I

THE PLANKTON OF EASTERN NOVA SCOTIA WATERS.

AN ACCOUNT OF FLOATING ORGANISMS UPON WHICH YOUNG FOOD-FISHES MAINLY SUBSIST.

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(WITH SEVEN PLATES.)

INTRODUCTION.

Within recent years much attention has been given to the floating microscopic organisms which abound in all great bodies of water—fresh and salt. It had not been sufficiently realized until it was insisted upon by Haeckel, Hensen, Brandt and others, that our attention has hitherto been arrested chiefly by the animal life of the sea and the great lakes to the neglect of the vegetable food-supply which necessarily forms the *conditio sine qua non* for the existence of all animal life. On land the vegetable kingdom everywhere seems to be predominant, and to account amply for all the animal life which feeds on it directly or indirectly. But in the ocean, the obvious plants—the seaweeds, brown, green and red—form a mere inconspicuous fringe of vegetation along the shore, and do not extend out beyond a few fathoms in depth. Such a fringe of vegetation can practically be neglected as the basic food-supply of the animal life of the ocean, and the question comes to be, 'Whence do marine animals derive their fundamental supply of nourishment?' Living creatures are either builders or destroyers of protoplasm, or in familiar parlance, either plants or animals, and the former are necessary to sustain the life of the latter. In what form then do these necessary protoplasm builders exist in the sea and other great bodies of water?

The answer is, in the form of microscopic plants, often quite invisible to the naked eye and yet present in such enormous numbers, not only at the surface but through the whole of the superficial layers of waters, some sixty fathoms deep (as far as the sunlight reaches, on the presence of which their power to build protoplasm depends) that it has been calculated that an acre of sea-water—surface measurement—furnishes as much nutritive vegetable matter as does an acre of rich meadow land in the course of a year.

No one sailing over the Atlantic suspects the presence of such a rich vegetation, and indeed it can only be disclosed by filtering the water through an exceedingly fine fabric—the finest silk gauze used by millers is that generally employed for the purpose —and this is usually done by towing a net of such a fabric behind a boat so as to insure a definite amount of water passing through it.

Investigations made in this way may be either qualitative—merely to determine the nature and relative numbers of the organisms so captured—or quantitative—to determine the absolute amount of the different kinds of organisms in a column of water of given dimensions.

It is such quantitative investigations which have rendered the statements as to the richness of the marine vegetation possible, which are made in the foregoing paragraph.

The tiny organisms obtained in this way are not all plants, many of them are animals, feeding on the former, and themselves serving as food for larger creatures.

Many of our important food-fishes, such as those of the herring and mackerel families, are known as plankton feeders, for their gill-arches are provided with a sifting apparatus which enables them to sift out from the water which they are breathing, the minute organisms it contains, and the young stages of all fish pass through a phase when they are dependent on the same kind of nourishment. Without a glance at the catch of a tow-net it seems incredible that fish of any size should be dependent on such inconspicuous food, but sometimes at the height of the summer a careful inspection of the water itself betrays its richness in life. In our inland lakes, e.g., the 'blossoming' or 'flowering' of the lake in August, when the water is full of minute green points, is a phenomenon which often attracts attention and is only a temporary exaggeration of a permanent condition. The astounding rate at which these minute creatures reproduce themselves, is one of the noteworthy facts about them.

Although there are various methods of reproduction, one of the commonest is that of division into two after they have grown to their typical size. Maupas has calculated that if a little Infusorian, not as big as the head of a pin, continued to reproduce at its ordinary rate of division—five times a day—it would, at the end of a month, form a mass of protoplasm a million times as big as the sun ! It is obvious that the rate of consumption of such creatures by larger forms must be very high to keep down the population to the normal relations in which we find them, and of course the rate of reproduction of the minute plants is dependent on the amount of the carbon, nitrogen, and other elements of their food available in the sea water.

But it must be remembered that these minute plants are constantly being devoured by animals, some little bigger than themselves, others much larger, hence no one species ever gets the opportunity of monopolizing the ocean.

Another noteworthy circumstance is that our northern waters appear to be richer in plankton vegetation than those nearer the equator, richer at least, in the mere quantity of vegetable matter, not in beauty or variety of form, for the tropical species are certainly more varied, and in many cases more beautiful than the northern ones. To this wealth in microscopic organisms of our waters we owe the circumstance that we are able to supply warmer climes with the surplus of our fish production. The reason of this greater richness is not apparent; Brandt has suggested that it may be due to a deficiency of nitrogen in warmer waters owing to the more favourable conditions for the growth of denitrifying bacteria.

Before giving a detailed description of the minute life of the ocean, a few remarks as to its general character will be appropriate. The simple plants which constitute the bulk of the marine vegetation are frequently *Peridinia* (Plate I.), single cells of odd shape usually furnished with a decorated shell, and swimming actively by means of two long lash-like 'flagella.' Some of these *Peridinia* it is improper to describe as plants, for they seem to be destitute of chlorophyll and therefore obliged to depend upon preformed living matter for their food.

Another group abundantly represented in the open water is that of the *Diatoms* (Plate II.). These have always a resistant siliceous shell, and do not swim actively like the foregoing. Both of these groups of plants, however, require to live in the stratum of water penetrated by sunlight, and they do this either by their own exertions, but usually owing to the presence of organs which render floating easy, such as long delicate spines or the like, or again, to the presence of fat or oil which diminishes the specific gravity of the cells.

The chlorophyll in the *Peridinia* and *Diatoms* is often masked by other colouring matters usually of a brownish hue, but there are also unicellular plants of a pure green chlorophyll like some of those represented in Plate III., while in addition to these there occur many extremely minute forms of various colours, but in shape approaching that of the *Chrysomonad,* Fig 11, so small as to elude the meshes of the fabric generally employed. The mesh of the latter is usually 1/200 of an inch on the side, but many little creatures actively swimming by means of lash-like prolongations of their protoplasm, the so-called *'Flagellata,'* do not exceed 1/3000 of an inch in diameter, and slip through such a mesh with ease, unless accidentally arrested by the threads.

As to the one-celled animals which, of course, feed on these smaller plants, they belong to the various groups represented on Plate IV., and some of them form with *Peridinia* and *Diatoms,* a conspicuous part of the food of oysters and similar molluscs.

Again, the plankton contains many young phases of higher animals which swim about for the earlier part of their life and afterwards settle down to more or less sedentary habits. Such is the case with the sea-urchins, worms, molluscs, &c., some of the young of which are represented on Plate V. These larvæ are, of course, dependent on the minute life of the plankton for their food, and are themselves devoured by larger animals.

But there are also adult animals of small size rarely more than the ⅛ of an inch or so in length, which are constantly eating up the crop of microscopic plants, and which themselves form the bulk of the food of plankton-feeding fish; such are the *Copepods* represented on Plates VI., and the *Tunicates,* on Plate VII. And, finally, reference should be made to the floating eggs of various fishes like the cod, occurring in enormous numbers, few of which ever reach maturity, but are destined to furnish nourishment to the plankton feeders.

Many of the creatures and eggs referred to are exquisitely adapted to their floating (pelagic) life, by their extreme translucency, which makes them almost invisible in the water. Such is notably the case with forms like those shown in Plate V., Fig. 13, and Plate VII., Figs. 11 to 13.

The following account of the organisms observed at Canso is intended as a preliminary one, one of the results of which it is hoped may be the lightening of the initial labours of future investigators into the Canadian plankton, and another, that some workers may thereby be induced to enter this interesting field of research, which requires, owing to the vast extent of our Dominion waters, to be sub-divided to give entirely satisfactory conclusions.

PERIDINIALES.

PROROCENTRIDÆ.

This family embraces the simplest forms of Dinoflagellata, and one of the genera at least suggests by the symmetry of its bivalve shell a relationship to the Diatoms, the colouring of which they also share. The characteristic girdling furrow of the more typical members of the order is absent.

