella*, but easily distinguished through "the annuli", the dividing lines being usually conspicuous in the optical section of wall. Only a couple of species are in some way intermediate between the present genus and the others, *Favella azorica* and particularly *F. ehrenbergi* var. *claparèdei*, with an "annulated" upper portion, distinctly limited from a lower, non-annulated one.

One species, *Coxliella helix*, seems to have a close connection with *Tintinnopsis*, just discussed in the preceding species.

I. Subgenus **PROTOCOHLIELLA** n. subg.

Wall of lorica (in fully developed specimens) apparently simple (singly) or with two imperfectly separated or developed lamellæ. Structure very fine or indistinct, apparently consisting of a very fine and pallid "primary" reticulation, or corresponding "prismatic elements" (or perhaps fine elevated plicæ, the 'annuli' apparently having uneven borders).

1. **COXLIELLA AMPLA** (Jörg.) Laackm. (Fig. 81 p. 73).

Laackmann 1911 p. 456. *Amphorella ampla* Jörgensen 1899 p. 17, pl. I figs. 4 a, b. *Cyttarocyclus?* (*Coxliella*) *ampla* Brandt 1907 p. 272. *Cyttarocyclus spiralis* Meunier 1910 p. 119 p. p., pl. IX fig. 18, not *C. spiralis* Ostf. & Schm. 1901 (p. 188).

This northern species was not present in the material of the "Thor", but is mentioned here, as it may easily be confounded with the following species. Lorica of similar shape and appearance as in that species, but generally short and wide, and rounded below, without a caudal prolongation. It is also much more thin-walled and pellucid, with a very indistinct or invisible structure.

Length $85\ \mu$ — $107\ \mu$, diameter of mouth $70\ \mu$ — $85\ \mu$.

A closely allied species, *Coxliella frigida* LAACKMANN p. p. (1911 p. 392, pl. XLIV fig. 4, pl. XLV fig. 2) is present in the Antarctic.

II. Subgenus **COHLIELLA** n. subg.

Wall of lorica with well developed and separated lamellæ and a more or less distinct or coarse "primary" structure, mostly also with a coarser "secondary" one.

2. **COXLIELLA LACINIOSA** (Bdt.) Laackm. (Fig. 82 p. 73).

Laackmann 1910 p. 450. *Cyttarocyclus* (*Coxliella*) *ampla* var. *laciniosa* Brandt 1906 p. 20, pl. 28 figs. 1, 2, 4, 5 (var. *lata* Brandt), pl. 29 figs. 2 (var. *lata*), 3; *Cyttarocyclus?* (*Coxliella*) *laciniosa* Brandt 1907 p. 270.

Sts. 16, 31, 60; 116, 128 (100 m.—0 m.), 145, 147, 152 (0 m., 250 m. wire, 950 m. wire), 156 (0 m., 250 m. wire, 950 m. wire), 158, 160 (0 m., 30 m.—0 m., 200 m.—100 m., 1000 m.—200 m.), 161, 163 (0 m., 80 m.—0 m.), 165, 182 (545 m. wire), 183, 187 (0 m., 190 m.—100 m., 945 m. wire), 189 (945 m. wire), 209 (80 m.—0 m., 1000 m.—200 m.). Everywhere very scarce or only found singly.

Lorica campanulate, below rapidly narrowing to a short and mostly acute caudal prolongation, the latter occasionally lacking. Thickness of wall greater in the upper half (of length); "annuli" narrower towards the mouth, generally seven or more.

Length of lorica proper $90\ \mu$ — $105\ \mu$, of caudal prolongation $5\ \mu$ — $15\ \mu$; diameter of mouth $55\ \mu$ — $64\ \mu$, consequently proportionately narrower than the preceding species.

No "secondary" structure, only a "primary" one.

Is a rather common warm-water species, also rather frequent in the Mediterranean, particularly in summer and in deeper layers of the inner regions. In winter it is apparently very rare at the surface.

Otherwise the species is widely distributed in the warmer regions of the Atlantic, at any rate from 30° S 9° W (the Fram, July 1911) to 42° N (16° W) (according to BRANDT 1907, LAACKMANN 1911

and my own collections). Also known from the Indian Ocean and the Pacific (New Amsterdam, LAACK-MANN l. c., New Pomerania, BRANDT l. c.; south-east coast of Arabia, at about 51° E., Handel-Mazzetti, Octob. 1910). First recorded from the Mediterranean by BRANDT 1907 (from Messina, taken by LOHMANN).

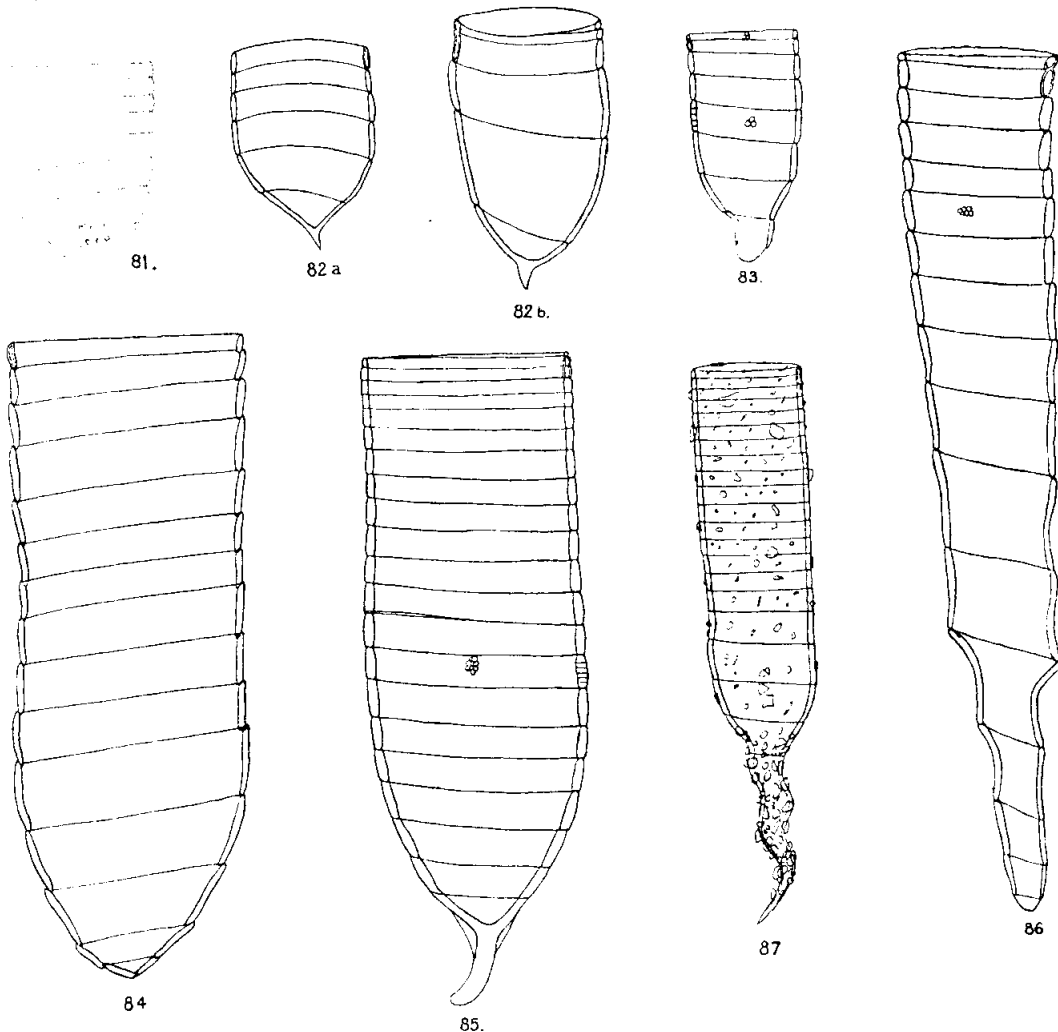


Fig. 81. *Coxiella ampla* (Jörg.) Laackm.; 300/ μ . Puddefjord, Bergen. 29/ μ 1898. Fig. 82. *Coxiella laciniosa* (Bdt.) Laackm.; 350/ μ . a: st. 152, 950 m. wire; b: st. 16. Lamellæ only shown at one side of the upper portion. Fig. 83. *Coxiella pseudannulata* (Jörg.); 350/ μ . S/S "Dronning Olga", 25/ μ 1910, far southeast of Nova Scotia. Fig. 84. *Coxiella annulata* (Dad.) Entz. jun. 350/ μ . Naples. Fig. 85. *Coxiella decipiens* n. sp.; 350/ μ . Naples. Fig. 86. *Coxiella fasciata* (Kof.) Laackm.; 350/ μ . St. 182, 545 m. wire. Fig. 87. *Coxiella helix* (Clap. et Lachm.); 350/ μ . St. 174.

Beside the above species, *Coxiella ampla*, there is another northern one, likely to be confounded with the preceding, namely

3. COXIELLA PSEUDANNULATA (Jörg.) (Fig. 83).

Cyttarocyclus pseudannulata Jörgensen 1901 p. 15, pl. II fig. 28. *Tintinnus*(?) calyptra Cleve? 1899 a, p. 24 pl. I fig. 2. *Cyttarocyclus*(?) calyptra Cleve? 1901 d, p. 108. *Cyttarocyclus pseudannulata* Brandt 1906/7 p. 269, pl. 28 fig. 8, pl. 29 fig. 1, incl. var. calyptra p. 270; *C. spiralis* Meunier 1910 (p. p.), pl. IX fig. 19 (20?); *C. sp.* Meunier l. c. pl. XXIII fig. 12.

Is usually smaller and particularly narrower than the preceding species (diameter 40 μ —60 μ), with a more or less distinct "secondary" structure, showing a single layer of "prismatic elements" bet-

ween both lamellæ (in the optical section appearing as unbroken short lines, "*Cyttarocyclus*-structure"). Mouth of lorica usually irregularly denticulate.

Subarctic species, extending from the west coast of Norway to Spitzbergen and Novaya Zemlya. I have also taken it at the border region between the Florida and Labrador Currents far south-east of Nova Scotia (41° N 59° W, April 1910). Not present in the Mediterranean.

The quoted figure in CLEVE strongly recalls certain species of Radiolaria (Polycyrtids), particularly on account of the structure. If this figure really represents a Tintinnid, the specific name of the present species ought to be *calyptra* (Cl.).

This species also has a representative in the Antarctic, the allied species *Coxliella intermedia* Laackm. (p. p.) 1911, pl. XLV fig 6.

4. COXLIELLA ANNULATA (Dad.) Entz jun. (Fig. 84 p. 73).

Entz jun. 1909, pl. 10 fig. 1 (6?). *Cyttarocyclus annulata* Daday 1887 p. 582, pl. 21 fig. 6. *Tintinnus zonatus* Zacharias 1906 p. 525 fig. 11. *Cyttarocyclus* (*Coxliella*) *annulata* Brandt 1907 p. 267.

Sts. 85 (singly), Naples (in August, several specimens).

A large species, with a lorica of not very firm consistence, similar to that of *Favella ehrenbergi*, to which it may be somehow allied.

Lorica almost cylindrical, towards the mouth frequently slightly dilated, more distinctly — though very slowly and evenly — widened towards the lower $\frac{1}{3}$, then rapidly and conically narrowed to the end, without a caudal prolongation (and without alary plicæ). "Annuli" very conspicuous to the very end, towards the mouth frequently narrower (lower), also narrower at the lower end, broadest at about lower $\frac{1}{3}$. Thickness of wall rather great; "annuli" (turns of the helix) very conspicuous on the optical section of wall, their upper border overlapping the lower one of the superposed "annulus".

Length 272 μ —315 μ or somewhat more, diameter of mouth 85 μ —90 μ , maximum diameter (below) up to about 95 μ . Thickness of wall about 4 μ —5 μ .

It was of great interest to find DADAY'S beautiful species, the name of which was earlier repeatedly misapplied, also by myself (1899). It proved to answer very accurately to his figure and the dimensions stated. It is a very well defined species, easily distinguished from allied forms, particularly by the very characteristic lower end. It was detected at Naples by DADAY (1887) and afterwards figured by ZACHARIAS 1906 as a new species from the northern Adriatic. Perhaps it is the same species which LOHMANN mentions as *Codonella annulata* Clap. et Lachm. 1903 from Syracuse, having changed the name in 1908 to *Cyttarocyclus annulata* Dad. ENTZ jun. reports it 1909 from the northern Adriatic and Naples, THEODORO 1922 from Venice.

Most probably a neritic species, being very rare in the material of the "Thor" and not mentioned in CLEVE (1901 d) from the open Atlantic; may be present near the coasts in many places; as yet, however, only observed in the Mediterranean and near Lisbon.

5. COXLIELLA DECIPIENS n. sp. (Fig. 85 p. 73).

Coxliella annulata Entz jun. 1909 (p. p.), pl. 10 fig. 4 (?), 5?

Naples, in August.

Lorica very similar in shape to that of the preceding species, differs, however, in being elongated below into a short, but generally not very thick, caudal prolongation, straight, or frequently curved, as a rule apparently conically widening above on account of three alary plicæ, extending up to lower portion of lorica proper, as in *Favella ehrenbergi* var. *helgolandica*.

The helicoidal line separating the "annuli" is less distinct than in the preceding species, being rather inconspicuous towards the lower portion of lorica; in the optical section of wall the successive turns of the helicoidal band are also more difficult to distinguish, not (or only indistinctly) overlapping.

Is also very similar to *Favella ehrenbergi* var. *claparèdei*; thickness of wall, however, not so great as in *F. ehrenbergi* and varr.

Dimensions about as in the preceding species, but lorica generally shorter: length $196\ \mu$ — $272\ \mu$, diameter of mouth $90\ \mu$, lower maximum of diameter less pronounced or wanting. Thickness of wall $4\ \mu$ — $5\ \mu$, "annuli" frequently numerous and narrow (low).

Occurred at Naples together with the preceding species and the two forms of *Favella ehrenbergi* mentioned. I saw no intermediate forms. It was present in greater numbers than *C. annulata*.

6. COXLIELLA FASCIATA (Kof.) Laackm. (Fig. 86 p. 73).

Laackmann 1911 p. 455. *Cyttarocyclus fasciata* Kofoid 1905 p. 297, pl. XXVI figs. 6, 7; *C. (Coxliella) fasciata* var. *procera* Brandt 1906 p. 20, pl. 28 figs. 7, 9; 1907 p. 268; *Cyttarocyclus (Coxliella) helix* Entz jun. (p. p.) 1909, pl. X fig. 3.

Sts. 14; 182 (545 m. wire), 206 (0 m., 1945 m. wire), 223 (1950 m. wire), everywhere only single, or in part incomplete, individuals.

Lorica elongated and narrow, very narrowly conical, frequently widening somewhat towards the mouth, below more rapidly constricted to a but slightly differentiated, not distinctly offset caudal prolongation of almost equal width, obtuse at the end and more like a narrowed and very elongated lower portion of the lorica proper. "Annuli" conspicuous, numerous, above, as well as below, more narrow (low), narrowest close to the mouth, broadest about at the lower $\frac{1}{3}$ (of length), here almost as broad as wide. In the optical section the "annuli" in the lower portion of lorica are more or less concave outwards, and slightly overlapping. Thickness of wall somewhat increasing above. A relatively distinct "*Cyttarocyclus*-structure" present, of secondary "prismatic elements" in one layer between the lamellæ.

Length (of the figured specimen) $374\ \mu$, diameter of mouth $68\ \mu$, thickness of wall $3\ \mu$ — $4\ \mu$.

This beautiful and easily recognized warm-water species was very rare in the Mediterranean, generally only present in very deep layers. It is scarcely indigenous here; the lorice were also but seldom uninjured (only at sts. 182 and 206, in deeper layers).

The dimensions given by KOFOID (l. c.), $520\ \mu \times 100\ \mu$ are probably too great, presumably on account of an error as to the magnification. His figure (6), with the magnification stated (490), gives $270\ \mu \times 50\ \mu$, answering to var. *procera* Brandt (l. c.), a "variety", only established in consequence of the different dimensions (see also LAACKMANN l. c.).

Outside the Mediterranean known from a few localities in the Atlantic (German South-Pole Expedition $\frac{25}{8}$ and $\frac{26}{8}$ 1903, west of South-Africa; Sargasso Sea, about $32^\circ\text{N } 44^\circ\text{W}$, and far south-east of Nova Scotia, as well as far south of Cape Farewell (BRANDT l. c.) noted by BIEDERMANN(?)). Also in the Pacific: off San Diego, 700 m.—0 m., KOFOID l. c.; New Pomerania, BRANDT l. c.

7. COXLIELLA HELIX (Clap. et Lachm.) (Fig. 87 p. 73).

Tintinnus helix Claparède et Lachmann 1858 p. 206, pl. VIII fig. 8. *Tintinnopsis helix* Daday 1887 p. 562; *T. annulata*? Daday 1886, p. 496, pl. 25 fig. 15, 1887 p. 550, pl. 19 fig. 17. *Tintinnus fistularis* Möbius 1887 p. 120, pl. 8 fig. 38. *Cyttarocyclus helix* Jörgensen 1899 p. 38; *C. (Coxliella) helix* Brandt 1906 p. 20, 1907 p. 213. Not *Coxliella helix* Entz 1909 pls. X—XII.

Sts. 109, 116, 134 (0 m.), 154, 169, 170 (0 m., in rather great numbers; 20 m.—0 m., 80—20 m., 200 m.—85 m.), Constantinople, 172 (0 m., 17 m.—0 m., 200 m.—51 m.), 173, 174, 175 (0 m., 30 m. wire, 350 m. wire, 1150 m. wire), 178 (in greater numbers), 179, Naples, 210.

Lorica narrow, of rather great length, generally of equal diameter throughout, sometimes very slowly narrowing in a downward direction, rarely somewhat widened below to a very slightly pronounced maximum diameter in the lower $\frac{1}{3}$, towards the lower end rather rapidly and conically narrowed to an offset, evenly narrowing and acute caudal prolongation, rather thick at its base, straight, or frequently

blique or more or less flexuose. Lorica with more or less scattered "foreign" bodies, mostly shining, angular, pieces, sometimes also shells of diatoms or other very small organisms. Wall with two distinctly developed and separated lamellæ, at any rate in upper half, throughout formed by a helicoidal band with numerous turns which are generally very distinct, being visible on the longitudinal section as far as the caudal prolongation, sometimes also farther down, where the foreign bodies mostly are more numerous, concealing the helicoidal spire. Very varying.