EXUVIAELLA.—*Cienkowsky.*

This differs from Prorocentrum in the lack of the prominent anterior spine of that genus. The specimens observed at Canso, and more frequently at Malpeque, P.E.I., belong to the species *E. marina* (Plate I., fig. 1), but there appears to be a slight difference in that the posterior half of the shell is decorated with some short projecting spines which may entitle it to the varietal name *'hispida.'* The dimensions are $42 \times 33\mu$.

PROROCENTRUM.—*Ehrb.*

P. micans E. (Plate I., fig. 2) also more abundant at Malpeque, appears to be identical with the common European form; it is longer and slenderer than Exuviaella and less symmetrical in outline. The two foregoing species, especially the latter, are important constituents of the oyster's food.

GYMNODINIIDÆ.

PYROCYSTIS.—*Murray.*

This genus was established by Sir John Murray for certain globular cells met with in the tropical and subtropical portions of the ocean, which are frequently responsible for the phosphorescence of the sea. The species met with, *P. noctiluca* (of large size, viz.: 600—800 in transverse diameter) was accompanied by a spindle-shaped form *P. fusiformis* Murray, measuring 1,000 × 160μ. Also at Canso a globular form of smaller dimensions (80 × 150μ) was frequent (Plate I., fig. 3), agreeing admirably in the nature of the protoplasmic contents with *P. noctiluca.* It was also accompanied by a crescentic form (Plate I., fig. 5) 180—250μ in length by 18—25μ greatest width which has been frequently found in the north Atlantic, and described by Schütt as *P. lunula.* The association soon turned out not to be fortuitous, for all stages of segmentation of the protoplasmic contents of the globe into 4, 8, 16, 32 balls were observed (Plate I., fig. 4), which eventually developed into crescents within the shell of the globe before they were freed by the bursting thereof. The curiously curved shapes which they acquire during their imprisonment are explained by their crowded arrangement. A further phase of development, in virtue of which six Gymnodinia (fig. 5, 5a) are formed within the crescent (one of which is distinguished from the others by a red spot), was observed such as is figured by Hensen (No. 1, Plate IV., fig. 30). Schütt figures examples with only a single Gymnodinium in the interior. It seems improbable that only one species of Gymnodinium passes through this remarkable cycle, and further studies may reveal globular and fusiform cystic stages for other species. Another cyst occurring along with the foregoing, but exceeding it in size (diameter 200 — 250μ) is probably related. It was observed frequently with daughter-cells sixteen in number of characteristic form (Plate I., fig. 6) and size (50—56 μ), one alone of which possessed a rosy spot. The cells afterwards undergo encystment when, within each, eight granddaughter cells of similar but smaller size, 12μ, are developed, one only of them retaining the original rosy spot.

In July and August there was frequently observed within dead Copepods or their appendages, a small pink Gymnodinium (Plate I., fig. 7) of subglobular form, 40μ in its longer diameter, generally in an encysted condition, the nuclei recalling the structure figured by Schütt (No. 2, Plate XXII., fig. 73). It is probably a stage in the development of a larger form.

POUCHETIA—*Schütt.*

This genus has been formed by Schütt for the purpose of separating certain chlorophylless species of Gymnodinium which are also distinguished, alone among marine forms, by the possession of more or less complicated organs of vision.

About the midde of July at Canso a form was common which possessed the yellow and brown chlorophyll of Schütt's *Gymnodinium geminatum*, disposed in strands, but in addition a well marked pigment spot with lens of the form represented in Plate I., fig. 8. As this is manifestly of the same character as the stigma of the other species of Pouchetia, that genus must be held to include also chlorophyll-bearing forms. The present species, which on account of its colour may be called *P. ochrea,* was always observed encysted, a single individual or one in various stages of division being inclosed in the cyst. The latter envelopes the body closely, and is not the thick gelatinous investment seen in *G. geminatum.* The undivided cell measures 55 × 45μ but when division is far advanced it gains a length of 100μ. The form and position of the lens and pigment body of the stigma may be gathered from the figure. The latter shows that the two daughter individuals, instead of being in contact by similar surfaces, have their opposite poles adjoining.

GYMNODINIUM.—*Bergh.*

A form (Plate I., fig. 9) was observed on one occasion in July, 1902, which is possibly referable to *G. gracile* Bergh. It is bright pink in colour and measures 125μ in its long diameter. In form it recalls *G. fusus* Schütt.—No. 2, Plate XXV., fig. 81.

PERIDINIIDÆ.

DINOPHYSIS.—*Ehrb.*

This genus is at once recognized by the compression from side to side and the far anterior position of the transverse furrow. Two species are common at Canso and at Malpeque; *D. norvegica* Clap. and Lach. (Plate I., fig. 10), the commonest form, measures 65 μ in its long diameter, and can be distinguished by the coarse reticulation of the shell, the green chromatophores and the curved posterior point.

D. rotundata (Plate I., fig. 11), the next most frequent form, measures little more than 50 μ in length, lacks chromatophores, possesses protoplasm of a very pale pink hue, often much vacuolated, and has a shell decorated with very minute round points. The anterior half of the shell projects considerably beyond the girdle, which is notably not the case in *D. norvegica.* A third species of ovate outline with green chromatophores, but smaller than either of the foregoing (35 — 45μ), resembles *D. ovum,* Schütt, in form, but is not so large.

PYROPHACUS.—*Stein.*

P. horologium Stein (Plate I., fig. 12) is distinguished by the fact that its two valves are subequal and much flattened, so that it presents to the observer one or other of its poles, being then distinguished by the broad transparent flanges overhanging the transverse furrow. The chromatophores are yellowish green. It owes its specific name to the watch-glass shape of its valves. These measure 72μ in diameter. It was common in the middle of July.

PROTOCERATIUM.—*Bergh.*

P. reticulatum Clap. and Lach, is a comparatively small form which no doubt frequently eludes observation. It is marked by the coarse reticulation of the shell (Plate I., fig. 13), which is divided off into angular areas bounded by ridges and provided with a central pore, also by the deep diatom-brown of its chromatophores. It occurred at Canso in July and August, the specimens measuring 46 μ in the longest diameter.

GONYAULAX.—*Stein.*

G. spinifera Clap. and Lach. resembles the foregoing in its colouring, but has a characteristic tubular prolongation of its anterior pole and carries spines on the posterior pole at the sides of the well-marked longitudinal furrow (Plate I., fig 14). The transverse furrow is markedly spiral. The long diameter is 80μ. It was observed in one gathering from Grand river, Malpeque in 1903.

PERIDINIUM.—*Ehrb.*

To this genus there belong several species which are often most abundant in the plankton, and constitute a very important element of the food of those animals which are dependent on such microscopic nourishment. Four species were recognized at Canso, not necessarily occurring at the same time, but frequently overlapping in their maximum periods. Three of these have the angular outline which is characteristic of most of the species, while the fourth is oval in contour. The three former, however, differ in dimensions and in colour. *P. divergens v. reniforme* Ehrb. (according to Jorgensen, No. 3, p. 36=*P. depressum* Bailey) is the largest (120μ in transverse diameter) and has protoplasm of pinkish hue (Plate I., fig. 15, a. & b.). *P. lenticulare* Ehrb. (Plate I., fig. 16), is greenish, and measures only 80μ across, while *P. pellucidum* fig. 17) is only half as wide, more pyriform, and quite colourless. At the beginning of August, 1902, a variety of *P. divergens* made its appearance, in which the pink colour was more intense, the reniform outline, when observed from one of the poles (fig. 15 c.) more marked, and the vertical height from pole to pole less. *P. ovatum* (Pouchet) Schütt (fig. 18) shares the pink hue of *P. divergens,* but is oval in outline except for the short tube of the apical pole. Its transverse diameter is 75μ and its vertical 55μ. The ventral fissure is bounded by two sharp teeth.

Diplosalis lenticula Bergh, was observed along with the foregoing, with which it may easily be confused on account of its oval outline, but it differs from it in possessing only five pre-equatorial plates instead of seven, and in the fact that the transverse furrow has a strictly equatorial and not slightly spiral course. Its dimensions are rather smaller.

CERATIUM.—*Schrank.*

This genus, like Peridinium, furnishes a very large part of the floating food-material of the ocean. It differs from it in having the tendency to develop flotation organs either in the form of three horns (one apical, two antapical), or by the acquisition of an exceedingly long and slender form like some of the plankton diatoms. The plates of the apical pole are fewer in number, there being only three pre-equatorial plates.

The commonest species at Canso is the widely-distributed *C. tripos* Nitsch, and the variety of this very variable species which is most abundant is *C. tripos macroceras (forma intermedia)* of Jorgensen. It will be seen that my sketches (fig. 19) resemble his figure (No. 3, Plate I., fig. 10) very closely. Another form in which the horns are much longer in proportion to the width of the body was commoner, earlier in the year, and is perhaps the form '*scoticum*' of Schütt, while isolated examples of a form with the antapical horns very slightly curved towards the apical pole approach the variety '*arcticum*.'

C. fusus (fig. 20) seems less variable than the foregoing. The right antapical horn is more or less suppressed, and the whole cell attains a length of over 1 mm.

GYMNASTER.—*Schütt.*

One or two examples of the singular little form *G. pentasterias* Ehrb. (fig. 21 a. & b.) were met with in July. The body is oval, 44μ in long diameter, and is distinguished by the presence of two intracellular skeletal plates of resistant siliceous material. After boiling with nitric acid the delicate form of these plates (No. 2, fig. 216) becomes more evident. This form is frequently regarded as one of the Silicoflagellata (p. 9).

DIATOMACEÆ.

Of this group a very large number of marine forms are known, some of them admirably adapted as Schütt has pointed out (Pflanzenleben der Hochsee) for a floating life; others on the other hand confined to a littoral life by the absence of such provisions. The adaptation for floating is generally achieved by a reduction in the amount of silica in the valves of the shell, and in addition by the flattening of the whole cell into a disc-like form or its elongation into a more or less needle-like shape. *Coscinodiscus* and *Rhizosolenia* exhibit the two extremes of these modifications, and both genera were frequently represented in the tow-nettings at Canso. Of the former genus some very large examples are met with; *C. concinnus* e.g. (Plate II., figs. 1 and 2) in which the sculpture of the valves is exceedingly fine. *C. oculus iridis* and *C. centralis* are smaller and have more obvious sculpture which frequently suggests artificial engine-turning (fig. 3). *Actinoptychus undulatus* Ralfs, *Actinocyclus Ralfsii* Smith and *Paralia sulcata* (Ehrb.) Cleve are not uncommon (figs. 4, 21*a* and *b*, 23.

The commonest species of Rhizosolenia was undoubtedly *R. styliformis* Brightwell, in which the adjacent ends of the valves have very characteristic fitting surfaces (Plate II., fig. 6), but *R. setigera* Bright. was also frequently represented, in which the valves terminate in long spines with a peculiar spear-blade-like enlargement towards the middle of their length (figs. 5 and 7).

Still another type of plankton diatom is that which is furnished with delicate bristles which enormously increase the amount of surface in contact with the water without materially adding to the weight. To this type belongs the genus *Chætoceras*, which is not only rich in species but is profusely represented by individuals in the plankton.

CHÆTOCERAS.—*Ehren.*

In the following account of this essentially planktonic genus, I shall follow the excellent paper of Gran (No. 4), which unfortunately I had not at my disposal when I made the sketches of the forms observed at Canso.

The genus is not only one of the most characteristic, but one of the most abundant of plankton diatoms. It embraces a number of species, the synonymy of which is much confused. I shall only attempt to enumerate those of the diagnosis of which I feel certain. As Gran remarks, the arrangement of the chromatophores is often of considerable diagnostic value : I have found this so in the sketches where it has been noted.

The various species of Chaetoceras generally form chains of more or fewer individuals. Each individual is a shorter or longer cylinder, more or less flattened, the shell bounding which is formed of two valves with an intermediate hoop. The faces of the valves where they come in contact with adjoining individuals are provided with two bristles or setæ, which interlock with the adjoining bristles and diverge from the surface of the chain at an angle generally characteristic for the species. The more littoral species form spores which are peculiar in shape and decoration for the various species, but no such spores were observed during the summer at Canso.

Gran recognizes two subgenera Phaeoceras, in which the brownish chromatophores penetrate into the setæ (which are frequently spinous), and Hyalochaete, in which the setæ are hyaline.

To the former group belongs *C. boreale* Bail. (figs. 9 and 10), the cross section of the cell of which is nearly cylindrical ($24 \times 22{:}5\mu$), and the setæ, which are over 5 mm. long and spinous, are situated in the sagittal plane. The foramina, gaps in the chain between the individual cells, are hexagonal in outline. This form was common at Canso during July and August.

Of the species belonging to the second group, I shall first refer to *C. decipiens* (Plate II., fig. 8) which attracts attention on account of its considerable width which I have measured up to 75μ. The terminal bristles of the chain are shorter and stouter, bear transverse striæ, and are directed nearly parallel to the chain. It was the commonest species observed at Canso. Less common members of the same group were *C. didymum* Ehrb., *C. laciniosum* Schütt and *C. diadema* Ehrb. The first may be recognized by the lyrate foramina caused by a protuberance on the surface of the concave valves as well as by the position of the two chromatophores which fit up against these. In the second (fig. 1), the terminal setæ are wider in the middle and decorated with interrupted spiral lines of thickening. The third species betrays itself, when seen from the valve-surface, by the circumstance that of the four setæ two are in a sagittal plane and two in opposite directions of the transverse axis.

BACTERIASTRUM.—*Schadb.*

This genus is also exquisitely adapted for its floating life. It is composed of cylindrical joints like Chætoceras, but instead of each cell having only four bristles, sixteen may be observed in an end view projecting from the interval between contiguous cells and bifurcating as they radiate outwards (fig. 13). The species, *B. varians*, was observed towards the middle of September, the joints measuring 50 × 25μ, the basal part of the bristles 25μ, and the forks 60μ.

SKELETONEMA.—*Grev.*

This is another similar form, which, however, appears to depend on the slenderness of its cylinders and the tenuity of its siliceous coat for its floating power. The species observed, which is also recorded from the North Sea, is *S. costatum* (fig. 14), portions of the slender cylinders being ribbed. The frustules in the specimens observed measured about 40μ in length by 4 in width.

In addition to the foregoing plankton diatoms, many other of more littoral habit were frequently taken in the tow-nets. Especially is this true of certain forms like *Nitschia closterium* (fig. 18), or *N. longissima* (fig. 19) whose shape favours flotation, or like Striatella (fig. 15), whose siliceous shells are thin, and specific gravity therefore small, or like Licmophora (fig. 16*a* and b) which are frequently found attached to floating or swimming organisms like Copepoda. But there are again other forms, the shape of whose aggregations adapts them to a floating life; such are *Synedra nitschioides* (fig. 22), *Nitschia paradoxa* (fig. 17), whose cells perform the most remarkable evolutions, Tabellaria (fig. 24), and Rhabdonema (fig. 20).

PROTOCOCOIDEÆ.

TROCHISIA—*Kuetzing.*

This genus includes certain unicellular forms with a thick cell-wall generally ornamented with spines or ridge-like projections.

Tr. Clevei Lemm., or a representative of this species, occurring at the same time which the spines are imbedded (Plate III., fig. 1); it was common towards the end of July. The dimensions (the cell 31μ, spines 10μ) are somewhat different from those recorded by Lemmermann (No. 5), and the ends of the spines have more than two or three points, but these differences do not appear to have more than varietal significance.

Tr. Clevei Lemm., or a representative of this species, ocurring at the same time as the above, agrees on the whole in its dimensions (cell 72 — 93μ, spines 98 — 51μ), with Lemmermann's account, but the conformation of the spines is slightly different. There is no gelatinous envelope, the cell-wall is thin and the hyaline spines are often 'flaming' or divided at the end, and may vary in length and strength (Plate III., fig. 2).

Tr. dictyon (Joerg.) Lemm.—I find a single example of this species, the cell-wall of which is marked off by ledge-like ridges into quadrangular or pentangular areas, recorded in my sketches in September, 1901 (fig. 4). The cell measures 96μ in transverse diameter.