Length of lorica proper usually $170\ \mu$ — $250\ \mu$, exceptionally $85\ \mu$ — $417\ \mu$, of caudal prolongation $34\ \mu$ — $60\ \mu$, exceptionally up to $196\ \mu$; diameter of mouth usually $47\ \mu$ — $55\ \mu$, but varying from $38\ \mu$ to $64\ \mu$, sometimes a secondary maximum of diameter below, up to $77\ \mu$. "Annuli" in the upper $\frac{1}{3}$ sometimes very narrow (low) and numerous. Structure of wall very varying; outside usually distinct to coarse "secondary" meshes, with or without(?) finer "primary" ones, are visible.

Caudal prolongation frequently injured, open at the end, or partly also laterally (unilaterally). As in *Tintinnopsis aperta* Bdt. and *T. fracta* Bdt. this is most probably due to the brittleness produced by certain preserving fluids.

I have mentioned above that certain forms or species of *Tintinnopsis* seem to approach *Coxiella helix* in a degree which may make it very difficult to distinguish between them. This is particularly the case with the form which I have above named *T. lindeni*; in most cases, *Coxiella helix* will be easily distinguished by the very distinctly double wall and the more conspicuous helicoidal spire. Here, and probably in all cases, the latter is due to development and superposition of new turns of the helicoidal band. Close to the mouth they are young and low, but will develop to a certain size, which is nearly always greatest somewhat above the caudal prolongation, being very small towards the mouth. In the double-walled loricae the border line between the turns is always much more distinct than in single-walled, probably because a coalescence of the parts in contact is difficult, when one of them is already developed into a firmer lamella. BRANDT (1907 p. 217) has another interpretation of the phenomenon, explaining it as a development of a supporting rib (Verstärkungsleiste) in the wall. (Compare above pp. 8, 30).

This species only occurred very sporadically and sparsely in the Mediterranean, was, however, present everywhere in the Black Sea region, sometimes in greater numbers. Otherwise known from the coasts of the North Sea, in autumn extending into the Skagerrack, the Cattegat and the western and southern regions of the Baltic, according to BRANDT also to the south-western coast of Finland. Probably also present on warmer coasts; is, however, easily confounded with species of *Tintinnopsis*.

If synonymous to *Tintinnopsis annulata* Dad., as supposed by BRANDT (l. c.), it was already stated for Naples in 1886, at any rate in 1893 by APSTEIN. *Coxiella helix* Laackm. (1913) from the northern Adriatic presumably is partly this species, partly (my) *T. lindeni* above (compare that species). It is — like the species of *Tintinnopsis* — a neritic form, indigenous on the Mediterranean coasts.

CLIMACOCYLIS n. gen.

Lorica of a rather soft or somehow jellied consistence, generally broadly tubular, with or without a large, more or less funnel-shaped dilation below where usually(?) widely open. Wall as in *Coxiella* formed by a single helicoidal band which is, however, provided outwards with a strongly protruding, coarse rib, running about in the middle of the band, parallel to its borders. Structure of wall a coarse and obvious "*Cyrtarocylis*-structure" of large "secondary" prismatic elements in a single layer between the well developed and separated lamellæ.

CLIMACOCYLIS SCALARIA (Bdt.) (Fig. 88).

Cyrtarocytilis (*Coxiella*) *scalaris* BRANDT 1906 p. 7 pl. 21 fig. 15, pl. 26 figs. 4—6, pl. 27 figs. 1—3; 1907 p. 264. *Coxiella scalaria* LAACKMANN 1911 p. 455.

Sts. 38, 60, 66, 68; 80, 92, 98, 126 (275 m. wire), 129 (1100 m.—0 m.), 152 (250 m. wire), 950 m. wire), 156 (250 m. wire), 160 (0 m., 100 m.—30 m., 200 m.—100 m.), 163 (80 m.—0 m.), 182 (545 m. wire), 189 (945 m. wire), 194 (0 m., 1145 m. wire), 199 (200 m.—80 m.), 206 (1945 m. wire), 209 (1945 m. wire), 217, 218, 220, 223 (0 m., 1950 m. wire), 229, 231 (1145 m. wire).

Concerning the constitution of lorica, see the generic diagnosis.

Animalcule unknown. The rather soft loricae of a very pallid appearance, easily overlooked (in water and glycerine). They are obviously but slightly heavier than water and, on account of the remarkable, outward, helicoidal rib, apparently strictly connected with or somehow fettered to the surrounding water, more so than most of other Tintinnids, so that they can only with difficulty be collected in the usual way. In the material of the "Thor" they were only present singly, though apparently not rare in warmer seas.

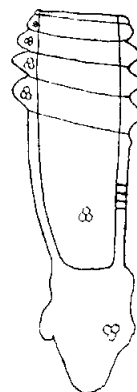
On the summer cruise this species was already met with in the Bay of Biscay, and afterwards from the Bay of Cadiz sporadically throughout the Mediterranean, until st. 182 (Euboea), but east of the Balears only met with at two stations at the very surface, otherwise only at deeper levels. It was throughout more frequent in deeper layers than at the surface, being present at 13 of the 22 Mediterranean stations for deep water samples.

In winter, however, it was very rare in the (surface of the) Mediterranean, only noted for two stations (just inside the Straits of Gibraltar, and near Sardinia).

An immigration into the Mediterranean from the west seems to take place in September, the species being present in the Bay of Cadiz as well as near the African coast. In June it was very rare in the Bay of Cadiz and not observed in the Atlantic Current along the African Coast; if it enters at this season it must have passed over to deeper levels in the Alboran Sea. In winter there was no indication of the species getting in.

Otherwise it is widely distributed in the tropical and subtropical regions of the Atlantic, in many places in greater numbers, particularly in the tropical zone (HENSEN 1911). It is met with altogether from 27° S to 43° N in the Atlantic, and, in addition, is known from Madagascar (BRANDT l. c.), and farther south-east (LAACKMANN l. c.), far west of the south-west coast of Australia (33° S 97° 20' E, S/S Tasmanic, capt. HÅKONSSON, May 1910), and from New Pomerania and Cook-Straits in the Pacific (BRANDT l. c.).

Was first reported from the Mediterranean by BRANDT l. c. (from Messina, taken by LOHMANN). It probably gets occasionally in from the Atlantic, but is perhaps present in deeper layers all the year.



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Fig. 88.
Climacocylis
scalaria (Bdt.);
350/1. St. 60.

CYTTAROCYLIS Fol (emend. Laackm.).

Wall of lorica with well developed and separated lamellæ. Structure of wall coarse, "secondary" meshes, belonging to a — nearly everywhere — single layer of prismatic elements between the lamellæ; in addition a more or less distinct "primary" reticulation is present (of similar, only much smaller, prismatic elements?). In the optical section of wall a — mostly — single layer of cross-lines are seen (side walls of prismatic "secondary" elements). Wall not "annulated", but provided with a more or less spreading to erect, broadly collar-shaped oral rim, here called the "collar", limited from the lorica proper by an inwards protruding, sharp rib.

The animalcule has repeatedly been reported to have many nuclei, like others of the genera

provided with a "collar", but in contradistinction to most genera of Tintinnids. It needs, however, further investigations as to whether there is not, also in this genus, a normal stage with two macro- and two micronuclei, the multinuclear stages being perhaps connected with a development of "spores".

1. CYTTAROCYLIS CASSIS (Hck.) Fol. (Fig. 89).

Fol. 1881 p. 22, pl. I fig. 6; 1884 p. 55, pl. IV fig. 6, pl. V fig. 10. *Dictyocysta cassis* HÄECKEL 1873 p. 563, pl. XXVII figs. 2, 3.

Sts. 10, Port Alice, 14, 20, Taormina, 23, 25, 26, 28, 29, 33, 36, 38, 39, 42, 66, 68, 69; 92, 126 (200 m.—100 m., 500 m.—120 m., 275 m. wire), 129 (100 m.—0 m., 600 m.—0 m., 1100 m.—0 m.), 132 (600 m.—195 m.), 134 (125 m.—75 m., 200 m.—125 m.), 152 (950 m. wire), 182 (545 m. wire), 186 (245 m. wire), 187 (190 m.—100 m.), 189 (945 m. wire), 199 (200 m.—80 m., 945 m. wire), 206 (1945 m. wire), 209 (200 m.—85 m., 1000 m.—200 m.), 213, everywhere singly or very scarce, at st. 126 (200 m.—100 m.) several specimens.

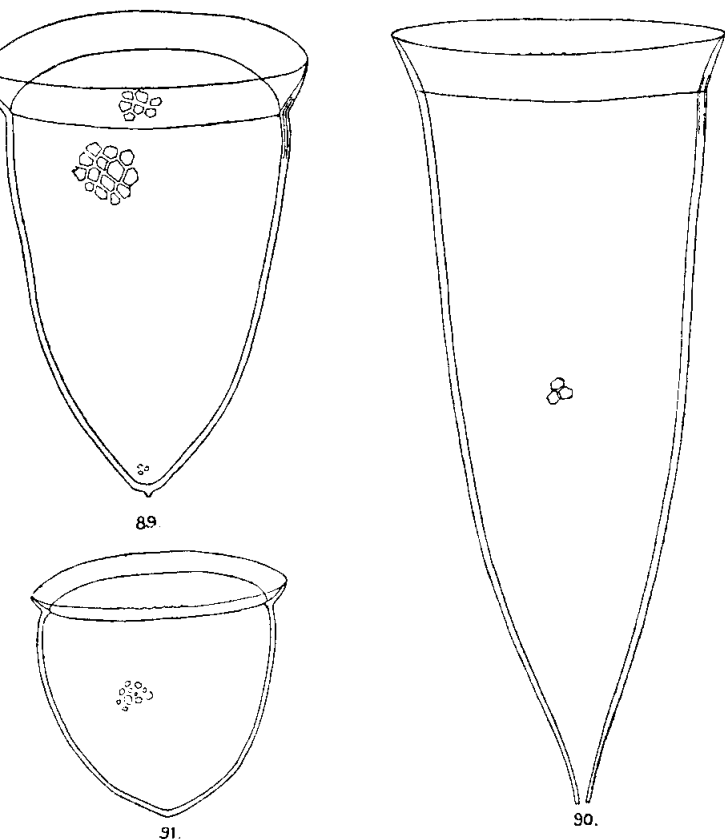


Fig. 89. *Cyttarocylis cassis* (Hck.) Fol; ³⁵⁰/₁. Fig. 90. *Cyttarocylis cassis* (Hck.) Fol, var. *magna* Bdt., ³⁵⁰/₁. St. 182, 545 m. wire. Denticles of rim only suggested. Fig. 91. *Cyttarocylis encephalus* (Hck.) Kof. ³⁵⁰/₁. Taormina Denticles of rim only suggested.

... sometimes truncate — then usually with a mamilla — to acute, sometimes with an open, fine channel. The structure is also varying, though on lorica proper rather uniform, on oral brim of more unequal meshes.

The distribution in the Mediterranean was very characteristic, recalling that of subtropical *Ceratia* and *Dinophysiaceæ*. In winter it was present in the Bay of Cadiz and in the middle regions of the Mediterranean, especially in the Tyrrhenian Sea, but very scarce or singly, only at st. 28 in somewhat greater numbers. In summer it had disappeared from the surface — only noted for a single station (213) in the Catalanian Sea — but was present at most of the stations for deep water samples (at 13 of 22

Lorica of greater length than width, below the suberect or somewhat spreading, outwards usually slightly convex, oral rim almost cylindrical for a short distance, then slowly and conically narrowing about to the lower $\frac{1}{3}$; then again more rapidly conical towards the very end which is usually more obtuse and most frequently provided with a mamilla, obtuse or acutish. Upper border of oral rim generally irregularly and slightly denticulated. Meshes with faintly elevated, rather thin walls, polygonal, or somewhat rounded with walls thickened at the corners, in the upper portion of oral brim 8μ — 9μ , in the middle of lorica 6μ — 7μ , towards the lower end 2μ — 3μ .

Length 179μ — 196μ ; diameter of mouth 124μ — 145μ , of the base of oral rim at the constriction 99μ — 128μ . Lower end of lorica varies from obtuse, or some-

in the Mediterranean), apparently at a rather great depth, 100 m. to 200 m. The loricae were nearly always empty; remains of the animalcule only noted for st. 134, 125 m.—75 m.

As already pointed out by BRANDT (1907 p. 195) the dimensions given by HAECKEL (l. c.) are considerably smaller than otherwise found, on account of which he considers HAECKEL's form, the main species, to be very rare. As, however, the rich material of the "Thor" does not contain a form of such small dimensions (less than $\frac{2}{3}$ of the usual) it may be considered almost certain that those small dimensions are owing to an erroneous note, probably a magnification of 400 (as in his figure of *Codonella orthoceras*) instead of 600 (as stated). Nor do I think we should attach too much importance to his figuring the lower end of lorica as acute — also in DADAY (1887 pl. 21 fig. 3) who gives the correct dimensions — such forms being very slightly different from the usual ones. In my opinion the usual Mediterranean form — as described above and answering to var. a BRANDT (1906/7 p. 195, pl. 34 figs. 2, 4, 5) — should be considered the main species, to which, if desirable, may be added a forma *acuta*. The similar var. *conica* Bdt. (p. 196, pl. 34 fig. 6, pl. 35 fig. 8) seems also to be only an accidental, more obtuse, form. On the other hand var. *magna* Bdt. (pl. 34 fig. 3, pl. 35 fig. 3) is presumably a separate species (see below), probably also var. e Bdt. (pl. 35, figs. 4, 5). This latter I have not yet seen.

Var. **magna** Bdt. l. c. p. 196 (Fig. 90, p. 78).

Lorica more elongated than in the other forms, as well as larger. Lateral outlines — of lorica proper together with the oral rim, which is very slightly or not at all outwardly directed — almost straight to below the middle, whence slightly convex, and then somewhat concave towards a protracted, rather offset, lanceolate point, frequently with a narrow channel opening at its end. Meshes of the oral rim unequal in size, polygonal, up to 9μ , in the middle of lorica about 5μ — 7μ and rather regular and equal-sized to the lower end.

Length 314μ — 332μ , diameter of mouth 140μ — 162μ .

Upper border frequently rather regularly denticulated.

Very rare in the material of the "Thor", only noted for one station: 182, 545 m. wire, a couple of individuals.

The main species is a relatively frequent warm-water species, of a wide distribution in the Atlantic, but generally present in small numbers. It is known from the south point of Africa (LAACKMANN 1911) to 39° N in the Florida Current, far south-east of Nova Scotia (BRANDT 1907) and seems to be on the whole rather common in this large area; exceptionally it extends to 46° N 42° W (where I took it singly in April 1910). Otherwise known from the Indian Ocean (German South-Pole Exp. $\frac{15}{5}$ 1903, far south-east of Madagascar, LAACKMANN 1911) and from the Pacific (south-west and south of Australia and New Zealand, BRANDT 1907). KENT (1882) reports it from Falmouth, and AURIVILLIUS (1898) from the Swedish coast in the Skagerrack (only once taken; in both cases the records may perhaps apply to the following species).

Var. *magna* is much rarer; according to BRANDT (l. c.) it is known from the Sargasso Sea, the Florida, the North Equatorial and the Benguela Currents, New Zealand, Tonga Islands and the sea south of Australia. I have not listed it as a separate species, only because there is a form, var. d Bdt. (l. c. p. 197, pl. 35 figs. 1, 2) which in size, as well as in shape, seems (to me) to be intermediate to the main species, answering to the latter in structure.

Cyrtarocyliis cassis was first recorded for the Mediterranean by HAECKEL (1873 and before) from Messina, afterwards by FOL (1881) from Villefranche, by DADAY from Naples and by ENTZ jun. (1904) from the northern Adriatic, together with var. *magna*.

2. CYTTAROCYLIS EUCECRYPHALUS (Hck.) Kof. (Fig. 91, p. 78).

KOFOLD 1912 p. 353. *Sethocephalus eucecryphalus* HAECKEL 1887 p. 1298, pl. 56 fig. 13. *Cyttarocyliis cassis* var. *plagiostoma* DADAY 1887 p. 581, pl. 21 fig. 13. *C. plagiostoma* BRANDT 1906 p. 22, pl. 35 fig. 7, pl. 36 fig. 12, 1907 p. 198, incl. var. a p. 199, pl. 36 figs. 1, 4, 8, and var. b p. 199, pl. 36 fig. 7.

Sts. 11, Port Alice, 14, 20, Taormina, 23, 25, 26, 27, 28 (several specimens), 29, 31, 33, 38, 39, 40, 60, 62, 66 (several specimens), 68, 69; 126 (200 m.—100 m., 500 m.—120 m., 275 m. wire), 129 (80 m.—0 m., 600 m.—0 m., 1100 m.—0 m.), 134 (125 m.—75 m.), 152 (250 m. wire, 950 m. wire), 156 (250 m. wire, 950 m. wire), 160 (200 m.—100 m.), 182 (545 m. wire), 186 (245 m. wire), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), 194 (0 m., 1145 m. wire), 199 (945 m. wire), 206 (1945 m. wire), 223 (1950 m. wire), 234 (200 m.—95 m.); always singly or very scarce, if not otherwise mentioned.

Lorica generally of greater width than length, roundedly campanulate; the oral rim narrower than in the preceding species, always rather spreading. Lorica at the lower end rounded, or usually more or less distinctly broad and conical, often very slightly protracted, but at the very end obtuse, frequently showing a very narrow, open channel, axial, or somewhat laterally situated. Structure of irregular meshes, very unequal in size, in the oral brim and near to the constriction usually some large ones, 8μ — 10μ , otherwise mostly of very different shape and size.

Length 94μ — 113μ , diameter of mouth 113μ — 140μ ; oral rim usually only 11μ — 13μ broad (long), often regularly and closely denticulated.

The animalcule seems to be unknown.

Is a more frequent species than the preceding one, but has a similar distribution, in the Mediterranean, as well as otherwise. The distribution in the Mediterranean, during the winter as well as during the summer cruise, was very similar to that of the preceding species; in summer it was only taken at one Mediterranean station at the surface (st. 194), whilst present in deeper layers at 14 of the 22 stations where such samples were taken in the Mediterranean proper, and at a corresponding depth to that in which the preceding species occurred.