HEXASTERIAS.—*Cleve.*

Several examples of the type species of this genus *H. problematica* Cleve (Plate III., fig. 5), occurred towards the end of August, both in 1901 and 1902. It is characterized by 6 (or 7) arms projecting from a central disc about 40μ in diameter. The arms end in sharp recurved teeth. The contents become brown with chloride of zinc, but neither the arms nor the disc show a cellulose reaction. This form has hitherto been recorded from the North Sea, Iceland, and the neighbouring parts of the north Atlantic.

Another form was observed in August, 1902, which appears to be allied to the above, and which may provisionally be referred to the same genus. One surface of the central disc in this instance is vaulted, and each of the six projections is divided into three tapering curved spines, the middle one of each group being curved inwardly towards the flatter of the two surfaces of the disc. In the specimen observed the disc measured 68μ, the spines 40. For convenience the species may be called *H. spinatrifida* (Plate III., fig. 6.)

I was inclined to refer to the same group an organism which was met with once in an oyster's stomach at Malpeque (Plate III., fig. 4), and which is evidently identical with Hensen's 'Sternenhaarstatoblast' (*l.c.* Taf. IV., figs. 23 and 24). I notice, however, that Hensen describes ciliation in the interior of his cysts.

HALOSPHÆRA—Schmitz.

This genus occurs in the form of free-swimming globular cysts, within which the contents break up into swarm-spores.

H. viridis Schmitz, first observed at the Naples Zoological Station, is a very familiar and abundant element of the plankton in June and July. The youngest cells have diffused chlorophyll with scattered starch-grains and the nucleus is not visible. Eventually the protoplasm exhibits peripheral divisions. It is segmented into numerous cells, still connected by protoplasmic bridges (Plate III., fig. 7), which soon are broken, the individual cells fashioning themselves into monadiform swarm-spores (fig. 7*a*). The largest cells measured were 360μ in diameter.

SILICOFLAGELLATA.

'Cells without external membranes with one or two flagella, one central nucleus and frequently many yellowish brown chromatophores, living within a shell formed of solid or hollow siliceous rods. Reproduction unknown.'

The above is the diagnosis given by Lemmermann of this singular group of which I have found for the most part only empty shells belonging to the genera Distephanus and Ebria.

DISTEPHANUS—*Stöhr.*

D. speculum (Ehrenb.) Haeckel is met with in a variety which appears to be that named *regularis* by Lemmermann, as the radial spines from the basal hexagon (20 μ in diameter) are equal in length (15μ).

EBRIA—*Borgert.*

Ebria tripartita (Schum.) Lemmermann (Pl. III., fig. 9) was not uncommon in August. The genus differs from Distephanus in having a solid skeleton and two flagella. It has hitherto been recorded from the Baltic and the Gulf of Naples. The shells (which measure 20μ in diameter) or fragments thereof, frequently occur in the stomachs of oysters at Malpeque.

FORAMINIFERA.

Comparatively few forms were observed in the plankton, and some of these were undoubtedly young examples of bottom forms swept up by storms. Only once in September did a thoroughly planktonic form make its appearance, viz., a young Globigerina (æquilateralis ?) 150μ in diameter with short delicate spines.

Examples of a Pulvinulina and a Discorbina (Pl. IV., figs. 1 and 2) were less uncommon, the former indeed very frequent in July and August, while a few examples of a Spirillina (fig. 3) were observed in the latter month. A re-examination of these after a study of the benthonic forms would render a closer diagnosis possible.

RADIOLARIA.

Very few members of this class were observed at Canso. Jorgensen records some sixty species off the west coast of Norway, but only three of these were found at Canso. It appears that they are commoner in the open ocean. Of those found, two belong to Hæckel's group of the Acantharia and one to the Nassellaria.

Acanthonia echinoides (Clap. and Lach.) Hæckel (Pl. IV., fig. 4) was abundant in August in both of the years spent at Canso. So abundant, that when sporulating it could be seen in the form of distinct pink dots in the plankton.

The second and much rarer Acantharian is *Acanthostaurus pallidus* (Pl. IV., fig. 5) while the Nassellarian, only observed on two or three occasions, is the *Plagiacantha arachnoides* Clap. (fig. 6).

INFUSORIA CILIATA.

This class is represented in the plankton chiefly by the family of the Tintinnidæ, a group exquisitely adapted for pelagic life. It belongs to the order Heterotricha, suborder, Oligotrichidea, in which the ciliary covering is reduced to a few specialized tracts, that round the mouth being the most important. A genus, Strombidium, belonging to another family, Halteridæ, is, however, met with under the same circumstances, and shares the peculiar adoral series of membranellæ.

Strombidium sulcatum (C. and L.) was described from salt water at Bergen, but was observed to be very frequent at Canso in August, 1901. Its outline is somewhat oval, but the posterior end is provided with certain characteristic furrows and the anterior with a projecting beak broader at its extremity than at its origin. The observed dimensions were: $440 \times 266\mu$.

TINTINNIDAE.

In discussing this interesting group of characteristic plankton Infusoria, I shall follow the account given by Jorgensen in his recent discussion of the Norwegian forms. (No. 6.)

I have reproduced in Plate IV., fig. 7, the representation of the characteristic ciliation of this group given by Lang in his Text-book (Protozoa, fig. 53).

TINTINNUS—*Schrank.*

This is characterized by the tubular case being open posteriorly. *T. acuminatus* Clap. and Lach. (fig. 8) was seen only on one occasion, but it is readily recognized by the ridges which occur on the posterior third of the case. The specimen observed measured $258 \times 17\mu$. T. *obliquus* Clap. et Lach. (fig. 9) was only seen in July, both in 1901 and 1902. Apart from its smaller dimensions ($80 - 100 \times 14 - 19\mu$), it may be recognized by the absence of the flaring anterior aperture.

AMPHORELLA—*Daday.*

This, like most of the other genera, has no posterior aperture. The commonest species of this genus, *A. subulata* (Ehrb.) Dad. (fig. 10), is exceedingly abundant in the plankton in July and August. Its case is translucent, is furnished with a long posterior spine and is at once recognizable by the series of denticulated rings which adorn its anterior end and seem to indicate additions to the length of the tube. It appears to constitute a considerable element of the food of the oyster in Malpeque bay.

TINTINNOPSIS—*Stein.*

This differs from the foregoing in having the case beset with foreign material. Two of the species commonly occurring at Canso were easy of diagnosis, viz.: *T. campanula* (Ehrb.) Dad. and *T. beroidea* Stein (figs. 12 and 13). The dimensions of the average examples were in the former case 150 × 130μ; in the latter 43 × 19μ. But in addition to these, forms similar in their general shape to *A. subulata* were very common. T. *davidow* Daday has a total length of 95μ of which 65μ belongs to the spine; it is 40μ wide. The specimen figured (Plate IV., fig. 14) exhibits lines of growth and a fine punctulation of the case, where unconcealed by the foreign material. Another variety measures 45μ in width and 240μ in total length, of which 95μ belong to the spine, which is set on obliquely to the case. No rings were observed in this variety, and the punctulation was confined to the spine (Plate IV., fig. 15). *T. cylindrica* is distinguished by the peculiar form of the aboral end of the case, which lacks the spine of the above, but has a short handle-like process of irregular outline covered with foreign matter.

T. lobiancoi (fig. 16), a cylindrical form, test-tube like in shape, (190 x 45μ) may possibly be a variant of Jorgensen's *T. subacuta,* but no annulations were observed.

CODONELLA.—*Haeckel.*

C. ventricosus (Plate IV., fig. 11) was not uncommon in July. Its form, small dimensions (60 × 42μ) and constricted neck sufficiently distinguish it.

C. lagenula Clap. and Lach.—Common in Malpeque bay, is similar in form, but has no foreign particles adhering to the shell.

PTYCHOCYLIS.—*Brandt.*

P. urnula (Clap. et Lach.) Brandt is a small form very easily recognized by its hyaline case, which is provided with two annular swellings and a thinner slightly inverted and toothed lip (Plate IV., fig. 19). The example observed approached Jorgensen's var. *minor,* in its dimensions (96 × 75μ).

CYTTAROCYLIS—*Fol.*

This genus is characterized by a wall formed of two lamellæ united by transverse plates. The most abundant form at Canso was *C. denticulata* (Ehrb.) Fol var. *gigantea,* Brandt (Plate IV., fig. 18), the tubes of which with their delicate reticular sculpture and toothed orifice were very abundant in the plankton in June and July. The average dimensions of the Canso examples were 470 × 70μ, but shorter and stouter specimens occurred, approaching the variety *typica,* in which the length is only three times the breadth. The sculpture ceases as the case narrows to its delicate terminal spine, which is as a rule sharp, but occasionally terminates in a knob.

ECHINODERM LARVÆ.

Three of these were observed, viz., (1) The Pluteus of *Strongylocentrotus dröbachiensis* in its second stage. In addition to the two pairs of ciliated epaulettes at the base of the post-oral and posterior dorsal processes, there is a posterior ring. The greatest length of the larva, which occurred in the end of June and the beginning of July, is 1.25 mm. (Plate V., fig. 1). At a later date (2) an Ophiopluteus made its appearance on July 11 (fig. 2), and a comparison of my sketches with Mortensen's figures (Nordisches Plankton IX., 16) induces me to refer it to Ophioglypha, of which *O. robusta ayres* is the common species at Canso. My sketches, however, are not sufficient to give an accurate picture of the form of the skeleton (Plate V., fig. 2). Still later, on July 18, (3) the first Bipinnariæ of *Asterias vulgaris* were recorded (fig. 3).

TREMATODES.

A few examples of what has been supposed to be the pelagic egg of a Trematode were detected in both years; such at least, is the interpretation placed upon these by Canu (Ann. de la Station Aquicol. de Boulogne-sur-mer, Vol. I., pt. 2, p. 112, Plate VII., fig. 8-9). The Canso specimens are longer and comparatively slenderer 290 μ (of which 182 to tail) × 50, while Canu's measure 150 × 42.

The larvæ of *Hemiurus appendiculatus* Rud, and *Derogenes varicus,* O. F. Müller, diagnosed by Dr. Stafford, are found occasionally free, as well as in the interior of Copepods (*Acartia* sp. at Malpeque).

ANNELIDA.

Of the two families which are exquisitely pelagic in their habit, the Alciopidæ and the Tomopteridæ, only the latter was represented in the tow-net takings at Canso, and that by a single example taken out at sea in the end of August. (Plate V., fig. 5). From Apstein's account of the Tomopterids of the Plankton expedition, one would have expected that it would have turned out to be *T. helgolandica* or *T. septentrionalis,* but his excellent account enables me to diagnose it as a young example of *T. Mariana.* It measured 1.25 mm. in length, had the cephalic tenacles the two pair of tentacular cirri and five pair of parapodia developed, of which the two first carried yellow (phosphorescent ?) 'rosettes' on the basal joint, while the middle line of the back had some twelve distinct pink spots, which were also present on the tentacular cirri of the parapodia. No rosette was observed on the fin of the third pair of parapodia.

LARVAL FORMS.

Before any satisfactory account can be given of these, it will be necessary to work over the adult Annelids of the region. Two Spionid larvæ, one of them *Polydora ciliata,* were very common, but I propose to confine myself here to registering the occurrence of some forms of particular interest. The Polygordius larva (Plate V., fig. 6) was frequent in July, as was also a Mitraria larva (fig. 7), but my attention was more arrested by a larva developing within an egg-membrane of peculiar character, of the systematic position of which I have not been able to satisfy myself. The embryo in question was first observed towards the end of July in an early stage of segmentation, with a large space between it and the peculiar shell of some 225 μ in diameter. On the inner surface of the latter were to be seen numerous pear-shaped vesicles apparently opening to the exterior (fig. 8). Towards th end of the month a single cilated band had been established and later a well-marked anterior bunch of cilia as well as a posterior ring (fig. 9).

Still later two bunches of provisional setæ, some 130 μ in length, five in each bunch made their appearance (fig. 10), two brown eye-spots became obvious, and two caudal (sensory ?) organs were observed. The shell lost the peculiar pear-shaped vesicles as development advanced; it was perforated by the cilia and bristles, and eventually was ruptured by the escape of the larva. This I observed towards the middle of September, but only detected a single example of such a free larva.

Another developing embryo of larger size, 555 μ, related to the above, was also observed less frequently in September. The shell lacked the vesicular structures observed in the other case, but had a peculiar superficial sculpture and certain oval depressions (fig. 11) not related to the two ciliary rings whose cilia projected through the shell in separate tufts. Several of the oval areas were counted in front of the prostomial ring.

Since the above was written Leschke's paper* on the pelagic Polychæte larvæ of the Bay of Kiel has appeared, in which he records having met on one occasion with a larva similar to the former of these. He also cites previous records of similar occurrences which had escaped me, and from which I am able to state that the Canso larvæ obviously belong to the genus Nerine.

POLYZOA.

The only larval Polyzoan met with was the Cyphonautes larva of *Membranipora sp.* (fig. 12), which was abundant in June and July.

CRUSTACEA.

CLADOCERA.

Two genera were represented abundantly at Canso, viz.: Podon and Evadne. Of the former there were two species appearing at the end of July and of August respectively. I have not been able from my sketches to determine these with certainty, as the diagnostic features given by Timm and Hansen (the number of bristles on the exopodites of the various legs) are not recorded there. I suspect the earlier species, however, to be *P. polyphemoides* Leuckart, on account of its shorter tail lancets and smaller size, and the latter to be *P. intermedius* Lilljeborg. I find my sketches record that the caudal lancets of the larger species (Plate VI., fig. 1) are tinged with violet and toothed, also that the sculpture of the surface of the shell is different in the two species (figs. 1 and 2).

The two species of Evadne, however, are obviously *E. Nordmanni* Loven, and *E. spinifera* P. E. Müller, the former characterized by the greater elongation of the shell and the latter by the spine which it carries (fig. 3). The former species was abundant at the end of June, the latter common at the end of August. The first winter egg was observed in it on September 6.

OSTRACODA.

Only two species of this order were observed, neither belonging to the genus Conchoecia, so it is possible that the few examples observed are fresh water forms swept into the plankton.

COPEPODA.

Comparatively few of the numerous species of this interesting order occurring have been definitely diagnosed. The commonest forms are, however, recorded here.

SUBORDER GYMNOPLEA.

CALANIDAE.

Of this family the largest representative, a very abundant one in the earlier part of the summer, was *Calanus finmarchicus* Gunner. It attracts attention by its

*Leschke, Beiträge zur Kenntniss der pelagischen Polychaetenlarven der Kieler Föhrde. Wissenschaftl: Meeresunters: VII.-123. Cunningham and Ramage, Trans. Roy. Soc., Edin., XXXIII. Claparede & Metschnikoff Z. W. Z. XIX, p. 329. Krohn & Schneider Müller's Archiv, 1867, p. 498.

large size and by its transparent pale pink colouration. Fig. 4, Plate VI., is after Giesbrecht's figure of this species, and serves to call attention to the arrangement of the appendages in the order.

Pseudocalanus elongatus Boeck (Plate VI., fig. 5) was exceedingly abundant in July and August, and can be readily recognized by the orange pigment and the green of the vulvar region, as well as by the morphological features described by Giesbrecht. The eggs, about 100μ in diameter, are in a loose cluster, from 7 to 13, and spermatophores of 310μ length were frequently observed with a longer or shorter tube. The individuals frequently carried clusters of a diatom (*Lichmophora,* sp.). As Giesbrecht has noticed, the larva of *H. appendiculatus* (p. 12) is found in this copepod, but it also occurs in *Acartia bifilosa.*

CENTROPAGIDAE.

Both *Centropages hamatus* Lilljeborg (Plate V., fig. 6), and *C. typicus* Lilljeborg were observed, the latter much less abundant and appearing considerably later than the former. They may be readily distinguished by the different armature of the genital segment of the female.

Temora longicornis, O. F. Müller, a northern form, was also abundantly represented.

PONTELLIDAE.