In the Atlantic it is rather common from 32° S, west of South Africa, to 40° N in the Florida Current, and to 43° N west of the north-western coast of Portugal. It is present in many places in greater numbers, especially in the Sargasso Sea (BRANDT l. c.). Is also known from the Indian Ocean (south-east of and near Madagascar, Red Sea, Somali Coast, Ceylon, Bay of Bengal, south-west of Australia) and from the Pacific (south of Australia, near New Zealand, New Pomerania and Tonga Islands). (Mostly according to BRANDT l. c., in part to LAACKMANN 1911 and my own samples).

It was detected in the Mediterranean by DADAY, at Naples, but is — strange to say — afterwards only reported from the Mediterranean by BRANDT. It is undoubtedly a well defined species, though rather closely allied to the preceding.

In the distribution of these two species no direct indications of an immigration into the Mediterranean from the west are seen. They are apparently true (indigeneous) Mediterranean species, having in common with other subtropical ones the peculiar occurrence, only in winter at the surface, withdrawing to deeper levels in summer. Such species, having large and relatively heavy loricae, may, however, normally belong to layers below the surface. *Cyttarocyliis cassis* was present at st. 92 in June, and may perhaps have got in through the Straits, passing over to deeper layers in the Mediterranean. An occasional invasion below the surface is very probable (in both species), but would not be perceived from the contents of the samples.

The generally scarce occurrence in the deep water samples seems to be suggestive of a mere passing over to deeper levels in summer, without any following swelling up in numbers, only with an occasional renewal of stock through immigration into the Mediterranean from the Atlantic.

DICTYOCYSTA Ehrb.

Lorica short and wide, more or less campanulate, having an upper, more or less distinctly offset and almost cylindrical "collar", consisting of a single or double row of large, rectangular or oval "windows", separated by more or less thin and columnar intermediate beams. Lorica proper below the collar somewhat swollen, roundish, double-walled and with different structure (in different species), consisting of smaller and larger meshes and the usual fine, primary structure. No caudal prolongation, nor denticles at the mouth; helicoidal constitution of wall wholly wanting.

Animalcule reported to have 8 macro-nuclei and 20 membranelles (DADAY 1887), according to BRANDT jun. 1909 3—11 macronuclei and 18 membranelles; there is also an apparatus for shutting the oral aperture.

1. DICTYOCYSTA ELEGANS Ehrb. (Fig. 92 p. 82).

EHRENBERG 1854 a, p. (54 and) 238; 1854 b, pl. XXXV A XXIV fig. D. BRANDT 1907 p. 65, pl. 1 figs. 7, 8, pl. 2 fig. 12, incl. var. a p. 66, pl. 1 fig. 9, pl. 2 figs. 4, 7, var. b p. 67, pl. 2 fig. 8, pl. 4 fig. 4 and var. c p. 67, pl. 2 fig. 1.

Sts. 10, 12 (several), 14, 16, Naupaktos, 23, 26, 28, 29, 31 (several), 33, 35, 38; 79, 80 (abundant and predominating), 81 (100 m. wire), 92, 93, 94, 95, 98, 99, 116, 120, 122, 126 (275 m. wire), 128 (100 m.—110 m.), 129 (600 m.—0 m., 1100 m.—0 m.), 134 (200 m.—125 m.), 152 (250 m. wire, several; 950 m. wire), 156 (250 m. wire), 175 (350 m. wire, 1150 m. wire), 178, 182 (545 m. wire), 186 (0 m., 245 m. wire, 1145 m. wire, and in Salpæ), 187 (945 m. wire), 189 (945 m. wire), 190, 194 (0 m., 1145 m. wire), 199 (200 m.—110 m.), 200, 206 (1945 m. wire), 209 (200 m.—85 m., 1000 m.—200 m., 945 m. wire, 1945 m. wire), 210, 211, 228 (0 m.), 234 (100 m.—25 m., 200 m.—95 m., 700 m.—200 m.). Scarce or singly if not otherwise mentioned.

Lorica — in this and the next two species — provided with a collar of large, angular windows, whilst the lower portion, lorica proper, shows a lattice-work of larger and smaller meshes, without transition to the large ones of the collar. In the present species the collar consists of a double row of large windows.

Highly varying in shape and structure. A particularly beautiful and frequent form is the following,

var. *speciosa* n var. (Fig. 93 p. 82).

Dictyocysta templum var. *disticha* Jørgensen 1899 p. 40 p. p. D. *elegans* "p. p. Möbius" Biedermann 1892 p. 9, pl. 1 fig. 2. D. *elegans* Brandt 1907, pl. 1 fig. 7.

Collar strongly offset, in shape as well as structure. Below the collar the lorica is abruptly dilated, the lateral outlines bulging, then conically converging towards an obtuse, dome-shaped lower end. A circle of large, oval windows are found about the middle of the lorica proper, close below its greatest diameter; below these larger windows mostly a circle of similar, somewhat smaller, or only some few scattered ones.

Length about 89 μ , collar slightly shorter than lorica proper. Diameter of mouth 42 μ —51 μ , maximum diameter of lorica proper 47 μ —59 μ .

This form is exceedingly similar to *D. lepida* and perhaps not always distinguishable from this latter species. (Compare BIEDERMANN l. c., as well as the following species).

BRANDT (l. c.) considers this form to be the main species, presumably for the following reason. BIEDERMANN (l. c., p. 11 pl. III fig. 3) gives a figure of *Dictyocysta mitra*, naming it *D. elegans* s. str. Ehrenberg. Accordingly, BRANDT (l. c. pp. 63, 65) refers the figure in Ehrenberg (1854 b l. c.) to *D. mitra*, in contradistinction to Ehrenberg's diagnosis of the species (1854 a). This must, however, be erroneous, the shape of the figure (in EHRENBERG) quoted already obviously showing a species different from *D. mitra*,

with two rows of large, angular windows. Besides, the figure in question shows, by dots, the very small meshes below the collar and elsewhere which are absent in *D. mitra*.

Decisive as to the choice of main species should be, either the figure quoted (in J. MÜLLER 1841 p. 233, pl. 6 fig. 6) 1854 a, which represents the present species, or — according to BRANDT (l. c.) — the following, or the figure, afterwards (1854 b) given by EHRENBERG himself. Both figures mentioned must in EHRENBERG'S time be considered to represent one and the same species; yet there should be no doubt as to the choice between these figures, the first representing a form which only here below, for the first time, is considered specifically different from the present species.

In short, it seems to be most correct to choose as main species a form answering somehow to the figure in EHRENBERG (1854 b), i. e. a form in which the collar is offset from the lorica only as to structure, not as to shape (lorica not bulging). Such forms do occur, are, however, very varying, particularly in structure, this latter being on the whole rather irregular, whilst var. *speciosa* is very well defined, both in structure and shape.

In winter *D. elegans* was widely distributed in the middle regions of the Mediterranean, but was not observed west of Sardinia; var. *speciosa* was frequent. In summer the species was already met with

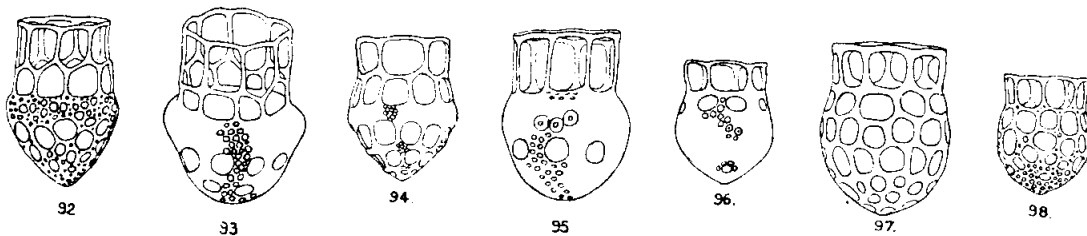


Fig. 92. *Dictyocysta elegans* Ehrb. a small specimen of f. *varians* n. f., from st. 80; $^{350}/_1$. Fig. 93. *Dictyocysta elegans* Ehrb., var. *speciosa* n. var.; $^{350}/_1$. Naupaktos. Fig. 94. *Dictyocysta mülleri* (Bdt.) n. sp.; $^{350}/_1$. St. 152, 950 m. wire. Fig. 95. *Dictyocysta lepida* Ehrb.; $^{350}/_1$. Naupaktos. Some coccoliths on the broader part of the lorica. Fig. 96. *Dictyocysta entzi* n. sp.; $^{350}/_1$. St. 26. Fig. 97. *Dictyocysta mitra* Heck.; f. *obtusa*, $^{350}/_1$. Messina $^{9}/_3$ 1911. Fig. 98. *Dictyocysta mitra* Heck., var. *minor* n. nom. var.; $^{350}/_1$. St. 199, 200 m.—80 m.

in the Bay of Biscay in June, partly abundant, and was also taken in the Bay of Cadiz, as well as just inside the Straits of Gibraltar. In the Atlantic Current along the coast of Africa it was lacking, and was farther on altogether very rare at the surface, but very frequent in deeper layers, being found at $2/3$ of the total number of Mediterranean stations where deep water samples were taken. It was stated to be present as far as into the Sea of Marmora.

The most frequent form in the west was var. *speciosa*, which also occurred in the northern Jonian Sea, and at st. 209 in the Catalanian Sea, below 85 m.

Forms answering to the main species — as defined by the figure in EHRENBERG (1854 b) — with lateral outlines passing evenly over from collar into lorica proper, were very rare or almost absent in the Mediterranean; corresponding forms were seen sparsely at sts. 14 and 80. Another form, f. *varians* (fig. 92), usually considerably smaller than var. *speciosa*, only slightly bulging below the collar, as well as with irregularly scattered "windows" in more than two circles on lorica proper, and with altogether less regular structure (of lorica), was frequent throughout the Mediterranean. Length $66\ \mu$ — $79\ \mu$, collar slightly shorter than lorica proper, maximum diameter of the latter $47\ \mu$ — $59\ \mu$, not much greater than at the mouth.

Dictyocysta elegans otherwise has its chief area of distribution in the northern Atlantic, being abundant in the cooler regions, particularly from the border line between the Labrador and the Florida Currents until near Iceland. In the north it extends to beyond 70° in the Norwegian Sea, in the south the border line of distribution is as yet rather indefinite, the species being difficult to distinguish with certainty from the two following species.

It was first reported for the Mediterranean by IMHOFF (1886 a), from Venice (*D. "templum" var. mülleri*), afterwards by LOHMANN (1903) from Syracuse, by ENTZ jun. (1904) from the northern Adriatic (figs. 24, 26—29, as *D. "templum"*, 1909 as *D. elegans*) and by BRANDT (1907) from Messina (taken by LOHMANN).

2. DICTYOCYSTA MÜLLERI (Bdt.) n. sp. (Fig. 94 p. 82).

D. elegans var. (c) mülleri Brandt 1907 p. 67, pl. 2 figs. 2, 5, 6, pl. 4 fig. 3. J. Müller 1841 p. 233, pl. 6 fig. 6 (?).

Sts. 152 (250 m. wire, several; 950 m. wire), 153, 156 (250 m. wire, 950 m. wire), 182 (545 m. wire), 186 (1145 m. wire and in Salpæ, 187 (945 m. wire), 189 (945 m. wire), 192 (945 m. wire), 209 (200 m.—85 m., several; 1000 m.—200 m., 945 m. wire), 211.

A beautiful and well defined species, similar to *D. elegans*, but having only 6 "windows" in the upper row of collar, a slight constriction between this row and the next, and the lateral outlines passing evenly over from collar into lorica proper. Also smaller than the preceding species.

The collar is conically dilated from the middle upwards as well as downwards, having 6 almost square windows in the upper row, partly broader than long, separated by strong beams; in the next row there are 7 or 8, somewhat smaller windows. Lorica proper has its maximum diameter somewhat below the collar, which is only in structure definitely limited from the lorica proper; the latter has round the middle 8 to 10 oval windows of somewhat unequal size, and below these a similar circle of smaller ones, less regularly developed. Above the middle row of windows, and partly between the latter, a more or less coarse structure of "secondary" meshes is found, partly small and rather regularly developed, without windows, partly greater, of rather unequal size and with a single or double circle of rather small, oval to roundish windows. Lorica proper of almost the same shape as in *D. elegans* f. *varians*, but below with a more distinct, though obtuse, point.

Length 54μ — 62μ , collar usually slightly longer than lorica proper; diameter of mouth 38μ — 42μ , at the middle of collar 34μ — 40μ , maximum diameter of lorica 43μ — 45μ .

Was very rare and always scarce or only present singly in the Mediterranean, only met with in summer and in the Eastern Mediterranean and the Catalanian Sea, also only in deeper layers save at one station (153) on the coast of Barca, and at one near Barcelona.

Up to the present only known from scattered localities in the warmer regions of the Atlantic, from west of South Africa in the Brazil Current (German South-Pole Exp. $18\frac{1}{8}$ 1903) about $28\frac{1}{2}^{\circ}$ S $4\frac{1}{2}^{\circ}$ E (LAACKMANN 1911) to the Sargasso Sea, about 31° N 48° — 50° W (BRANDT 1907). Also in the Indian Ocean, south of Madagascar (BRANDT l. c.).

3. DICTYOCYSTA LEPIDA Ehrb. (Fig. 95 p. 82).

EHRENBERG 1854 a, p. 237; KOFOLD 1915 p. 64. *D. templum* HÆCKEL 1873 p. 564, pl. XXVII fig. 6; ENTZ sen. 1885 p. 208, pl. 14 figs. 18—21, 23; v. DADAY 1887 p. 385, pl. 21 figs. 8, 9; BRANDT 1907 p. 68, incl. varr. a—c, f, pl. 3 figs. 1—4, 7—9, pl. 4 figs. 1, 2, 5, 6, excl. varr. d, e, g, h.

Sts. 10, 11, 12, 14, 15, 16, Naupaktos, 18, 20, Taormina, off Naples, 23—29 (abundant), 31 (likewise), 33 (likewise), 35, 36 (predominant and abundant), 38 (abundant), 39 (numerous), 40, 42, Galita, 45, 55, 57—59, 60 (many), 62, 66, 68, 69 (many); 80, 81 (100 m. wire), 87, 89, 91, 92, 95, 118, 119, 120 (abundant), 122, 125, 126 (0 m., 200 m.—100 m., 275 m. wire), 128 (100 m.—0 m.), 129 (80 m.—0 m., 600 m.—0 m., 1100 m.—0 m.), 132 (600 m.—195 m.), 135, 138, 152 (250 m. wire), 186 (0 m., 245 m. wire, 1145 m. wire, and in Salpæ), 189 (945 m. wire), 194 (0 m., 1145 m. wire), 199 (945 m. wire), 200, 204 (0 m., 945 m. wire), 206 (1945 m. wire), 209 (1000 m.—200 m., 945 m. wire, 1945 m. wire), 234 (25 m.—0 m., 100 m.—25 m., 200 m.—95 m.).

Lorica very similar to that of *D. elegans* f. *varians* and — particularly — var. *speciosa*, but differs in having only a single row of large windows in the collar. The latter is cylindrical, or mostly slightly widened in an upward direction, with 6, 7 or 8, exceptionally 5 or 9, rectangular — rarely shorter to

nearly square — windows, separated by rather thin (narrow) to strong, almost straight, to outwardly more or less convex, beams, sometimes of an oblique direction in regard to the longitudinal axis of lorica. The latter always strongly offset from the collar, in shape as well as in structure, broadly dome-shaped (a slightly elongated hemisphere) widest somewhat below the collar, below almost rounded or faintly suggestive of being pointed; usually, about the middle a circle of mostly 8 (7 to 10) roundish or oval, but often irregularly developed, windows. Otherwise a "secondary" structure of usually coarse, more or less irregular and unequal-sized, polygonal meshes, frequently with a few or several, somewhat smaller, windows below the normal median ones, sometimes also with small, numerous and more or less irregularly scattered, windows on the upper broader portion of lorica proper. The "primary" structure mostly relatively coarse and obvious.

Highly varying in nearly all respects, though for the most part easily distinguished from the very closely allied *D. elegans*. There seems to be no other difference which holds good in all cases, beyond the single, or double row of windows in the collar, this being also the only difference between the specific diagnoses of Ehrenberg. This difference also sometimes fails, the lower row of windows being irregularly developed and partly wanting; transitional forms are, however, more or less rare, so that, for practical reasons, it may be of advantage to consider *D. lepida* as specifically different from *D. elegans*.

Length 64μ — 76μ , of which lorica proper makes 40μ — 45μ ; diameter of mouth 42μ — 51μ , maximum diameter below the collar 47μ — 48μ .

A very remarkable and important form is

var. **coccolitholega** (Lohm.).

Dietyocysta coccolitholega Lohmann 1912 p. 205, figs. 1, 2, 1920 p. 230; *D. templum* var. d Brandt 1907 p. 71, pl. 2 fig. 10, pl. 4 fig. 7, var. e duplex p. 72, pl. 2 fig. 9.

Differs from the main species in wanting windows on lorica proper. The latter shows a rather uniform, very coarse structure of large, roundish, overlapping meshes, partly intermingled with smaller ones.

In living state the species has its lorica covered with coccoliths of different Coccolithophoridae; LOHMANN has stated to be present *Coccolithophora wallichii*, *C. pelagica* and *C. leptopora*.

D. lepida belongs to the most characteristic and important Tintinnids of the Mediterranean, being frequent in most regions of that sea. Compared with the very closely allied *D. elegans*, it is a more southern, thermophilous species; correspondingly, it was plentiful in the Bay of Cadiz in winter. I have also seen it from Straits of Gibraltar in Decbr. 1908 (S/S Sevilla, capt. Rød).

During the winter cruise it was common in the Tyrrhenian Sea, as well as in the Ligurian Sea, at the surface, frequently abundant, and was present throughout the route save in the Atlantic Current in the west, along the African coast.

During the summer cruise it had, on the whole, almost exactly the same distribution as *D. elegans*, all the way from the Bay of Biscay, only here, and in the Eastern Mediterranean, rare, in the latter region only taken at three stations. *D. lepida* did not extend farther in than to the west coast of Greece and to Barca, whilst *D. elegans* was present as far as into the Sea of Marmora.

This great accordance in distribution of both species in the Mediterranean is also in favour of considering *D. lepida* as only a variety of *D. elegans* (Cleve 1901 d, BIEDERMANN 1892).

Var. *coccolitholega* was very rare in the Mediterranean; it was only seen, typically developed, at st. 120 in the northern Balearic. Forms intermediate to the main species, showing coccoliths between collar and median row of windows on lorica proper, about at maximum of diameter, were somewhat more frequent. The coccoliths disappeared in formaline, glycerine and on addition of acids, leaving a

similar, very coarse structure to that in BRANDT (l. c.) pl. 3 figs. 4, 5. Particularly frequent were round discs with a dot (pore) in the middle, presumably coccoliths of *Coccolithophora leptopora*.

In regard to the still obscure question as to formation of the loricae, I think *Dictyocysta lepida* var. *coccolitholega* may afford excellent information. The structure of this form (cf. BRANDT 1906 pl. 2, figs. 9, 10) differs so essentially from that of the usual forms, that most authors certainly would consider this variety a well distinguished species. It is particularly striking that the usual middle circle of large windows is wanting.

Considering the way in which the "incrustation" of coccoliths on the outer side of the lorica has been produced, it seems impossible that the lorica was finished when the coccoliths were agglutinated, the structure of a finished lorica being presumably no more changeable. Any sort of symbiosis between the *Dictyocysta* and the Coccolithophorids seems therefore impossible, if these organisms are not captured at the very moment when the substance of the lorica is being secreted. More probably, it is only the shells, the coccoliths, which are imbedded in or agglutinated to the lorica, originated as faecalia from captured and devoured organisms. Where the lorica has remained destitute of such coating, the usual structure has developed. I have seen specimens with few coccoliths, scattered round the widest portion of the lorica below the collar; in this case the usual circle of windows was present. The irregular, sometimes double structure of this upper portion of the lorica, below the collar, may be due to such an agglutination of coccoliths (cf. BRANDT 1906 pl. 1 figs. 7, 8, pl. 3 figs. 2—5).

Dictyocysta lepida is a rather common warm-water species, widely distributed in the Atlantic, all the way from 44° S (9° E., CLEVE 1901 a) to Iceland, in the South Equatorial Current abundant (Sept. 1889, see BRANDT l. c. p. 58). Also frequent in the Indian Ocean, in the south as well as in the north (CLEVE 1901 a, b, OSTENFELD and SCHMIDT 1901, BRANDT 1907, LAACKMANN 1911; in part according to my own samples). I have also seen it from 51°—53° S, of the west coast of southern South-America (the Melderskin, capt. JACOBSEN, June 1909, and the Alden, capt. KARS, January 1910) and from the west coast of Mexico, south of Californian Gulf (21° N, the Alden, Febr. 1910).

Var. *coccolitholega* and allied forms with coccoliths I have taken near the border between the Labrador and the Florida Currents, April 1910. A similar form is presumably also *D. templum* var. h LAACKMANN 1911 p. 434, pl. XLIX fig. 3, from the South Equatorial Current (German South-Pole Exp., 11th and 21st of Sept. 1903). LOHMANN'S *D. coccolitholega* was taken in the Brazil Current, about 38° S 42° W, Aug. 1911.

D. templum was detected by HAECKEL at Messina (see HAECKEL 1873) and afterwards reported by FOL from Villefranche, by ENTZ sen. and by DADAY from Naples, by ENTZ jun. and by ZACHARIAS from the northern Adriatic, and by LOHMANN from Syracuse.

4. DICTYOCYSTA ENTZI n. sp. (Fig. 96 p. 82).

D. mitra ENTZ sen. 1885 p. 211, pl. 14 fig. 22, not *D. mitra* Heck. *D. templum* var. g BRANDT 1907 p. 73, pl. 3 fig. 6 (a deviating form).

Sts. 11, 25, 26, 28, 29, 55; 189 (945 m. wire), everywhere singly.

A beautiful, small species, allied to *D. mülleri*, by ENTZ sen. referred to *D. mitra*, by DADAY (1887 p. 586) to *D. elegans*, by BRANDT to *D. lepida*. Shape of lorica characteristic, most similar to a short and wide *D. mitra*. Collar not distinctly offset, slightly and conically dilated towards the mouth, nearly always with 6, rarely but 5, in the form of BRANDT 7, windows in a single row, square, or somewhat transversely rectangular. Lorica proper rounded, below the collar widening evenly by evenly convex — or above conical — outlines, merging below to an angular, very obsolete, point. Minimum diameter (of upper half) at the transition of collar into lorica; just below there is mostly a row of rather distant, rarely more closely set, roundish or oval windows, 5 to 8 or 9 in number, in the latter cases sometimes forming a continuous

circle, strongly recalling the second one, from above, in *D. mülleri*. Below this more or less complete (second) circle of windows, one finds in *D. entzi* mostly a rather uniform, more or less coarse "secondary" structure of polygonal, roundish or oblong meshes, extending down to the very end, as well as to the broader interstices between the windows (of the second circle); there is, however, sometimes also a third circle of windows, irregularly developed as to shape, dimensions, number and situation, particularly numerous if there are many windows, close together, in the second circle. On the other hand, forms occur, having below the windows of the collar a rather uniform, very coarse, structure of polygonal, unequal-sized meshes without proper "windows".

Total length 45μ — 51μ , of which the collar takes up 12μ — 15μ ; diameter of mouth 34μ — 43μ , maximum diameter, about in the middle of lorica proper or above, rarely somewhat below, 40μ — 45μ . The secondary meshes (below the windows) usually 3μ — 4μ (rarely 2μ or 5μ), the windows of the second row about $11\mu \times 12\mu$.

Varies in a similar way to *D. elegans* and *D. lepida*; the form mentioned, without windows of lorica proper, is analogous to *D. lepida* var. *coccolitholega*.

Very rare in the material of the "Thor", occurring from the south coast of Spain as far as the Jonian Sea, in the surface as a winter species. The variety mentioned, without windows on lorica proper, was taken at st. 55. I have myself taken it at 44° N $43\frac{1}{2}^{\circ}$ W, far east of New Foundland, April 1910. BRANDT'S species (or form), showing very acute, distended spines at the mouth — by optical delusion? — was caught in the Sargasso Sea.

ENTZ sen. found this species at Naples, in Salpæ.

5. DICTYOCYSTA MITRA Hck. (Fig. 97 p. 82).

HAECKEL 1873 p. 563, pl. 27 figs. 4, 5; v. DADAY 1886 p. 497, pl. 25 fig. 16; BRANDT 1907 p. 63, pl. 1, figs. 1, 2. pl. 2 fig. 11. *D. elegans* BIEDERMANN p. p. ("s. str.") 1892 p. 11, pl. III fig. 3; v. DADAY 1887 p. 586.

Sts. 10, 11 (several), Port Alice, 12—15 (abundant), 16, Naupaktos, 18, 20, Taormina, off Naples (many), 24 and 25 (abundant), 26, 27, 28 (many), 29, 31 a. 33 (abundant), 35, 36 (several), 38, 39 a. 40 (many), 42, 55—62 (singly), 66, 68, 69; 126 (500 m.—120 m.; 275 m. wire, abundant), 128 (100 m.—0 m., many), 129 (80 m.—0 m., singly; 600 m.—0 m., several; 1100 m.—0 m.), 132 (600 m.—195 m., several; 1090 m.—57 m.), 134 (75 m.—0 m.; 125 m.—75 m., several; 200 m.—125 m., 350 m.—185 m.), 152 (250 m. wire, 950 m. wire), 153 (singly), 156 (250 m. wire, 950 m. wire), 160 (200 m.—100 m., 1000 m.—200 m.), 163 (80 m.—0 m.), 179, 182 (545 m. wire), 186 (0 m.; 245 m. wire, in greater numbers; 1145 m. wire, and in Salpæ, many individuals), 187 (0 m., 190 m.—100 m., 945 m. wire), 189 (945 m. wire), 192 (0 m., 545 m. wire), 194 (0 m.; 1145 m. wire, several), 197, 199 (30 m.—0 m.; 200 m.—80 m., several; 945 m. wire), 200, 202, 204 (945 m. wire, abundant), 206 (1945 m. wire, several), 208, 209 (below 33 m., abundant), 210, 211. Scarce if not otherwise mentioned.

Lorica different from that of the other species in being a lattice-work of windows separated by rather broad beams without larger and smaller areas of "secondary" meshes. Such are only found singly here and there in corners between 3 or more, contiguous, windows, or near the lower end of lorica where also the windows are smaller; only in the var. *minor* such smaller meshes are more numerous in the lower $\frac{1}{3}$ of lorica.

Collar not or only indistinctly offset; nearly always, however, the upper row of windows, close to the mouth, consists of greater, more squarish meshes, forming an indistinct collar — often slightly widening in an upward direction — with a single row of windows, frequently somewhat constricted at its base. Lorica proper usually somewhat widening from base of collar towards the middle or somewhat above; below it is usually angularly acutish, more rarely distinctly acute, or rounded, with a very small, offset point or a tiny, obtuse mamilla.

The main species, according to HAECKEL and to BRANDT (l. c.), is not very broad, and only slightly dilated towards the mouth.

A very frequent form is the following.

f. **obtusa** n. f. (Fig. 97 p. 82).

D. mitra var. b Brandt (l. c.) p. 64, pl. 1 fig. 3, pl. 4 fig. 8.

Collar with much larger meshes than those of the next following row — about $17\ \mu$, against $11\ \mu$ in the latter — obviously squarish, whilst those of the second and following rows are more rounded in the corners. The lorica is also usually shorter and wider than in the main species, being obtuse or rounded below, frequently ending in a small obtuse or acute mamilla.

Length $65\ \mu$ — $74\ \mu$, diameter $48\ \mu$ — $51\ \mu$; collar with 7, rarely 8 windows.

It is this form which many where in the Mediterranean is abundant, f. i. at st. 186 in the Jonian Sea, at st. 204 in the Balearic, and at st. 209 of the Catalonian Sea.

Very similar to the form mentioned, though on the other hand also a characteristic one, is

f. **dilatata** Bdt. (as var. a *dilatata*, p. 64, pl. 1 fig. 4).

Towards the lower end more pointed (acuminate) and distinctly acute, frequently also with a collar more distinctly pronounced, more dilated towards the mouth, and, on the whole, somewhat smaller dimensions.

Widely distributed, but always more or less scarce.

Much more different from the main species is

var. **minor** n. var. (Fig. 98 p. 82).

D. mitra var. c Brandt l. c. p. 64, pl. 1, figs. 5, 6.

Lorica shorter and proportionately wider than in the main species, in the lower $\frac{1}{3}$ with meshes of very unequal size, with many intermingled, small, "secondary", meshes.

Length $47\ \mu$ — $53\ \mu$, diameter of mouth $31\ \mu$ — $34\ \mu$, maximum diameter $36\ \mu$ — $38\ \mu$.

In shape, size and structure intermediate between *D. mitra* and *D. entzi*; most closely allied to the former species.

Very rare in the material of the "Thor": sts. 126 (275 m. wire), 199 (200 m.—80 m.), singly. BRANDT'S specimens were taken at the border between the Florida and the Labrador Currents. According to LAACKMANN (1911) at $0^{\circ} 27' N$ $17^{\circ} 47' W$, in the South Equatorial Current (German South-Pole Exp., $\frac{21}{9}$ 1903).

Like *Dictyocysta lepida*, the present species, *D. mitra*, belongs to the most frequent Tintinnids of the Mediterranean, showing a great accordance with that species as to distribution. In winter it was frequent in the Bay of Cadiz, as well as near the south coast of Spain, but was lacking in the Atlantic Current along the north coast of Africa. Like *D. lepida* it was common and abundant in the Tyrrhenian Sea, as well as in the northern Jonian Sea and in the southern Adriatic. During the summer cruise it was altogether absent west of a line from the Balears to Tunis, and was everywhere very rare and scarce at the surface, but present below the same in nearly all — 19 out of 22 — stations for deep water samples, apparently occurring chiefly at a depth of 100 m. or somewhat more. It extended as far as the entrance to the Dardanelles.

It is a frequent warm-water species, widely distributed in warm-temperate regions of the Atlantic, in the northern temperate zone, as well as in the southern, whilst in truly tropical regions it seems to be rare or partly lacking. To the north it is distributed, at any rate from $30^{\circ} N$ (Brandt l. c.) in the western and median regions, and from the Cape Verd Islands in the east (CLEVE 1901 d) as far as $53^{\circ} N$

(37° E, CLEVE l. c.) and to the Channel (Novbr. 1907, Bulletin trimestriel); in the south it is known from 41° S (6° W) to 14° S (6° W, CLEVE l. c.). Also known from the southern Indian Ocean, from the south point of Africa to far south-east of Australia (43° S 117½° E, S/S Akershus, capt. MARTIN, March 1911; see also CLEVE 1901 a) and in the north to 25° S (56° E, German South-Pole Exp., 15/5 1903, LAACKMANN 1911).

In the Mediterranean it was detected by HAECKEL (l. c.) at Messina. Afterwards it was recorded from Naples by ENTZ sen. and by DADAY 1887, from Syracuse by LOHMANN (1908), and from the coast of Dalmatia by LAACKMANN (1913).

PETALOTRICHA Kent.

Lorica short and wide, campanulate or roundish; wall double, with distinctly separated and well developed outer and inner lamellæ. Lorica in the upper portion more or less constricted and provided with a strong, inwards protruding, circular rib, dividing the lorica into a lower "lorica proper" and an upper "collar", which again is divided by a similar rib into an upwardly dilated lower "neck" and a more or less spreading and narrow, oral rim. Structure a more or less inconspicuous "primary one", also present between the lamellæ (in 2—3 layers, ENTZ jun. 1909 p. 109); in addition there are more or less scattered or numerous, oval to roundish windows of small size, confined to a smaller portion of lorica, mostly in a more or less broad circular zone near the maximum of diameter, according to ENTZ l. c. being perforations, according to BRANDT 1907 "vesicular bodies". Also a "secondary" structure of the usual appearance may be present, as well as rounded markings or small windows along the upper annular rib, with or without conspicuous radiating striæ of the neck or of the oral rim.

Animalcule with 18 membranelles (DADAY 1887, ENTZ jun. 1909), low, rounded lobes of peristome collar, and only one large macronucleus (DADAY l. c., ENTZ jun. l. c. in part, LAACKMANN 1911); also many small nuclei are reported (DADAY l. c., ENTZ l. c. — up to 300; sporulation?).

PETALOTRICHA AMPULLA (Fol) Kent (Fig. 99 p. 89).

Kent 1881, p. 627, figs. 1, 2. *Tintinnus ampulla* Fol 1881 p. 20, pl. 1, figs. 1—3; 1884 p. 53, pl. 4 figs. 1—3, pl. 5 fig. 7. *Petalotricha ampulla* Daday 1887, p. 572, pl. 21, figs. 7, 11, 12, 14, 17—19.

Sts. Port Alice, 14, 18, 23, 25, 27, 28, 29, 31, 36, 38, 58, 59 (several), 60 (abundant), 62 (several), 64, 66 (abundant and by far predominant), 68 (common and predominant), 69 (several); 81 (100 m. wire), 87 (numerous), 89, 99, 126 (200 m.—100 m., 275 m. wire), 129 (80 m.—0 m.), 134 (125 m.—75 m., 200 m.—125 m., 350 m.—185 m.), 139, 163 (80 m.—0 m.), 186 (245 m. wire), 199 (200 m.—80 m.), 205, 209 (80 m.—33 m., 200 m.—85 m., 1945 m. wire), 234 (100 m.—25 m., common; 200 m.—95 m., abundant and predominant). Singly or very scarce, where not otherwise mentioned.

Lorica below rounded, or provided with a tiny, obtuse point, or mamilla. Near the inner edge of oral rim a rather regular series of conspicuous small windows; the outer border frequently rather regularly denticulate. Otherwise, see the generic diagnosis.

Is a rather common warm-water species, of wide distribution. Its occurrence in the Mediterranean was rather singular. During the winter cruise it was only taken in the median and northern regions of the Mediterranean and at two stations of the Eastern Mediterranean, otherwise only just inside the Straits of Gibraltar, being here, as well as in Bay of Cadiz present everywhere, plentiful or even abundant. It was lacking in the Atlantic Current along the African coast.

During the summer cruise it was present sparsely in the Bay of Cadiz, but absent in the western regions of the Mediterranean, save at a single station (99) just inside the Straits. Now, in summer, it was

on the whole almost only present at deeper levels, and also there only rare or in single individuals; at the surface, it was only taken singly at two stations (205 and 139) in the Balearic.

Accordingly, there seem to be good conditions for an immigration into the Mediterranean from the Atlantic in winter, these, however, giving a negative result, at any rate as to the surface. On the other hand, the scarce occurrence in deeper layers in summer, together with the relative frequency at the surface in winter, seems to indicate that the Mediterranean stock is essentially dependant on immigration into that sea from the west, probably in late autumn.

On the whole, this species is rather common and often occurring in greater numbers in the warmer and warm-temperate regions of the Atlantic, all the way from the south point of Africa and off Buenos Ayres (the Fram 1911) as far as 51° — 52° N in the median and eastern regions and to the border between the Florida and the Labrador Currents in the north-west. In the Atlantic it seems to be much more frequent in the temperate regions than in the very warm ones, being particularly plentiful in cooler

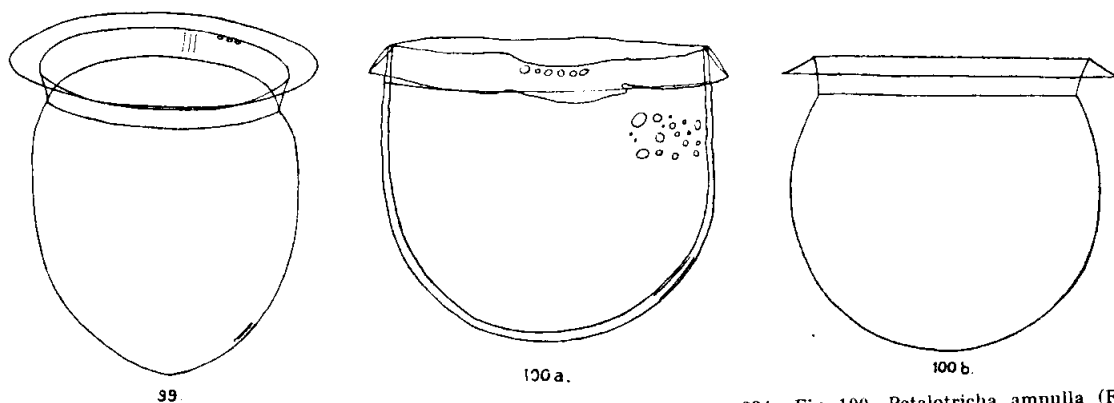


Fig. 99. *Petalotricha ampulla* (Fol) Kent; $350/\mu$. Outline of a specimen from st. 234. Fig. 100. *Petalotricha ampulla* (Fol) Kent var. major n. var.; $350/\mu$. a: a deformed specimen from a slide. b: the same according to a sketch and the noted dimensions.

currents of the tropical zone. Also known from the Indian Ocean (Mascarene Current, far west and south-west of Australia, Red Sea and Arabian Gulf) and from the Pacific (New Zealand and New Pomerania). (According to CLEVE 1901 d, BRANDT 1907, LAACKMANN 1911 and my own samples).