Tortanus.—This generic name has recently been substituted by Giesbrecht for Corynura (preoccupied), and expresses the remarkable distortion of the abdominal region which characterizes the genus. One species of this genus (*T. discaudatus* I. C. Thompson and H. Scott), Plate VI., fig. 9, was exceedingly common at Canso from the end of July to the middle of August. It was first recorded by the authors named from the Gulf of St. Lawrence and afterwards observed by Wheeler at Wood's Hole and described as *Corynura bumpusii.* I have little to add to the excellent account furnished by him except to suggest an explanation for the distortion of the furcal region. The second post-genital segment of the female carries a bunch of stiff hairs adjacent to that on the first, while the second abdominal segment of the male has certain grooves on the chitinized projection formed by the right posterior angle, as well as a few scattered bristles. In the right antenna of the male the first joint distad of the knee (19-21) carries two pectinate ridges, while the 17th and 18th joints have one each (fig. 11).

The explanation for the distortion of the abdominal region of the female (which is also transmitted in a less degree to the male) is furnished, I believe, by the mode of attachment of the spermatophore, which I had occasion to observe very frequently. The spermatophore itself is over 1 mm. long by 125μ wide. It is attached to the genital segment, in the ordinary way by a conical cement piece, but a much larger piece of yellowish cement is plastered on to the large right furca and its spine, and is connected with the beginning of the efferent canal of the spermatophore by a solid cord of cement of the same appearance (fig. 10).

Some cases were noticed in which an attempt had been made to attach a second spermatophore; in such the supplementary supporting patch of cement did not succeed in finding anchorage.

SUBORDER PODOPLEA.

CYCLOPIDÆ.

Oithona plumifera Baird (fig. 8) is one of the commonest forms of this section, and apart from its form can be recognized by the bright-red elongated eye-spot and a certain faint orange tinge in the abdomen. The spermatophores are pyriform, with a short stalk, and measure about 70μ.

HARPACTICIDAE.

Microsetella atlantica Brady and Robertson (fig. 12) was frequently taken in the beginning of July. Ripe females are readily recognized by the long setæ, as long as the body (547 μ), the orange-red colouring which extends to the eggs disposed in a single packet underneath the abdomen, and the denticulation on the segments.

Harpacticus chelifer (fig. 13) is also common.

AMPHIPODA.

The commonest member of this order in the Canso plankton is *Euthemisto compressa* Goes, Plate VI., fig. 14. It was most abundant in June.

DECAPODA.

Throughout the month of July there was plenty of opportunity of observing the various larval phases of Cancer and two species of Pagurus. One of the latter which occurred towards the end of the month differed from the figures I have studied by the presence of sixteen setæ on the telson, and a rostrum which only reached to the middle of the basal joint of the antennulæ.

UNIDENTIFIED EGGS.

Two pelagic eggs are of very frequent occurrence. One of these (Plate VII., figs. 1 and 2) is that of a gastropod and is contained in a horny capsule which suggests in its shape a low wide-brimmed hat, and resembles closely the figures given by Hensen (l.c. Taf. IV., fig. 25-30) of his 'Barbierbecken-statoblast.'

A further resemblance to his figure 25 is that two eggs are frequently found in the cavity of the capsule. The dimensions, however, of these structures do not agree for whereas the whole capsule of Hensen's statoblast merely measures 200 μ, that of the egg in question is 675 — 775 μ, the flat rim measuring 140 — 160 μ or so, the capsule proper some 400 μ; its cavity, (or cavities if there are two eggs) 140 — 150 μ, and the unsegmented egg about 120 μ. Segmentation had begun towards the end of June, the spheres having a certain pinkish hue by reflected light. By the eighth of July the shell and velar cilia could be made out. Larvæ ready to escape were observed up till the middle of August, but were not recognized in the plankton nor referred to the parent mollusc. Fig. 3 is a rough sketch of the shelled larva. I have not found any pelagic gastropod egg-capsules referred to in any of the literature accessible to me.

The second egg-capsule, commoner than the foregoing, I have not been able to localize even as definitely. It has something of the same form (fig. 4), viz., a subglobular capsule of 120 μ in diameter, with a thin rim 100 μ broad, which, however, unlike the former, does not lie entirely in the same plane, but is often much curled. The capsule is yellowish in colour and the rim shows a network of fine fibres (fig. 5). Empty capsules were common, and embryos (fig. 6) were observed in July and August within others, but I did not succeed in diagnosing them. These egg-capsules, when deserted, were frequently occupied by a species of Chytridium.

Among the numerous gastropod veligers found at Canso that of *Aeolis despecta* (fig. 7) was particularly common and attracted attention by its pellucid shell. Larvæ of the following Pteropods were also found, Clione aurantiaca (fig. 8) and two species of Hyalaeaceæ (figs. 9 and 10).

TUNICATA.

Although this Phylum furnishes a very large number of interesting forms belonging to the plankton, the only members of it found at Canso belong to the class *Copelata,* which permanently retain the tail and notochord of the larval Tunicate.

The excellent account by Lohmann of the forms belonging to this class, secured on the Plankton Expedition, renders diagnosis easy of the three forms found at Canso. Two families are recognized by him, one Kowaleskidæ, distinguished by the absence of the endostyle, the other Appendicularidæ, embracing all the remaining genera of the group. It is to the latter family that all the three species under consideration belong. The first of these to appear during the early part of July was ***Fritillaria borealis*** Lohmann (Plate VII., fig. 11). The length of the trunk of the example figured was 540μ, of the tail 1 mm. Projecting from the lateral edges of the trunk posteriorly are two processes like those which mark the species *F. pellucida.* No signs of the 'house' of the species were observed.

The two remaining species belong to the genus Oikopleura, distinguished from the foregoing by the plumper form, and by the circumstance that the fin of the tail begins at its attachment, not at some distance therefrom as in Fritillaria. ***O. labradoriensis*** Lohmann replaced the foregoing during the latter end of July, while ***O. dioica*** Fol was very abundant in the latter part of August. These can be at once separated by the fact that the former has some 16-18 globular 'sub-chordal' cells under the notochord in the latter half of the tail, while *O. dioica* (figs. 12, 13) has two stellate cells in the same position. It is the only dioecious species; ripe females with eggs 70μ in diameter were observed on August 20. Although like other strictly pelagic creatures for the most part transparent, *O. dioica* shows some traces of pigment in its intestinal tract, the œosphagus having a faint pinkish hue, while the rest of the intestinal wall, and especially the large gastric cells of the left compartment of the stomach, are decidedly violet. This species appears to live on a small green Flagellate (8μ in diameter) which I only observed in its stomach.

NOTE.—Through inadvertence some of the literature has been cited in the text, and some by the numbers which follow:—

No. 1. Hensen.—Ueber die Bestimmung des Planktons.—Berlin, 1887.

No. 2. Schütt.—Die Peridineen der Plankton-Expedition.—Kiel and Leipzig. 1895.

No. 3. Jorgenson.—Protophyten and Protozoen.—Bergens Museums Aarbog, 1899.

No. 4. Gran.—Protophyta. Norwegian North Atlantic Expedition.

No. 5. Lemmermann.—Nordisches Plankton.—2te Lieferung.

No. 6. Jorgenson.—Tintinodeen der Norwegischen West-Küste. Bergens Museums Aarbog, 1899.

EXPLANATION OF PLATES.

PLATE I.

FIG. 1. Exuviaella marina. × 600.
2. Prorocentrum micans. × 600.
3. Pyrocystis lunula, globular stage. × 250.
4. " with contained crescents.
5. Pyrocystis lunula with contained Gymnodinia. × 250.
5a. A single Gymnodinium. × 500.
6. Pyrocystis sp. × 150.
7. Gymnodinium sp. × 400.
8. Pouchetia ochrea. × 400.
9. Gymnodinium gracile. × 250.
10. Dinophysis norvegica. × 450.
11. Dinophysis rotundata. × 450.