A very striking form is

var. **major** n. var. (Fig. 100).

Petalotricha ampulla var. b Brandt 1906/7 p. 341, pl. 82 figs. 8, 15 (?).

Lorica almost spherical, with an upwardly somewhat dilated "neck" and a spreading, somewhat recurved, oral rim. Length of lorica proper 114μ , diameter at base of collar 102μ , at outer border of oral rim 128μ .

Only one individual seen, at st. 170 (80 m.—20 m., in the Marmora Sea). It was not immediately figured — only provisionally sketched — and was deformed in the slide. I have therefore given two figures of it, one (fig. 100 a) answering to the deformed individual; the other (fig. 100 b) altered according to my (earlier) sketch.

From st. 87, at the south-western corner of Portugal (Cape San Vincent), I saw among many normal individuals a deviating one, perhaps answering partly to *P. entzi* Kofoid 1915. Unfortunately, this specimen was lost, and I did not succeed in finding another.

Petalotricha ampulla was detected in the Mediterranean at Villefranche by FOL (1881). Afterwards it was reported from Naples by ENTZ sen. (1884) and by DADAY (1887), from the northern Adriatic by ENTZ jun. (1904), and from Syracuse by LOHMANN 1908.

CODONELLA Hck.

Lorica urn-shaped, above divided by a constriction into a lower, roundish or oval, lorica proper, and an upper collar, conical or ascending, sometimes incurved towards the upper border. No helicoidal "annuli". Wall of lorica double, with two, more or less distinctly separated lamellæ, above apparently single. Structure an irregular reticulation of unequal-sized, partly very coarse "secondary" meshes, answering to an irregular "*Cyrtarocylis*-structure", in addition to a finer "primary one"; structure of lorica sometimes more or less completely concealed by a close "incrustation" of agglutinated "foreign" bodies, answering to those in the genus *Tintinnopsis*. The species may, however, easily be distinguished from those of the latter genus by having a "collar".

Animalcule recorded to have many nuclei as in the genus *Cyrtarocylis*, which on the whole seems to be the most nearly allied genus.

An apparatus for shutting off the lorica at about the level of the constriction below the collar, is present, at any rate in some species. Outsides, the lorica may be covered by more or less regularly arranged, rounded or oval discs, with or without a pore or grain or rod in the middle, most probably coccoliths, disappearing in diluted acids.

1. CODONELLA GALEA Hck. (Fig. 101 p. 91).

Haeckel 1873 p. 567, pl. 28 figs. 8, 9; Fol 1884 p. 61, pl. V fig. 14. *Codonella lagenula* Entz 1884, 1885, Daday 1887, Cleve 1901 d, 1902 b, 1903 b, not *Tintinnus lagenula* Claparède & Lachmann 1858 p. 204, pl. 8 figs. 10, 11.

Sts. 10 (abundant and by far predominant), 11, Port Alice, 12 (abundant), 14 (numerous), 15 (numerous), Naupaktos, 18, 20 (several), Taormina, 23 (abundant), 24 (numerous), 25 (rather numerous), 26, 27 (several), 28 (abundant), 29, 31 (several), 33 (several), 35, 36, 38 (several), 39 (several), 40, 42, 50, 53 (common and by far predominant), 55 (several), 57, 58, 59 (several), 60, 62, 66 (numerous), 68 (several), 69; 81 (0 m., numerous and alone; 100 m. wire, common and predominant), 87, 89, 92 (numerous), 93, 94, 95 (several), 96, 98 (several), 99 (several), 100, 115, 116, 118, 120, 123, 126 (500 m.—120 m., 275 m. wire), 128 (100 m.—0 m.), 129 (600 m.—0 m., 1100 m.—0 m.), 132 (600 m.—195 m. singly); 1090 m.—57 m., common), 134 (75 m.—0 m., 125 m.—75 m., 200 m.—125 m., 350 m.—185 m.), 152 (250 m. wire; 950 m. wire, several), 156 (0 m., 250 m. wire, 950 m. wire), 160 (100 m.—30 m.; 200 m.—100 m., many; 1000 m.—200 m., many), 163 (80 m.—0 m., several), 182 (545 m. wire), 183, 184 (945 m. wire), 185, 186 (0 m., singly; 245 m. wire, many; 1145 m. wire, several; in Salpæ), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), 190, 192 (0 m., 545 m. wire), 194 (0 m., singly; 1145 m. wire, several), 199 (200 m.—80 m., 945 m. wire), 204 (0 m., singly, 945 m. wire, several), 205, 206 (1945 m. wire), 209 (80 m.—33 m., 200 m.—85 m.; 1000 m.—200 m., common; 945 m. wire, common; 1945 m. wire, several), 210, 211, 213, 217, 228 (1145 m. wire), Gibraltar, 231 (1145 m. wire), 234 (0 m., singly; 25 m.—0 m., several; 100 m.—25 m., numerous; 200 m.—95 m., numerous; 700 m.—200 m., common and predominant), 235. Scarce when not otherwise mentioned.

Lorica proper oval or obovate, slightly widened above the middle, below very obtuse or usually rounded, rarely slightly acutish. Collar conically dilated towards the mouth. Structure highly varying, owing to more or less numerous, agglutinated, bodies of different kinds, rather frequently as in *Tintinnopsis* of irregular, angular and shining bodies, intermingled with opaque, black particles, sometimes of coccoliths, particularly circular, quite regularly disposed discs with a dot (pore) in the middle, apparently belonging to *Coccolithophora leptopora* Lohm. (but generally not overlapping). These coccoliths may be removed by diluted acids; a structure of very coarse "secondary" meshes then appears, with a finer one in the interstices, partly also larger "windows".

Length 86μ — 104μ , of which the collar makes 23μ — 26μ ; diameter of mouth 46μ — 59μ , at the

constriction (base of collar) 38μ — 45μ , maximum diameter (at about the upper $\frac{1}{3}$ of lorica proper) 57μ — 63μ . The more frequent coccoliths or corresponding markings 5μ — 6μ .

Wall of lorica single and thin in the upper half of collar and in the lower portion of lorica proper, apparently nowhere with well developed and separated lamellæ.

Is a very constant and easily distinguished species, save only for the rather different "incrustation".

During the winter cruise it was present in the surface almost everywhere, save in the Atlantic Current along the coast of Africa. Was present at several stations in greater numbers, as in Bay of Cadiz, at st. 53 in the eastern Alboran Sea, off Naples and in the Jonian Sea, near the coast of Italy.

In summer it was only taken at $\frac{1}{3}$ of all stations, again lacking in the Atlantic Current, save just inside the Straits in June. In the western regions of the Mediterranean, west of Sardinia, it was not rare in the surface, particularly in the moderately salt water of the middle and the northern Balearic, as well as in the Catalanian and the Ligurian Seas; farther to the east it was almost wholly confined to deeper layers, being only met with in the surface at seven stations singly, whilst present almost everywhere at some deeper level, taken at 20 of the 22 stations for deep water samples. At the latter stations

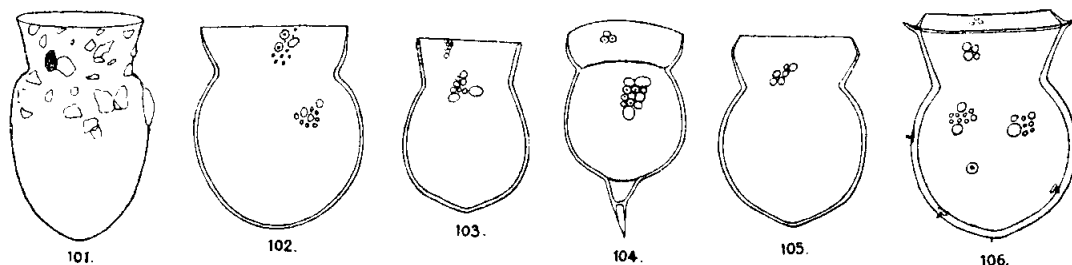


Fig. 101. *Codonella galea* Hck.; $350/\mu$, Naupaktos. Fig. 102. *Codonella nationalis* Bdt.; $350/\mu$, Taormina. Fig. 103. *Codonella acerca* n. sp.; $350/\mu$, St. 156, 250 m. wire. Fig. 104. *Codonella amphorella* Biederm.; $350/\mu$, St. 152, 250 m. wire. Fig. 105. *Codonella perforata* Entz; $350/\mu$, St. 11. Fig. 106. *Codonella cistellula* (Fol) Bdt.; $350/\mu$, Taormina.

it seems to be most frequent at a greater depth, between 100 m. and 200 m., and somewhat deeper. Also at st. 234 near the west coast of Portugal it was relatively most plentiful beneath 200 m.

HAECKEL detected the species at Messina (and Lanzarote, Canaries); it is, however, perhaps not quite certain that his species really is that which is now generally named *Codonella galea*. He states the width as 80μ (with a length of 100μ which is not very excessive), and he figures the lorica proper almost spherical, by a collar of just the correct and very characteristic shape. The species of Fol (1884) is, however, quite certainly the present one; he found it abundant at Villefranche. In the same year it was reported from Genoa by Gruber, and afterwards from Naples by Entz sen. (1884) and Daday (1887), from the northern Adriatic by Entz jun. (1904), and from Syracuse by Lohmann (1908).

Is widely distributed in the Atlantic, from the south point of Africa and 31° S (the Fram 1911) at any rate to $43\frac{1}{2}^\circ$ N (the Texas, capt. Pedersen, April 1910), frequent on the European, as well as on the American side. Also known from the Red Sea, the Arabian Gulf and the Mascarene Current in the Indian Ocean.

2. CODONELLA NATIONALIS Bdt. (Fig. 102).

Brandt 1906 p. 3, pl. 5 figs. 9, 10, pl. 6 figs. 1, 2, pl. 10 fig. 10; 1907 p. 91. *Dictyocysta polymorpha* Entz sen. 1885 p. p. *Cyttarocylis polymorpha* Daday 1887. 577, pl. 20 figs. 25, 26, 30 (29?).

Sts. 10, 11, 14, 16, Naupaktos, 18, 20, Taormina (numerous), 23 (numerous), 24, 25, 26, 27, 28 (numerous), 29 (several), 31, 33, 38, 40, 42, 45, 55, 66, 68; 92, 126 (500 m.—120 m.), 129 (1100 m.—0 m.), 134 (125 m.—75 m.), 152 (250 m. wire), 156 (950 m. wire), 163 (80 m.—0 m.), 182 (545 m. wire), 186 (0 m., 245 m. wire, 1145 m. wire, and in Salpæ), 189 (945 m. wire), 199 (200 m.—80 m., 945 m. wire), 200, 204

(945 m. wire), 206 (1945 m. wire), 208, 209 (1000 m.—200 m., 945 m. wire), 211, 220, 224, 234 (100 m.—25 m., 700 m.—200 m.).

Lorica somewhat similar to that of the preceding species, but more clumsy. Lorica proper broadly oval or almost spherical, below usually evenly rounded. Collar ascending by convex lateral outlines, above erect. Wall of lorica rather thick, with well developed, but approximated outer and inner lamellæ, save towards the mouth. Structure of "secondary" polygonal, unequal-sized meshes in a single layer between the two lamellæ, together with a relatively coarse "primary" structure; in addition, frequently greater, roundish or mostly oval "windows", irregularly scattered, are present. Collar sometimes low, perhaps in young loricae.

Length $85\ \mu$ — $107\ \mu$, of which the fully developed collar makes $25\ \mu$ — $28\ \mu$; diameter of mouth $62\ \mu$ — $70\ \mu$, of constriction above $49\ \mu$ — $57\ \mu$, maximum diameter $65\ \mu$ — $77\ \mu$.

Most meshes about $3\ \mu$ in diameter, the larger ones usually $7\ \mu$ — $8\ \mu$.

Perhaps DADAY is right in considering this species to belong rather to *Cyrtarocyllis*; in structure it seems to be allied to *C. eucecryphalus*; is, however, also certainly allied to the preceding species and the next following ones.

This species, still only known from rather few localities, proved to be frequent in the Mediterranean during the winter cruise, being present all along the route, only wanting at very few stations. In summer it had mostly disappeared from the surface, being only met with at five stations of the Western and one of the Eastern Mediterranean. It was taken at more than half the stations for deep water samples, throughout the Mediterranean as far as Euboea, though nowhere in greater numbers. In January there is perhaps an immigration into the Mediterranean from the Atlantic, probably also in late autumn and perhaps in June, in the latter season only if we may suppose the species to pass over into deeper layers in the Western Mediterranean.

Seems to be indigeneous in the Mediterranean, occurring at the surface as a winter species; the stock is probably maintained through some immigration into the Mediterranean from the Atlantic every year.

This species was already detected in the Mediterranean by ENTZ sen. (l. c.) at Naples, was known from the same place by DADAY, was taken by LOHMANN at Messina (BRANDT l. c.) and afterwards reported by ENTZ jun. (1904) from the northern Adriatic. Otherwise it has been taken from 21° S (5° W, 400 m., German South-Pole Exp. $25/8$ 1903) and 23° S 37° W — very frequent between South Africa and Brazil (the Fram, Aug. 1911) — to near the border between the Florida Current and the Labrador Current, far south-east of Nova Scotia, and to the Azores, only stated at few, distant localities (BRANDT l. c.). Also in the Pacific (New Pomerania and Tonga Islands, BRANDT l. c.).

3. CODONELLA ACERCA n. sp. ad int. (Fig. 103 p. 91).

C. nationalis Brandt var. b? 1907 p. 93, pl. 5 figs. 11, 11 a.

Sts. 152 (950 m. wire), 156 (250 m. wire, 950 m. wire), 160 (30 m.—0 m.), 163 (80 m.—0 m.), 187 (945 m. wire); everywhere singly.

Lorica very similar to that of the following species, but without caudal prolongation. Collar slightly dilated in an upward direction, or towards the mouth erect to slightly incurved. Lorica proper broadly ovate or oval, with maximum of diameter below the middle, at the lower end broadly obtuse-angled (on the optical section). Wall of lorica thin and single, or not distinctly double, the outer and the inner lamellæ being incompletely developed and separated, though showing a "secondary" structure of a single layer of "prismatic elements" (seen on the optical section). On the outside of the lorica the "secondary" meshes are very unequal-sized, roundish polygonal, mostly $2\ \mu$ — $3\ \mu$, partly much larger and frequently oval, towards the mouth mostly very small.

Length $64\ \mu$ — $72\ \mu$, of lorica proper $47\ \mu$ — $49\ \mu$; diameter of mouth $40\ \mu$ — $43\ \mu$, at the constriction $36\ \mu$ — $37\ \mu$, maximum diameter $48\ \mu$ — $52\ \mu$.

Differs from *C. nationalis* in being smaller, of a less clumsy appearance, in having a thinner wall of lorica, a maximum diameter in the lower portion — in *C. nationalis* mostly somewhat above the middle — and the obtuse-angled outline below. Is so strikingly similar to *C. amphorella* that I should have considered it a “tailless” variety of that species if I had seen any forms suggestive of a transition.

I was only lately aware that this form differed from *C. nationalis*, and too late to be able to ascertain that it was not taken also in winter, which some of my notes seem to suggest. In summer it only seemed to occur sparsely and rarely below the surface in the Eastern Mediterranean.

4. CODONELLA AMPHORELLA Biederm. (Fig. 104 p. 91).

Biedermann 1892 p. 16, pl. II fig. 1; Brandt 1907 p. 100 pl. 9, figs. 2, 3, pl. 10 fig. 8; Laackmann 1911 p. 439, pl. XLIX fig. 4.

Sts. 10, 11; 152 (250 m. wire, 950 m. wire), 156 (950 m. wire), 160 (200 m.—100 m., 1000 m.—200 m.), 182 (545 m. wire), 186 (1145 m. wire), 187 (945 m. wire), 189 (945 m. wire), everywhere singly or very sparsely.

Lorica similar to that of the preceding species, only provided with a caudal prolongation of medium length, very acute and with an inner transverse wall at about the upper $\frac{2}{5}$ of length.

Total length of the figured specimen 88μ , of caudal prolongation 20μ , of lorica proper 45μ ; diameter of mouth 45μ , diameter at the constriction 38μ , maximum diameter (below) 50μ .

Very rare and scarce in the material of the “Thor”, only taken in the Eastern Mediterranean. Otherwise met with west of southern South-Africa (German South-Pole Exp. $8-19/8$ 1903, see LAACKMANN l. c.) and from about 9° S in the Atlantic as far as to the northern regions of the Florida Current (BRANDT l. c.) and to about $41\frac{1}{2}^\circ$ N 43° W (S/S Texas, April 1910, capt. PEDERSEN). Deviating forms (according to BRANDT l. c.) in the Agulhas Current and from New Pomerania.

It was first recorded from the Mediterranean by ENTZ jun. 1909, from Naples.

5. CODONELLA PERFORATA Entz sen. (Fig. 105 p. 91).

Entz sen. 1884 p. 415, pl. 24 figs. 12—14. *C. polymorpha* Entz sen. 1885 p. 205 p. p., pl. 14 figs. 1, 2. *C. perforata* Brandt 1907 p. 95, pl. 6 figs. 3, 4, 8, pl. 10 fig. 11, incl. var. a p. 96, pl. 6 figs. 6, 7.

Sts. 10 (many), 11 (several), 14, 16, Naupaktos, 23, 24 (several), 25, 26, 28, 66, 68; 92, 95, 148, 152 (250 m. wire, 950 m. wire), 160 (100 m.—30 m.), 163 (80 m.—0 m.), 164. Singly or sparsely, when not otherwise noted.

Lorica in shape and size very similar to that of *C. acerca*, but the collar consists of a lower portion, conically dilated in an upward direction, and an upper, conically narrowing to almost the same extent, both of them united at their maximum diameter, at or above the middle of collar. Lorica proper broadly oval, maximum diameter about the middle, below frequently with a more or less distinct, obtuse, point. Wall rather thin, without distinctly developed lamellæ, mostly with a single layer of “prismatic elements”, on the outside appearing as strongly outlined “secondary”, polygonal and unequal-sized meshes. Around the lorica at its greatest width there is frequently a double or multiple row of particularly large, rounded or oblong, “windows”, sometimes scattered about in different places.

Total length of well developed specimens 79μ — 85μ , of lorica proper 57μ — 62μ ; diameter of mouth 45μ — 47μ , of constriction at base of collar 42μ — 44μ , maximum diameter of lorica proper about 60μ , of collar 54μ — 57μ .

May easily be confounded with *C. acerca*, and presumably also with younger forms (?) of the following species, on account of which the Mediterranean distribution may need revision.

The distribution and extent of this species are altogether too little known as yet. It is recorded from one locality in the Sargasso Sea, one near the Azores, from the Bay of Bengal and New Pomerania

BRANDT l. c.), as well as three localities in the North- and in the South Equatorial Current (German South-Pole Exp. $26/8$, $7/9$, $1/10$ 1903, LAACKMANN 1911). In the Atlantic it has been taken from 21° S, far west of South-Africa (German South-Pole Exp. $25/8$ 1903), to near the Azores (BRANDT l. c.) and to 31° N in the Florida Current off the coast of North America (the Texas, Novbr. 1909, capt. PEDERSEN). It is also met with in the Indian Ocean (Bay of Bengal, BRANDT l. c., and at $39\frac{1}{2}^{\circ}$ S, south-west of the south-western corner of Australia, the Tasmanic, May 1910, capt. HÅKONSSON) as well as in the Pacific (New Pomerania, BRANDT l. c.).

6. CODONELLA CISTELLULA (Fol) Bdt. (Fig. 106 p. 91).

Brandt 1907 p. 96, pl. 8 fig. 4, incl. varr. a-c pp. 98, 99, pl. 7 fig. 3, pl. 8 figs. 1-3. *Cyttarocyclus cistellula* Fol 1884 p. 56, pl. V fig. 8; Daday 1887 p. 578, pl. 20 fig. 27, pl. 21 figs. 2, 10, 15, 20. *Cyttarocyclus punctata* Daday 1886 p. 495, pl. 25 fig. 13.

Sts. 10, 11, Port Alice, 12, 14, 16, 18, 20, Taormina, off Naples, 23, 24, 25, 26, 27, 28 (several), 29, 31, 35, 36, 38, 39, 42, Galita, 45, 50, 55, 59; 126 (200 m.—100 m.), 128 (100 m.—0 m.), 129 (80 m.—0 m.), 600 m.—0 m., 1100 m.—0 m.), 132 (1090 m.—57 m.), 134 (125 m.—75 m., several; 200 m.—125 m.), 152 (250 m. wire, 950 m. wire), 156 (250 m. wire, 950 m. wire), 160 (100 m.—30 m., 200 m.—100 m.), 163 (80 m.—0 m.), 182 (545 m. wire), 183, 186 (0 m., 245 m. wire, 1145 m. wire), 187 (190 m.—100 m., 945 m. wire), 189 (945 m. wire), 192 (545 m. wire), 194 (0 m., 1145 m. wire), 199 (200 m.—80 m.; 945 m. wire, several), 202, 204 (945 m. wire), 206 (1945 m. wire), 209 (80 m.—33 m., 1000 m.—200 m., 945 m. wire, 1945 m. wire), 210, 231 (1145 m. wire), 234 (200 m.—95 m.). Scarce or singly if not otherwise mentioned.

Resembles a large and strong form of the preceding species, but having a prominent supporting rib around the collar at its greatest diameter. Lorica proper mostly spherically rounded, more rarely showing a small, obtuse point below. Collar with a larger lower, upwards conically dilated, portion, and a short upper one, conically narrowing; where they unite, at their maximum of diameter, a more or less strongly developed, obliquely spreading, annular rib is situated, making this species very easily distinguished.

Total length of figured specimen 96μ , of lorica proper 64μ ; diameter of mouth 52μ , of constriction 48μ , maximum diameter of lorica 66μ , of annular rib 70μ .

Structure consisting of larger and smaller "secondary" meshes, different in shape, partly with agglutinated discs, mostly circular and frequently with a shining grain in the middle. Wall of lorica rather thick, at the mouth single and thin, otherwise double, with approximated lamellæ.

Was very frequent in the Mediterranean, nearly everywhere, however, very scarce. In winter it was only wanting (at the surface) at few stations, whilst in summer it was very rare at the surface, but present at some deeper level nearly everywhere at the stations where such samples were taken. In summer as well as in winter, it was most frequent in the Tyrrhenian Sea.

Is certainly a true, indigeneous Mediterranean species, only a very faint indication of an invasion from the west in winter being suggested in the material in question. Generally distributed at the surface in winter it disappears towards summer, to reappear in certain deeper layers, a phenomenon, remarkably frequent among the Tintinnids of the Mediterranean.

Otherwise, the distribution in the Atlantic is remarkably similar to that of *C. nationalis*. It is also known from New Pomerania in the Pacific (BRANDT l. c.).

In the Mediterranean it was detected as a new species at Villefranche by FOL (l. c.) and was afterwards taken at Naples by DADAY (l. c.), in the northern Adriatic by ENTZ jun. (1904), at Messina by LOHMANN (BRANDT l. c.), also at Syracuse (LOHMANN 1908).

STENOSEMELLA n. gen. ad int.

Lorica short and wide, of a firm consistence, strongly covered with agglutinated bodies of the same kind as in *Tintinnopsis*, completely concealing the real structure of the wall. No caudal prolongation, nor any distinct helicoidal constitution of the wall. Round the mouth is developed a low (narrow) collar, thin-walled and mostly destitute of agglutinated bodies or, at any rate, less closely covered than the rest of the lorica, in rare cases perhaps consisting of two or three narrow turns of a helicoidal band.

Animalcule with two macro- and two micronuclei (according to ENTZ jun., LAACKMANN and others); membranelles 20 (ENTZ 1909). According to FAURÉ-FREMIET (1924 pp. 95—98, fig. 31) it is fixed to the bottom of the lorica, without a pedicle, in a swimming state extended far beyond the mouth of the lorica, above dilated to a very broad peristome collar, without distinct lobules. The outermost (largest) cilia of the membranelles incrassated in lower $\frac{1}{3}$ to a sort of joint, which apparently enables the upper portion to move freely in an outwards direction.

1. STENOSEMELLA VENTRICOSA (Clap. et Lachm.) (Fig. 107).

Tintinnus ventricosus Claparède et Lachmann 1858 p. 208, pl. IX fig. 4. *Codonella ventricosa* Fol 1884 p. 59, pl. 5 fig. 12. *Tintinnopsis ventricosa* Cleve (pp.) 1900 a; Brandt 1906/7 (pp.), pl. 17 fig. 9. *T. ventricosa* var. *major* Fauré-Fremiet 1908 p. 32 fig. 18. *T. ventricosoides* Meunier 1910 p. 143, pl. XIII figs. 1—8.

Sts. 16, 45, 46 (in greater numbers), 58 (abundant), 59 (in rather great numbers), 62 (likewise), 66, 68; Cadiz, 101, 170 (1000 m.—195 m.), 223 (1950 m. wire), 228 (1145 m. wire), Lisbon, 237, Brest (in greater numbers).

Lorica more or less completely covered with agglutinated, mostly shining and sharp-edged pieces, oval, below somewhat pointed, but at the very end rounded or very obtuse, above rather abruptly narrowed by rounded outlines. Wall very firm and presumably double; the real constitution cannot, however, be seen with any certainty in the optical section, on account of the numerous agglutinated bodies, in connection with the wide, rounded shape of the lorica. Collar of a less firm consistence than the rest of the lorica, low and sometimes scarcely prominent, usually single-walled and simple, sometimes perhaps with two or three indistinct "annuli" (?).

Length $70\ \mu$ — $77\ \mu$, diameter of collar (mouth) $31\ \mu$ — $32\ \mu$; length (height) of collar $2\ \mu$ — $3\ \mu$, rarely more, maximum diameter of lorica $65\ \mu$ — $74\ \mu$.

This species has been partly confounded with two others, with *Stenosemella steini* (Jørg. 1912) — see BRANDT 1906/7 pl. 17 fig. 2, pl. 18 figs. 1, 2, according to OSTENFELD synonymous to *Codonella relictæ* Minkiewicz 1903, a species, widely distributed in the Baltic and the Cattegat (*S. steini*), also occurring in the Sea of Azov and in Lake Aral (*Codonella relictæ*) — and with the following smaller species. Its real distribution is therefore at present only imperfectly known. It has been taken on the west coast of Norway (Clap. et LACHM., JØRGENSEN 1899), in Skagerrack (AURIVILIUS 1898, JØRGENSEN 1912), in the Channel (CLEVE 1900 a, FAURÉ-FREMIET 1908), in the North Sea (CLEVE 1900 a, MEUNIER 1919: common in the south-west), near Iceland and the Orkneys (OSTENFELD 1899, 1900), in the innermost regions of the Vestfjord (the Lofoten 0—600 m., or JØRGENSEN 1905), as well as near the southern island of Novaya Zemlya (rather common, MEUNIER 1910, *Tintinnopsis ventricosoides*).

In the Mediterranean it was first taken by FOL (1884) at Villefranche. Afterwards it was reported from Messina by BRANDT (l. c., taken by LOHMANN 1896), and from Naples and the northern Adriatic by

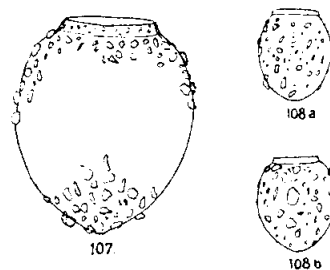


Fig. 107
Stenosemella ventricosa (Clap. et Lachm.); $350\times$. St. 58; a specimen with incrusted collar.

Fig. 108
Stenosemella nucula (Fol p. p. 2, Laackm.); $350\times$. a: st. 33. b: st. 26.

ENRZ jun. (1904 and 1909). In the material of the "Thor" it was only present at few stations, very irregularly scattered, and mostly situated near to the coasts. Like the species of *Tintinnopsis*, this and the following species are chiefly neritic, apparently, however, not so closely confined to the coasts as nearly all species of *Tintinnopsis*.

Stenosemella ventricosa, together with or replaced by nearly allied species, apparently also occurs in many places on warmer coasts, of the Atlantic, as well as of the Pacific and the Indian Ocean.

2. STENOSEMELLA NUCULA (Fol p. p.?, Laackm.) (Fig. 108 p. 95).

Codonella nucula Fol. 1884 p. p.?. *Tintinnopsis nucula* Laackmann 1906 b p. 19, pl. I fig. 4 (5?) pl. III figs. 48—50. *Codonella ventricosa* Entz 1884, Imhof 1886, 1891, Möbius 1887, Wright 1907. *Tintinnopsis ventricosa* Daday 1887, Bresslau 1906. *T. nitida* var. *ovalis* Jørgensen 1905 p. 143, pl. XVIII fig. 115. *T. nucula* Brandt 1907 p. 158 p. p. "T. Bornandi(?)" Entz jun. 1909 p. 199, pl. 8 fig. 5, pl. 9 fig. 6, not "T. nucula(?)" pl. 13 figs. 4, 9. *T. ventricosa* var. *minor* Fauré-Fremiet 1908 p. 232 fig. 18. *T. nivalis* Meunier 1910 p. 143, pl. XIII figs. 26, 27, *T. oliva* Meunier l. c. p. 144, pl. XIII figs. 9—13, *T. avellana* Meunier 1919 p. 30, pl. XXII fig. 37, *T. glans* Meunier *ibid.* figs. 35, 36.

Sts. 11, 14, 24, 26, 28, 29, 31, 33, 38, 55, 58 (abundant), 59, 60, 62, 68; 165, 170 (20 m.—0 m., 80 m.—20 m.), 172 (200 m.—81 m.).

Is remarkably similar to the preceding species, only much smaller. Intermediate forms unknown.

Length usually $37\ \mu$ — $51\ \mu$, diameter of collar $20\ \mu$ — $23\ \mu$, maximum diameter $32\ \mu$ — $45\ \mu$; length (height) of collar $3\ \mu$ — $6\ \mu$.

Considerably varying in shape — maximum diameter above, at, or rarely below, the middle — as well as in height and diameter of collar. Not seldom the latter seems wanting in empty loricae, of this as well as of the preceding species; it is, presumably, less lasting than the lorica proper, according to LAACKMANN (l. c.) it is never wanting in living specimens.

The figure 4 in LAACKMANN, which might be considered to represent the main species, shows a maximum diameter above the middle of the lorica, a low collar and a wide lorica; MEUNIER'S species *nivalis* and *glans* answer to this figure. *Tintinnopsis oliva* Meunier and f. *ovalis* Jørg. (l. c.) has the greatest width of lorica about the middle. *T. avellana* Meunier seems (to me) to be an accidental form, with the greatest width at or somewhat below the middle, as well as a more conical shape of the lorica in its lower portion.

The animalcule, as in the preceding species, has two macro- and two micronuclei (LAACKMANN l. c. pl. III fig. 48).

Most probably local or geographical races or varieties may be distinguished (as small-species) in these and other neritic species of wide distribution.

As seen from the list above, this species was very frequent in winter throughout the Mediterranean, whilst in summer, it was only taken in the innermost, less saline regions, from outside the Dardanelles to the Black Sea, where present in the most saline layer. It should, however, be remembered that the present species is too small to be safely caught by plankton nets; it was also rather scarce in the samples, or mostly but present singly.

This species is obviously widely distributed, both in warmer, in temperate and in cooler and colder seas. It is recorded for many places from the Mediterranean along the coasts of southern, western and northern Europe as far as the Barents and Kara Seas. Answering to its frequent occurrence in the less salt water of the Black Sea Region, it extends from the Skagerrack and Cattegat all the way into the western Baltic (see JØRGENSEN 1912 p. 3).

In regard to the name of this species I have already (l. c.) given my opinion that the specific name *nucula* Laackm. may be used, even though we really cannot exactly decide which species "*Codonella nucula*" Fol (1884) properly represents. The first important condition, that LAACKMANN'S species does occur in the Mediterranean, is undoubtedly verified; his species also answers very well to FOL'S descrip-

tion, but — it is true — badly to the figure given by FOL (1884 p. 60, pl. V fig. 13). DADAY'S *Tintinnopsis nucula* (DADAY 1887 p. 554, pl. 19 figs. 30, 31) from Naples seems to be another species, unknown to me, whilst his *T. ventricosa* answers to the present species. BRANDT (1907 p. 159) has obviously considered the present species to be that of FOL, but he figures under this name a different form (BRANDT 1906 pl. 16 figs. "12 and 10 (? 1, 3, 9, 13, 14)", or probably two species differing from each other, and quotes as synonymous the species of LAACKMANN with an added "?".

The remarkable figure in FOL is perhaps only intended to show that the collar may have agglutinated bodies. BRANDT gives two main figures (10, 12), similar to that in FOL, but scarcely representing the same species as those in LAACKMANN (1906 b figs. 4, 48—50); in connection with the occurrence at Kiel, the latter author is quoted, and BRANDT also himself admits that his species *nucula* (Brandt) perhaps comprises more than one species. For clearness, one should always write *nucula* Laackm.

METACYLIS n. gen. ad int.

Lorica short and wide, broadly oval, having a wide mouth and a very short and wide collar, formed by a helicoidal band with one to few low turns. Wall simple (single) or with indistinctly developed outer an inner lamellæ, more distinct above. No agglutinated foreign bodies present (exceptionally some very few and small accidental ones). Structure indistinct, apparently consisting of a very fine reticulation of slightly elevated plicæ (wrinkles), probably in addition to or coincident with the usual fine "primary" structure.

Animalcule unknown.

Occupies apparently an intermediate position between *Amphorella* and *Codonellopsis* or *Stenosemella*, perhaps more nearly allied to the latter, provisional genus, being, however, of quite another appearance, owing to the thin, hyaline wall.

METACYLIS MEDITERRANEA (Mereschk.) (Fig. 109 p. 98).

Tintinnus mediterraneus Mereschkowsky 1881 p. 211, pl. 12 fig. 1 ("var. neapolitana"); Laackmann 1913 p. 38, pl. VI figs. 88—90. *Amphorella mediterranea* Daday 1887 p. 543. *Codonella Jörgenseni* Cleve 1902 a p. 22; v. Breemen 1905 p. 50; Jörgensen 1912 p. 4. *Tintinnus ureolatus* Brandt 1906 p. 30, pl. 62 fig. 3, not Ostf. *Amphorella joergenseni* Fauré-Fremiet 1908 p. 235 fig. 22 ("A. Jörgensi"). *Tintinnus Jörgenseni* Ostenfeld 1916 p. 133. *Ptycho cylis amphorella* Meunier 1919 p. 14, pl. XXII figs. 4—7.

Sts. Cadiz, 170 (20 m.—0 m., 80 m.—20 m., 1000 m.—195 m.), 175 (350 m. wire), Barcelona, Brest. Everywhere singly or very sparsely.

Lorica hyaline with a short and wide, very short funnelshaped, "annulated" collar, with 2—5 low (narrow) "annuli", and broadly obovate lorica proper, at the lower end with a short point, varying from rudimentary or indistinct to somewhat elongated, with intermediate forms. Structure very indistinct, apparently consisting of a very fine reticulation on a slightly rough surface; no structure, or a still finer one, on the collar.

Length of lorica proper and collar together, but without the caudal prolongation, about 60 μ , the latter up to 14 μ , but frequently very short or only suggested; diameter of mouth about 45 μ , maximum diameter 49 μ —51 μ .

Is obviously a coastal form.

The "tailless" variety is

var. *pontica* Mereschk. (Fig. 109 b p. 98).

Mereschkowsky l. c. fig. 2.

Sts. 152 (250 m. wire), 171, 172 (0 m., 50 m.—17 m., 200 m.—51 m.).