12 a and b. Pyrophacus horologium. × 300.
13. Protoceratium reticulatum. × 400.
14. Gonyaulax spinifera. × 400.
15 a and c. Peridinium reniforme. × 200.
16. Peridinium lenticulare. × 300.
17. Peridinium pellucidum. × 300.
18. Peridinium ovatum. × 400.
20. Ceratium fusus. × 100.
21 a and b. Gymnaster asterias. × 600.

PLATE II.

FIG. 1. Coscinodiscus concinnus. × 100.
2. Coscinodiscus from side.
3. Coscinodiscus centralis. × 150.
4. Actinoptychus undulatus. × 250.
5. Rhizosolenia setigera. × 200.
6. Rhizosolenia styliformis. × 200.
7. Rhizosolenia setigera. × 500.
8. Chætoceras decipiens. × 150.
9. Chætoceras boreale. × 350, end-view of chain.
10. Chætoceras boreale. Girdle-view of end of chain.
11., 12. } Chæeoceras dichaeta, side view. × 250.
13. Bacteriastrum varians. × 250.
14. Skeletonema costatum. × 600.
15. Striatella unipunctata. × 350.
16. Licmophora lingbyei. × 350.
17. Nitschia (Bacillaria) paradoxa. × 400.
18. Nitschia closterium. × 300.
19. Nitschia longissima.
20. Rhabdonema sp.
21. Paralia sulcata.
22. Synedra (Thalassiothrix) nitschioides. × 350.
23. Actinocyclus Ralfssi. × 250.
24. Tabellaria sp.

PLATE III.

FIG. 1. Trochisia brachiolata. × 400
2. Trochisia Clevei. × 300
3. Trochisia dictyon. × 300
4. Undetermined organism, similar to Hensen's 'Sternenhaar-statoblast.'
5. Hexasterias problematica. × 450
6. Hexasterias spina-trifida. × 300
7. Halosphæra viridis. × 150
7a. One of the swarmspores.
8. Distephanus speculum. × 1000
9. Ebria tripartita. × 750
10a, b, c and d. Eutreptia sp. growing in old boat at Canso, from side. × 1250, 10*a* from mouth, 10*b* to show pyrenoid, 10*c* development in cyst.
11. Chrysomonad.

PLATE IV.

FIG. 1. Globigerina sp.
2. Discorbina sp.
3. Spirillina sp.
4. Acanthonia echinoides.
5. Acanthostaurus pallidus.
6. Plagiacantha arachnoides.
7. Diagram of ciliation of a Tintinnid after Lang.
8. Tintinnus acuminatus. × 175
9. Tintinnus obliquus. × 350
10. Amphorella subulata.
11. Codonella ventricosa. × 600
12. Tintinnopsis campanula. × 250
13. Tintinnopsis beroidea. × 600
14. Tintinnopsis davidoffi. × 200
15. Tintinnopsis davidoffi var:
16. Tintinnopsis davidoffi var cylindrica.
17. Tintinnopsis lobiancoi.
18. Cyttarocylis denticulata gigantea. × 125
19. Ptychocylis urnula. × 250

PLATE V.

FIG. 1. Pluteus of Strongylocentrotus droebachiensis.
2. Pluteus of Ophioglypha.
3. Bipinnaria of Asterias vulgaris.
4. Canu's Trematode egg ?
5. Tomopteris Mariana.
6. Polygordius larva.
7. Mitraria larva.
8., 9. Annelid larva (Nerine sp.) within egg-membrane.
10. Provisional setæ of larva.
11. Another allied larva.
12. Cyphonautes larva.
13. Sagitta sp.
14. Shell of Pteropod larva ?

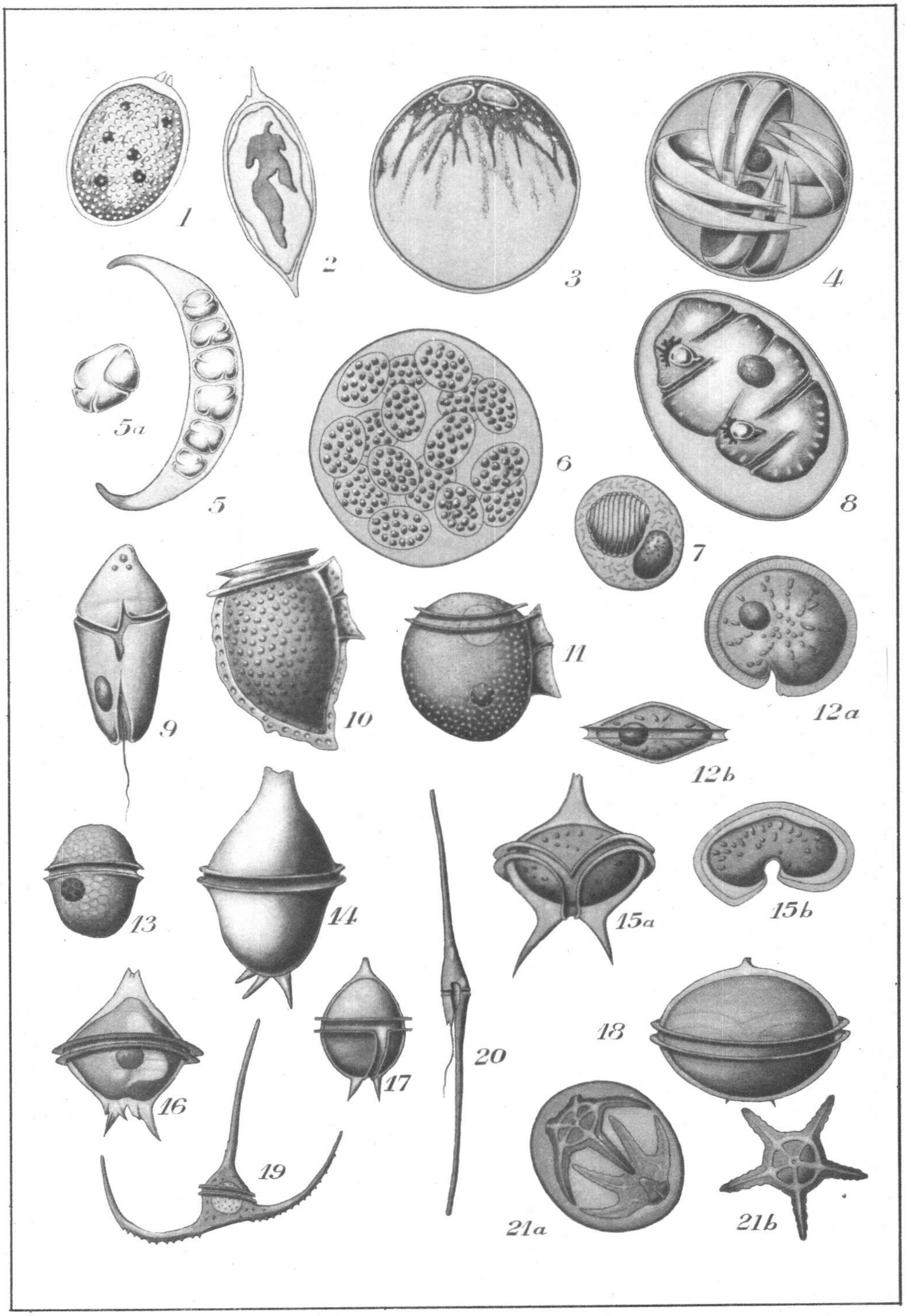
PLATE VI.

FIG. 1. Podon intermedius.
2. Sculpture of shell of P. polyphemoides?
3. Evadne spinifera.
4. Calanus finmarchicus, after Giesbrecht.
5. Pseudocalanus elongatus.
6. Centropages hamatus.
7. Temora longicornis.
8. Oithona plumifera.
9. Tortanus discaudatus.
10. Abdomen of Tortanus fem. with spermatophore attached to furca.
11. Part of grasping antenna of Tortanus.
12. Microsetella atlantica.
13. Harpacticus chelifer.
14. Euthemisto compressa.

PLATE VII.