On the whole a relatively wider and at the lower end rounded lorica.

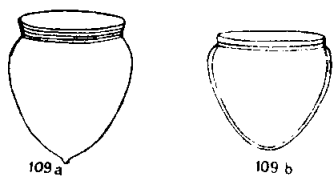


Fig. 109.

Metacyclops mediterranea (Mereschk.);
³⁵⁰/1. a: f. neapolitana Mereschk.; Ca-
 diz (June). b: var. pontica Mereschk.;
 st. 153.

Length of lorica proper about 50μ — 52μ , collar about 4μ — 5μ , maximum diameter 50μ — 54μ .

Was in the Black Sea relatively most frequent at the deeper level, 200 m.—51 m. The main species was at st. 170 (in the Marmora Sea) proportionately most frequent between 80 m. and 20 m.

Outside the Mediterranean the main form of this species occurs all the way from the Bay of Cadiz to the Channel, the south-western part of the North Sea — where rather common (MEUNIER l. c.) and already stated by CLEVE (l. c.) and v. BREEMEN (l. c.) — Limfjord (Denmark, OSTENFELD l. c.), Skagerrack (JÖRGENSEN l. c.), and Bergen (BRANDT l. c.).

In the latter region I have seen it repeatedly in Björnefjord in July. Otherwise I have seen specimens from Bocca Grande near Key West (Florida) and from the East China Sea.

In the Mediterranean it was first observed by MERESCHKOWSKY at Naples, but afterwards not seen till it was recorded by LAACKMANN (l. c.).

CODONELLOPSIS n. gen.

Lorica with an “annulated” collar, distinctly offset from lorica proper, as well as of a different appearance. Lorica proper as in *Codonella*, oval to roundish, with or without a caudal prolongation. Wall with well developed and separated lamellæ. Structure as in *Codonella* consisting of irregular, unequal-sized “secondary” meshes, partly developed as “windows”, between which the “primary” structure is generally coarser. More or less frequently agglutinated bodies are found, on the whole similar to those of *Tintinnopsis*, or more or less regularly disposed, rounded or oblong, proportionately thick, discs, with or without a pore or grain (or a small rod) in the centre, most probably coccoliths (see f. i. SCHWEYFR 1909, pl. 10 fig. 3, *C. orthoceras* with agglutinated coccoliths belonging to *Coccolithophora pelagica* (?)). The collar has generally only an inconspicuous primary structure, without “foreign bodies” or with only relatively few and small ones.

The animalcule is reported to have 18 membranelles, rounded (semilunar) lobes of peristome collar, and numerous macronuclei, in the latter respect answering to the genera *Codonella* and *Cyrtarocyclus* (see pp. 77,90). I have myself found only two macronuclei in the northern *Codonellopsis pusilla* (Cl.) var. *ovata* Jörg. (1899 p. 27, 1905 pl. XVIII fig. 117). A closing apparatus, like that of *Codonella*, is found in *C. orthoceras* (see BRANDT 1906 pl. 8 fig. 6).

1. CODONELLOPSIS ORTHOCERAS (Hck.) Fig. 110 p. 99).

Codonella orthoceras Haeckel 1873 p. 567, pl. 28, fig. 10; Brandt 1907 p. 109, pl. 9 fig. 5, pl. 11 fig. 6, incl. varr. a—f, i, k. *Codonella annulata* Daday 1887 p. 571, pl. 20 fig. 21, not *Tintinnus annulatus* Claparède & Lachmann 1858 p. 207, pl. IX fig. 2.

Sts. 10, Port Alice, 14, 16, Naupaktos (common), 20, Taormina, off Naples, 23, 25, 26, 27, 28 (numerous), 29, 31, 35, 38, 39, 40, 42, 45, 55, 68; 126 (275 m. wire), 134 (75 m.—0 m., 125 m.—75 m., 200 m.—125 m., 350 m.—185 m.), 152 (250 m. wire, 950 m. wire), 156 (250 m. wire), 160 (100 m.—30 m., 200 m.—100 m., 1000 m.—200 m.), 186 (245 m. wire, 1145 m. wire), 187 (945 m. wire), 189 (945 m. wire), 199 (945 m. wire), 204 (945 m. wire), 206 (1945 m. wire), 218, 220, 223 (1950 m. wire, many), 224, 228 (0 m., 1145 m. wire), 231 (1145 m. wire). Scarce or in summer mostly singly if not otherwise mentioned.

Lorica in a well developed state with an “annulated” collar of considerable length, sharply offset from lorica proper and with a different structure. Lorica proper oval, frequently more or less irregular in shape, above for a short distance cylindrical, below the base of collar frequently somewhat swollen, obvi-

ously in order to afford a stronger support for the latter. Below an offset, thick and usually very obtuse, caudal prolongation of different length, short to rather elongated, by an inner transverse wall limited from the cavity of the lorica. Collar cylindrical, or more or less widened conically towards the mouth, consisting of very numerous, more or less low (or narrow) turns of a helicoidal band, towards the mouth — which in cylindrical collars is usually more or less abruptly curved outwards — very low; wall showing well developed and separated lamellae. Structure of lorica proper generally completely concealed by a more or less continuous agglutination of a similar appearance to that in *Tintinnopsis* — sharp-edged, shining, larger and smaller pieces intermingled with opaque or blackish particles or different other “foreign bodies” — more rarely of coccolith-shaped shells of regular shape and disposition, as in the genus *Codonella*. Collar usually completely destitute of agglutinated bodies or at any rate with much more distant and small ones; otherwise nearly always showing only the inconspicuous “primary” structure. Where the lorica proper is destitute of “foreign bodies”, this delicate “primary”, as well as a coarser “secondary” structure is generally seen, sometimes together with a still coarser “tertiary” one (BRANDT), which, however, at any rate partly, may only be markings left by deciduous foreign bodies. Very frequent are large, roundish “windows”, containing a primary structure and separated by areas with a similar, but coarser one.

Total length of well developed specimens $200\ \mu$ — $300\ \mu$; length of lorica proper $85\ \mu$ — $110\ \mu$, of caudal prolongation $20\ \mu$ — $50\ \mu$, of collar $90\ \mu$ — $130\ \mu$. Maximum diameter of lorica proper $71\ \mu$ — $78\ \mu$, diameter of mouth $64\ \mu$ — $68\ \mu$, of collar at base $51\ \mu$ — $54\ \mu$. The collar may, however, also be quite short, even squarish (in optical section) or shorter, in — probably — young or not quite normally developed specimens.

This frequent and easily recognized warm-water species was a common winter species at the surface of the Mediterranean, during the winter cruise present all along the route and off Naples present at most stations in proportionately great numbers, in the Bay of Patras common. During the summer cruise the circumstances had changed; on the inward journey it was not met with until the Tyrrhenian Sea (st. 126) and only below the surface (275 m. wire), being in all only taken at the surface at a few western stations in September, whilst present at most stations throughout the Mediterranean where deep water samples were taken. The samples are directly suggestive of an immigration into the Mediterranean from the west in January and in September; I have also seen the species from Straits of Gibraltar in Decbr. 1908 (S/S Sevilla, capt. RÖD). The distribution in the Mediterranean in winter seems, on the whole, to answer to an immigration into that sea from the west in late autumn.

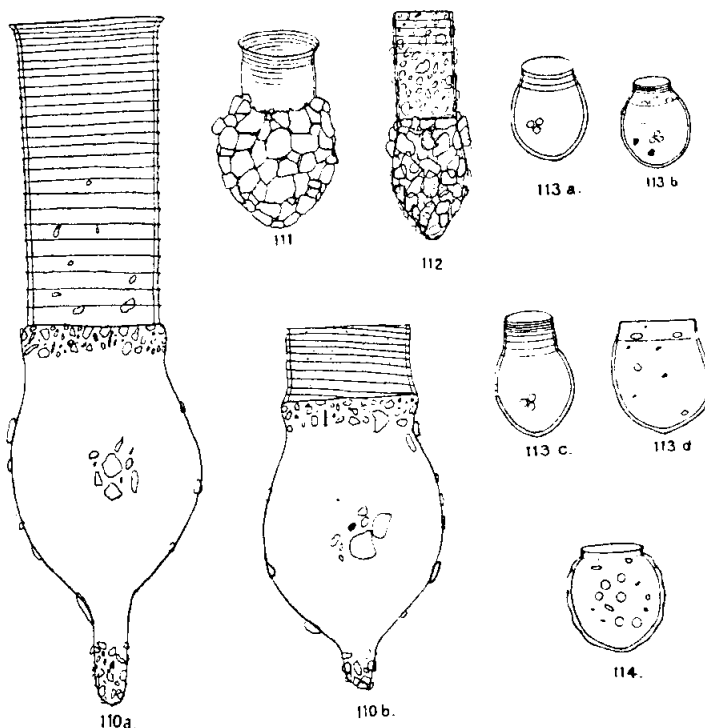


Fig. 110. *Codonellopsis orthoceras* (Hck.); Naupaktos, $350/1$. b: a specimen with a short, presumably unfinished, collar. Fig. 111. *Codonellopsis morchella* (Cl.); $350/1$. Florida Current $30^{\circ} 27' N$ $80^{\circ} 4' W$, S/S Texas, capt. Pedersen $30/11$ 1909. Fig. 112. *Codonellopsis lusitanica* n. sp.; $350/1$. Lisbon. Fig. 113. *Codonellopsis lagenula* (Clap. et Lachm.); $350/1$. a: west of Bergen, $10/10$ 1901. b: st. 206. c: st. 80, in Salpæ. d: st. 172; perhaps specifically different. Fig. 114. *Codonellopsis(?) tuberculata?* (Dad.); $350/1$. St. 172, 200 m.—50 m.; only a few of the scattered circles shown.

Outside the Mediterranean this species is widely distributed in the Atlantic, from west of South Africa, in the Benguela Current (BRANDT l. c.) to Rio de Janeiro (the Fram 1911) and in the north as far as the border between the Florida and Labrador Currents, exceptionally to 50° N, far south-west of Ireland (CLEVE 1901 d). Seems to be frequent in the Indian Ocean (Red Sea, Arabian Gulf, Bay of Bengal, Malay-Archipelago, Mascarene Current, see CLEVE 1901 c, 1903 b, OSTENFELD and SCHMIDT 1901, BRANDT 1907, LAACKMANN 1911) and is also taken near New Pomerania in the Pacific (BRANDT l. c.).

Codonellopsis orthoceras was first detected by HAECKEL at Messina (see HAECKEL l. c.) and afterwards recorded by DADAY from Naples (1887), by CLEVE (1903 b) from the Alboran Sea and the southern Balearic, by ENTZ jun. (1904) from the northern Adriatic, and by LOHMANN (1908) from Syracuse.

2. CODONELLOPSIS MORCHELLA (Cl.) (Fig. 111 p. 99).

Codonella morchella Cleve 1900 pp. 969-970; Brandt 1906/7 p. 124, pl. 13 figs. 1-3, pl. 14 fig. 3, pl. 15 fig. 1, incl. var. *erythriensis* p. 126, pl. 14 fig. 4.

Lorica with an oval "lorica proper", closely covered with agglutinated foreign bodies of the *Tintinnopsis*-type, and a strongly offset, hyaline, almost cylindrical, shorter, "annulated" collar without foreign bodies, somewhat dilated at its mouth.

Total length 86 μ , length of lorica proper 68 μ ; diameter of mouth 51 μ , maximum diameter 61 μ .

Only a single individual was seen, at st. 66 (Bay of Cadiz).

Is a subtropical species of wide distribution, particularly known from coastal waters, to the north as far as the New Foundland Bank and to near the Azores (in Novbr. CLEVE 1901 d). Is widely distributed in the northern warmer regions of the Indian Ocean, and is also known from the Malay Archipelago and from New Pomerania in the Pacific (OSTENFELD and SCHMIDT, CLEVE 1901 c, BRANDT l. c.).

3. CODONELLOPSIS LUSITANICA n. sp. (Fig. 112 p. 99).

Lorica similar to that of the preceding species, but different in shape and in other respects. Collar cylindrical, consisting of numerous, less conspicuous "annuli", the border lines of which are partly concealed by numerous agglutinated "foreign bodies" of rather small size. Lorica proper rather similar to that of *Tintinnopsis beroidea* Entz, almost cylindrical, or slowly narrowing, to below the middle, then more rapidly and conically narrowed into an obtuse or rounded lower end, closely covered all over with larger and smaller pieces, throughout much greater and closer than on the collar.

Total length of a well developed specimen 94 μ , of lorica proper 50 μ ; diameter of mouth 23 μ , maximum of diameter (below the middle of lorica proper) 34 μ . Only seen very sparsely from Lisbon Roads (13/9, 1910).

4. CODONELLOPSIS LAGENULA (Clap. et Lachm.) Fig. 113 p. 99).

Tintinnus lagenula Claparède et Lachmann 1858 p. 204, pl. 8 figs. 10, 11. *Codonella pusilla* Cleve 1900 d, p. 970; *C. pusilla* var. *inornata* Brandt 1906/7 p. 120, pl. 20 figs. 7, 8.

Sts. 80 (in Salpæ, frequent), 175 (350 m. wire, very scarce; 1150 m. wire, singly), 206 (1945 m. wire, singly), Gibraltar (singly).

Lorica beautifully urn-shaped, oval to roundish, with a wide, "annulated" collar. The latter slightly dilated at the mouth, then somewhat narrowing, then again dilated and almost evenly passing over into lorica proper, as to shape, but distinctly offset from it through a more or less conspicuous border line. Lorica proper oval to broadly oval or roundish, below rounded, but frequently with oblique lateral outlines, showing a faintly marked pointing of the lower portion. Structure of lorica proper very characteristic, consisting of proportionately large and strong-walled, regularly hexagonal or roundish "secondary" meshes or "prismatic elements", in a single layer between the approximated lamellæ. In the middle of

the meshes a very fine dot or pore may be seen (as very frequently in a similar structure in many other microscopic organisms, e. g. diatoms and peridinians). Collar much more pallid and thin-walled, showing up to seven "annuli", the upper 3 to 4 being very narrow (low); structure only the very fine "primary" one, but sometimes — particularly on the lowermost "annulus" — also one or two, rarely more, circular or transversely oval "windows". "Foreign bodies" are generally wanting or rare (and small).

Length of well developed specimens about $50\ \mu$, diameter of mouth = $20\ \mu$ — $23\ \mu$, rarely but $17\ \mu$; maximum diameter (about in the middle of lorica proper) $32\ \mu$ — $40\ \mu$, meshes about $2\frac{1}{2}\ \mu$ — $3\ \mu$.

This tiny species, undoubtedly that of CLAPARÈDE and LACHMANN, is apparently widely distributed and considerably varying; is, however, so small that it will certainly as a rule slip through the finest nets. It is therefore very probably much more frequent in the Mediterranean, than the few records above show. It is not rare on the west coast of Norway, and was already well described and figured by CLAPARÈDE and LACHMANN. Their figures (quoted) give an oblique view, on account of which they show the length, in proportion to the width, too short. The authors mentioned state the length as $30\ \mu$, which is rather low; their fig. 11, at the magnification quoted, also gives a somewhat greater length.

To this species apparently belongs *Codonella ecaudata* var. *brasiliensis* BRANDT 1906/7 p. 119, pl. 13, figs. 4, 6, pl. 20 fig. 9, probably synonymous with my *Codonella lagenula* var. *ovata* (JÖRGENSEN 1899 p. 27, 1905 pl. XVIII fig. 117, a figure, not particularly good). This latter variety of the present species is larger than the main species and is much more closely covered by "foreign bodies", concealing the characteristic structure of the outer lamella. Otherwise it apparently answers to the present species; it was found to have two roundish oval macronuclei.

The main species is distributed from the Bay of Biscay and the sea west of the same as far as the New Foundland Bank, the south point of Greenland and the southern region of Davis Straits, thence to Iceland, Scotland, the North Sea and the west coast of Norway, and in the north as far as Barents Sea. CLEVE reports it from $39^{\circ}\text{S } 10^{\circ}\text{W}$ to $42^{\circ}\text{S } 3^{\circ}\text{W}$ in the Southern Atlantic (CLEVE 1901 a). The var. *ovata* also at the Lofoten; if synonymous with *Codonella ecaudata* var. *brasiliensis* it was taken near Pernambuco and at about $30^{\circ}\text{S } 43^{\circ}\text{W}$ far off the southern coast of Brazil (LOHMANN 1920). Some of the localities given by CLEVE for *Codonella pusilla* are situated west of the south-west coast of Ireland; a "*Codonella ecaudata* (?)" is recorded from the area of the Irish seasonal investigations of the sea (May 1910), probably the same species which LOHMANN reports from the Channel in May 1911 as *C. ecaudata* var. *brasiliensis*.

5. CODONELLOPSIS(?) TUBERCULATA? (Dad.) (Fig. 114 p. 99).

Amphorella tuberculata? Daday 1887 p. 541, pl. 18 fig. 20.

Lorica broadly oval or roundish, with a low, simple or "annulated" (?) collar, strongly offset from lorica proper. The outline of the latter angular at the end (which is indistinctly pointed), at the sides very slightly, though regularly, wavy. The collar distinctly limited from the lorica proper, wider at the base, at the mouth erect or somewhat curved outwards. "Annuli" of collar, if present at all, very indistinct; at the base, where — eventually — the lowermost turn of the helicoidal band should be, sometimes one or very few transversely oval "windows", as in the preceding species, are seen. Wall of lorica apparently as a rule with distinct lamellæ, in a thin-walled specimen these latter were, however, incompletely separated. The outer surface of the lorica proper appears more or less regularly dented; in one case faintly marked, rather distant, equal-sized circles were seen (in front). The outside of lorica proper also shows a very fine and indistinct reticulation, more plainly visible in thin-walled, less opaque specimens. Finally, some few, very distant and irregular, agglutinated particles may occur, similar to the smaller ones of *Tintinnopsis*.

I saw only three specimens from st. 172, 200 m.—50 m. (Black Sea).

III. BRIEF SURVEY OF THE OCCURRENCE OF THE SPECIES

The Tintinnid-fauna of the Mediterranean is remarkable for its abundance of species combined with a general scarcity of individuals, as in the two other groups of protists, the Ceratia and the Dinophysiaceae, which I have previously treated from the material of the "Thor" (conf. this Report vol. II J. 1 a. J. 2). Only very few species occurred in any great number and this as a rule only occasionally, with the exception, however, of *Rhabdonella spiralis* which was mostly very numerous or predominant and sometimes occurred in huge quantities.

For comparison with the Ceratia I have counted the total number of individuals examined in that group and the present, and give here the result in tenths of the total number (Ceratia+Tintinnids). These numbers do not claim any great accuracy — an even mixing being also difficult to obtain with organisms so dissimilar, heavy or light, with or without adaptations for drifting — but may be of some use in giving a safer idea of the occurrence on the whole than a mere estimate.

For the winter cruise I found the following figures:

sts.	10	11	P. A.	12	14	15	16	Naup.	18	20	T.	Nap.
Tint., tenths	6	4	2	3	6	5	2	5	3	2	2	1
sts.	23	24	25	26	27	28	29	31	33	35	36	38
Tint., tenths	4	5	3	4	3	6	5	6	5	3	3	5
sts.	39	40	42	G.	45	46	50	53	55	58	59	60
Tint., tenths	3	2	1	3	1	0	3	1	2	4	1	3

The Tintinnids were at this season, compared with the Ceratia, relatively numerous, at the surface often more numerous than the Ceratia, particularly in the Ligurian, the Tyrrhenian and the Jonian Seas, average number 4 in each, lesser in the Alboran and the Balearic, average number for each 2. For the Bay of Cadiz the corresponding figure was 3.

The numbers for surface samples in the Western Mediterranean during the route outwards of the summer cruise were found to be:

sts.	98	99	100	101	102	103	106	108	109	110	111	112	113
	1	1	0	0	0	0	0	0	1	0	0	0	1
sts.	114	115	116	117	118	119	120	122	123	125	G.	126	127
	8	9	9	6	9	2	6	4	0	1	0	0	2
sts.	128	129	131	132	133	134	135	T.	136	137	138	139	
	4	2	3	1	1	2	1	0	0	5	3	2	

and the corresponding figures for the return journey:

sts.	194	195	196	197	N.	198	199	200	202	203	204	205	206	208	209	210	211
	3	0	1	2	9	1	2	3	2	6	6	1	1	1	0	4	5
sts.	Barc.	212	213	215	216	217	218	219	220	221	224	225	226	227	228	Gibr.	
	4	1	0	2	2	1	2	0	1	0	0	0	0	0	1	0	

The average numbers for the different seas are:

Alboran Sea in June 0, in September 0; Balearic in June 5 (0 to 9), in July, south-eastern region, 2 (0—5), in September 1 (0—2); Catalonian Sea (August) 2 (0—5), Ligurian (July) 1 (0—4), Tyrrhenian in July 2 (0—4), in August (return journey) 3 (0—9).

The figures for samples from deeper levels are essentially higher:

sts.	126			128	129			132	
depth.	200 —100 m.	500 —120 m.	275 m. w.	100 —0 m.	80 —0 m.	600 —0 m.	1100 —0 m.	600 —195 m.	1090 —57 m.
Tint.	4	8	3	4	1	4	5	10	10
sts.	134				194	199			204
depth.	75 —0 m.	125 —75 m.	200 —125 m.	350 —185 m.	1145 m. w.	30 —0 m.	200 —80 m.	945 m. w.	945 m. w.
Tint.	4	6	7	10	5	3	7	6	8
sts.	206			209			223	228	
depth.	1945 m. w.	80 —33 m.	200 —85 m.	1000 —200 m.	945 m. w.	1945 m. w.	1950 m. w.	1145 m. w.	
Tint.	5	3	8	10	6	7	3	1	

This fact, that the relative number of Tintinnids increases towards the depth, is partly owing to an absolute increase to a certain depth, varying in different species, partly to the decrease and final disappearance of the Ceratia.

Striking are the low averages for the Atlantic Current: in June 0, in September 1; outside the Straits of Gibraltar the corresponding average numbers for the Tintinnids were 2 (0—6) and 4 (2—5).

For the Eastern Mediterranean I found the following numbers for the surface samples:

sts.	140	143	145	147	148	151	152	153	154	155	156	158	160	161
Tint.	4	0	3	1	0	0	3	5	1	1	3	2	2	7
sts.	162	163	164	165	167	168	169	170	K.	171	172	173	174	175
Tint.	2	4	1	1	0	0	0	0	1	0	0	1	1	0
sts.	178	179	180	181	182	183	184	185	186	187	189	190	192	
Tint.	0	1	1	5	2	6	1	2	4	2	1	2	4	

This gives an average for the Ionian Sea in July of 4 (3—5), in August (during the return voyage in the northern region) 2 (1—4), for the Levant (August) 2 (1—3), for the Aegean Sea 3 (0—7), in the Dardanelles 0, in the Marmora 0 (0—1), in the Bosphorus 1 (0—1), and in the Black Sea 1 (0—1).

In deeper levels the Tintinnids are again more dominating:

sts.	152		156		160				163	
depth	250 m. w.	950 m. w.	250 m. w.	950 m. w.	30 -0 m.	100 -30 m.	200 -100 m.	1000 -200 m.	80 -0 m.	
Tint.	5	6	4	8	1	3	7	9	3	
sts.	170				172			175		
depth	20 -0 m.	80 -20 m.	200 -85 m.	1000 -195 m.	17 -0 m.	50 -17 m.	200 -51 m.	30 -0 m.	350 m. w.	1150 m. w.
Tint.	0	1	4	10	0	1	1	0	1	1
sts.	182	184	186		187			189	192	
depth	545 m. w.	945 m. w.	245 m. w.	1145 m. w.	25 -0 m.	190 -100 m.	945 m. w.	945 m. w.	545 m. w.	
Tint.	5	6	5	5	2	5	4	6	5	

In the Black Sea Region (sts. 168—178) the Tintinnids are generally scarce, the Ceratia numerous, except in very deep layers.

Of special interest is the question of immigration into the Mediterranean through the Straits of Gibraltar; from the material of the "Thor" such an immigration should be expected to be traceable for the months of February and January, June and September (at least).

The very low figures above stated for the relative frequency of the Tintinnids, on the whole, in the region of the Atlantic Current in June and September, 0—1 and 0—2, on an average 0 and 1, compared with the higher values for the Bay of Cadiz, 2 and 4, show that the summer, or at all events June and September, cannot be a favourable season for an invasion into the Mediterranean of the Tintinnids in general.

It should, however, be remembered that the data available do not definitely settle the question (of immigration). For the month of June they only show the state of things for the surface: no surface species outside the Straits appears as a surface species inside the same in greater numbers at a series of stations in the Atlantic Current. There are, however, other possibilities. LOHMANN (1920 p. 228), on his voyage with the "Deutschland" (1911) found that the Tintinnids in the cooler waters were more numerous at the surface, but in the warmer had a second, and equally high maximum of frequency at 100 m. below the surface, or even the absolute maximum there, in the latter case increasing in numbers right from the surface. In the Mediterranean, on the whole, the Tintinnids were in summer remarkably numerous in deeper layers, or, properly speaking, remarkably scarce at the surface, many species being found there only occasionally or not at all. It is therefore possible that a species of these, relatively very rapidly moving animalcules, may pass over into deeper layers inside the Straits and therefore escape detection. On the other hand, as the Atlantic Current reaches downwards to a certain depth, a species may have entered the Mediterranean below the surface.

Applying these views at the observations for June — the last mentioned case excepted — there should be a possibility for immigration into the Mediterranean through the Straits of Gibraltar in the following cases:

1. when the species is present outside the Straits, as well as inside, in the Atlantic Current,
2. when the species is present outside the Straits, but does not appear at the surface inside them, or only just inside, being, however, frequent at deeper levels farther east,
3. when the species is absent outside the Straits, but appears somewhere in the Atlantic Current inside them.

The first case shows an obvious invasion when the species in question is found at a series of stations, outside as well as inside the Straits, but this seems to be a rather rare case among the Tintinnids. Still rarer are cases of an obvious increase in frequency inside the Straits in the Atlantic Current; there exists, however, here — as in the Ceratia — a somewhat similar, though very rare, case, when a species (*Rhabdonella spiralis*) in the western region of the Atlantic Current decreases strongly in numbers, apparently struggling for life, but finally, at the eastern end of the current, swells up to great masses, mostly consisting of a modified form (*Rhabdonella spiralis* α), now taking the lead at the surface, whilst the invading form (var. *elongata* or near to it) passes over to deeper levels.

In June, case 1. above only gives two or three species entering the Mediterranean from the Atlantic, *Tintinnus fraknööi*, decreasing in numbers, *Xystonella acus* and perhaps *Amphorella steenstrupi*, scarce. Case 2. seems to be applicable to several of the more frequent Mediterranean species: *Codonella galea*, frequent in the Bay of Cadiz and present at three stations subsequent just inside the Straits, but then suddenly vanishing from the surface, probably passing over to deeper layers where it is frequent farther in, *Dictyocysta elegans*, *D. lepida*, *Undella claparèdei*, *U. hyalina* and perhaps *Cyrtarocyclus cassis*, *Climacocylis scalaria*, *Codonella nationalis* and *C. perforata*. Case 3. might further only give *Petalotricha ampulla*, perhaps occasionally entering the Mediterranean from the west.

From September we have but scanty material for judgment on the same question, but now there are also two deep-water samples, from sts. 231 and 228, 1145 m. wire. According to Dr. SCHMIDT these "wire-samples" should chiefly correspond to a depth half as great as the length of wire, i. e. in this case below the Atlantic Current. On hauling in, some species from this current may be caught (singly); otherwise these two deep-water samples should only contain emigrating species. This latter case, the same species present in both deep-water samples, is not very rare, but may perhaps apply to only empty loricae or sunken dead specimens. At this season there is an obvious immigration into the Mediterranean of *Rhabdonella spiralis* (var.) *elongata*, though in decreasing numbers, of *Undella hyalina* in increasing numbers, further of *Tintinnus fraknööi*, *Climacocylis scalaria* and perhaps of *Amphorella quadrilineata*. Besides, *Dictyocysta elegans* and *Favella azorica* are occurring singly inside the Straits in the Atlantic Current and may have entered from the Bay of Cadiz in the way above suggested.

In winter (February) the average number for the Tintinnids is 2 (tenths) inside the Straits and 3 outside, the conditions for an immigration into the Mediterranean accordingly better. No winter samples from deeper levels being at hand, we have to judge from the surface samples alone. The Mediterranean stations in the Atlantic Current are, according to the hydrographical data, sts. 60, 59, 46 and 45; less markedly Atlantic are sts. 58, 53 and 50. The following species seem to enter through the Straits: *Codonella galea*, abundant at st. 53, *Dictyocysta lepida*, *Undella claparèdei angustior*, *U. hyalina* in increasing numbers; *Cyrtarocyclus eucecryphalus*, *Climacocylis scalaria*, *Xystonella acus* and *Dictyocysta mitra* vanish from the surface a little way inside the Straits. *Petalotricha ampulla* was abundant outside and just inside the Straits, but vanished from the surface a short distance farther in. A few other species, as *Undella aculeata* and *U. marsupialis*, were present singly at a couple of stations outside the Straits, but disappeared at a short distance inside them.

As already suggested in my papers on the Ceratia and Dinophysiaceae of the "Thor", the best seasons for a successful immigration of species through the Straits of Gibraltar into the Mediterranean might be late autumn and perhaps some time in spring, when there may be no noticeable difference in temperature between the Atlantic Current and the surrounding water in the Western Mediterranean.

The character of the Mediterranean Tintinnid fauna is, on the whole, that of a marked southerly or warm-water fauna, consisting mainly of warm-temperate or even subtropical, perhaps also tropical, forms. This is in full accordance with the characters of the Ceratia and Dinophysiaceae. In order to obtain more accurate statements, which later may be supplemented and corrected, I will try to introduce special provisional designations, dividing the species of the material into five geographical groups: tropical

species, not or scarcely reaching the Azores (from the south), subtropical, liberally reaching the Azores and partly the sea west of Portugal, occasionally to the southern region of the Bay of Biscay, warm-temperate, reaching the Channel and Ireland, in the open Atlantic about to 50° à 53° N., exceptionally (in late autumn) farther, cold-temperate, reaching the south coast of Iceland and the coast of Nordland (Norway), and subarctic, reaching past Iceland, to the northern regions of the Norwegian Sea and the regions of the Barents Sea and other northern regions where properly arctic conditions do not yet prevail. These divisions apply to the oceanic species, not to the neritic, and only to the distribution on the northern hemisphere; if necessary to avoid confusion they may be supplied with the prefix boreo-, in contradistinction to austro- for the southern hemisphere.

I. Group (B₂) of oceanic boreo-subtropical species.

Climacocylis scalaria, *Codonella amphorella*, *C. cistellula*, *C. nationalis*, *C. perforata*, *Coxiella fasciata*, *C. laciniosa*, *Cyttarocylis cassis* and *eucecryphalus*, *Epiplocylis acuminata*, *E. undella*, *Rhabdonella elegans*, *Undella aculeata*, *U. hyalina*, *U. marsupialis*, *Xystonella treforti*, *Xystonellopsis cymatica*.

The species of this group are rarely present in greater numbers, all present also in winter, and do not enter the Sea of Marmora. Of the 17 species above the following 9 are in summer in the Eastern Mediterranean only noted for deeper levels: *Climacocylis scalaria*, *Codonella amphorella*, *C. cistellula*, *Cyttarocylis cassis* and *eucecryphalus*, *Epiplocylis acuminata*, *Undella aculeata*, *U. hyalina* and *U. marsupialis*, whilst all 17 in summer are found almost exclusively below the surface.

To this same group of markedly warm-water species also many of the other species certainly belong, their distribution being as yet only imperfectly known.

II. Group (B₃) of oceanic warm-temperate species.

To this group probably belong almost all the rest of the Tintinnids in the material of the "Thor"; their distribution being, however, still mostly uncertain or very little known, I will here provisionally only list the following species:

Amphorella ganymedes(?), *Codonella galea*, *Codonellopsis orthoceras*, *Dictyocysta mitra*, *Petalotricha ampulla*, *Protorhabdonella simplex*, *Rhabdonella spiralis*, *Tintinnus fraknóii*, *Undella claparèdei*, *Xystonella acus*(?).

These species are less markedly warm-water species; they are partly or sometimes occurring in great numbers and include the more dominating species of the Mediterranean. Some of them extend into the Sea of Marmora (*Petalotricha ampulla* var., *Tintinnus fraknóii*, *Undella claparèdei*).

III. Group (B₄) of oceanic cold-temperate species.

Such species are rare and nearly always scarce in the material of the "Thor". They are mostly true northern (forms or) species, more or less closely allied to corresponding southern forms (or species): *Amphorella quadrilineata*, the main species, *A. steenstrupi*, the main species(?), *Undella caudata*, in contradistinction to *U. lohmanni* and *U. aculeata*.

Some are northern forms of southern species:

var. *tubulosus* av *Tintinnus lusus-undae*, and *Dictyocysta elegans* var. *speciosa* (var. *disticha* Jörg. 1899 p. p.) which may be a northern or cold-temperate form of the more southerly (or less northerly) distributed *D. lepida*.

To this group also seems to belong *Codonellopsis lagenula* which, however, perhaps is a neritic species. Nearly all species of this group extend into the Sea of Marmora.

IV. Group (B₁) of properly tropical species.

Such species, of a true tropical character, may perhaps occasionally enter the Mediterranean from the west, chiefly in winter?, and keep alive for some months, apparently by preference in deeper layers of the Eastern Mediterranean. Here may belong the following species:

Undella collaria and *tricollaria*, *Xystonellopsis paradoxa* and perhaps *Dictyocysta mülleri*. By the imperfectly known distribution it may later be proved that these species properly belong to the subtropical group. They are all — only the last species excepted — present (in the Mediterranean) in winter at the surface, and in summer only known from deeper layers of the Eastern Mediterranean. *Dictyocysta mülleri* is not noted for the winter (may have been included in *D. elegans*) and occurs also at st. 209 in deeper layers (besides in the Eastern Mediterranean).

V. Group (B₅) of oceanic subarctic species, in part or wholly comprising the so-called boreal species (CLEVE, GRAN).

Species of this group scarcely occur in the Mediterranean. Here belong the main species of *Tintinnus acuminatus* (including var. *secatus* Bdt.), certain forms of *Dictyocysta elegans* (probably the main species), as well as *Favella denticulata* and the genus *Ptychocylis*. They extend southwards about to the northern limit of the warm-temperate species (group B₃).

The neritic species were in the material of the "Thor" as a rule very scarce, only very few plankton catches being made at coast stations. Here belong the species of *Tintinnopsis* and *Stenosemella*, *Favella serrata*, *F. adriatica*(?), *F. ehrenbergi* and *márkusovszkyi*, *Coxiella helix*, *Helicostomella subulata* and *Metacylis mediterranea*. These species are generally or frequently very widely distributed, over both colder and warmer regions, a remarkable fact, as, a priori, one might expect the coast forms to be developed into many more or less local forms or species, in contradistinction to the oceanic. In fact, the state of things seems rather to be the inverse, the oceanic genera are highly differentiated into species, and these generally into forms, the neritic are, as a rule, remarkably uniform. An exception is the genus *Tintinnopsis*, in which the number of species is very great; also here, however, many species appear to have a remarkably wide area of distribution, from subarctic, or in part even arctic, localities to subtropical or tropical. The characterization of the species of this genus is, however, more or less difficult, and requires great experience. The species of the Mediterranean still await much better elucidation.

Of special interest, compared with the oceanical groups, is the fact that the neritic species, more closely corresponding to the northern oceanic forms, answering roughly to group B₄, were by no means rare in the Mediterranean, sometimes even numerous as to individuals. Here belong *Tintinnopsis beroidea* Entz, the species of *Stenosemella*, *Favella ehrenbergi* var. *helgolandica* and var. *claparèdei*, *F. serrata*, *Coxiella helix* and *Metacylis mediterranea*. There are also others which either do not extend so far to the north, as *Favella adriatica*, or are confined to the Mediterranean, as *Favella markusovszkyi*(?); or are otherwise only known from warmer localities, as *Tintinnopsis compressa*, *T. radix*, *T. angulata* and allied species.

There still remains a rather numerous group of species, as yet only known from the Mediterranean or, most of them, here above established as new species. These are in part true warm-water species, the northern waters being rather well explored as regards Tintinnids, in part very small forms, the distribution of which is as yet quite unknown on account of their slipping through the plankton nets commonly used.

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