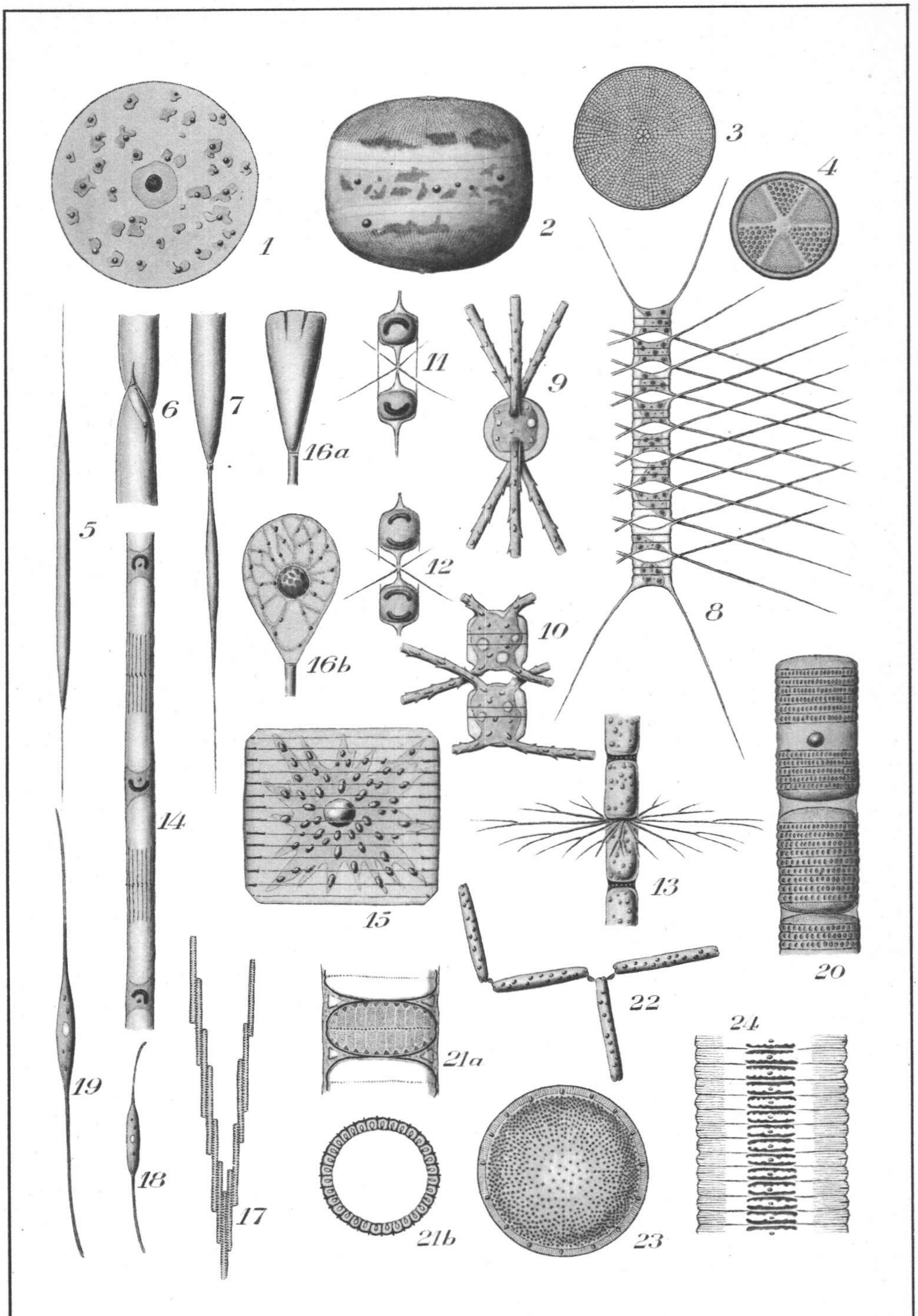
FIG. 1. Undetermined pelagic gastropod egg.
2. Undetermined pelagic gastropod egg.
3. Contained larva with shell.
4. Undetermined pelagic egg.
5. Structure of flange of same.
6. Contained larva.
7. Larva of Eolis despecta.
8. Larva of Clione aurantiaca. × 30.
9., 10. Larval shell of Hyalaeaceæ. × 150.
11. Fritillaria borealis.
12. Oikopleura dioica.
13. Oikopleura dioica, the tail with subchordal cells.

PLATE I.



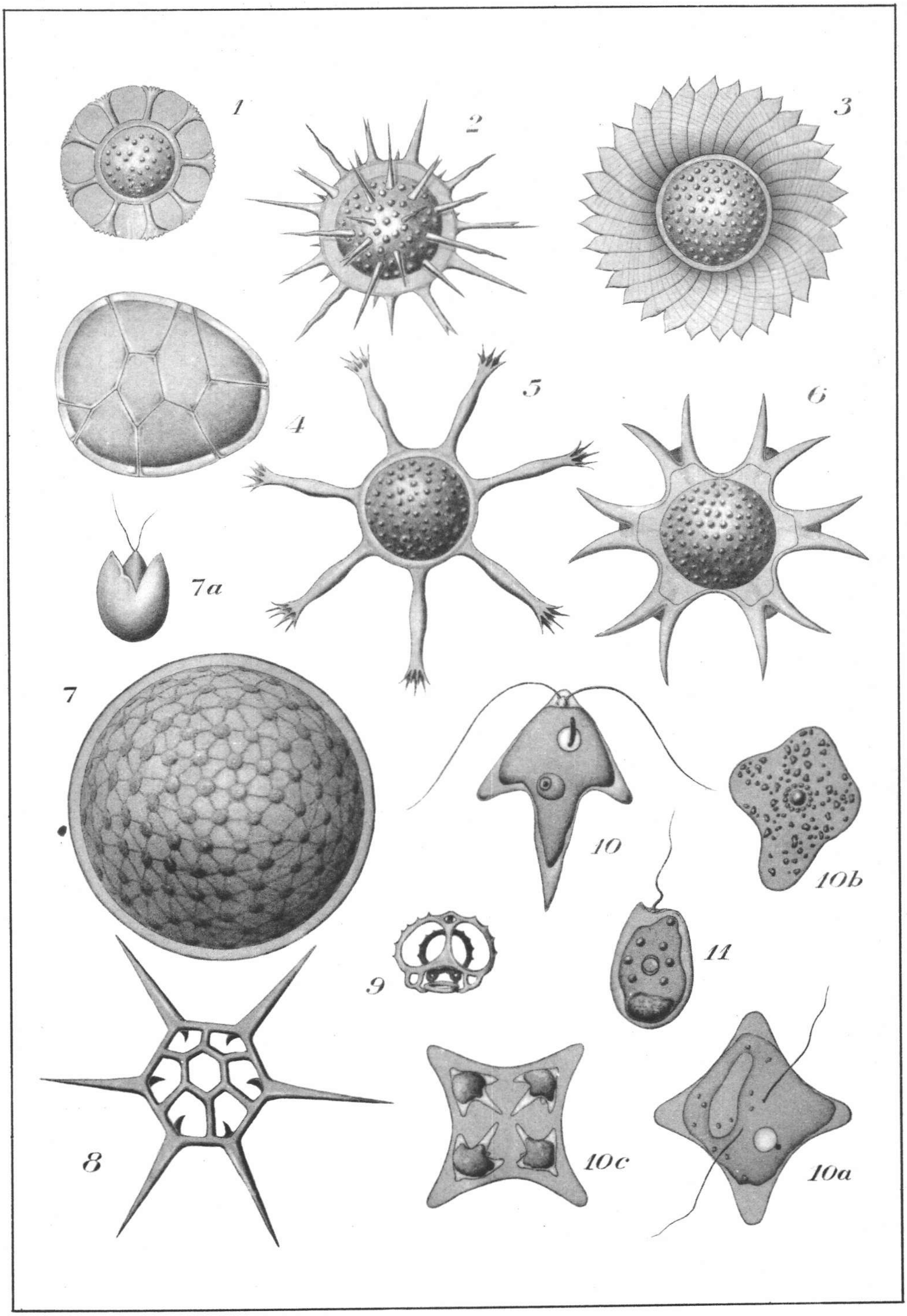
J. R. G. Murray after sketches by R. Ramsay Wright.

PLATE II.



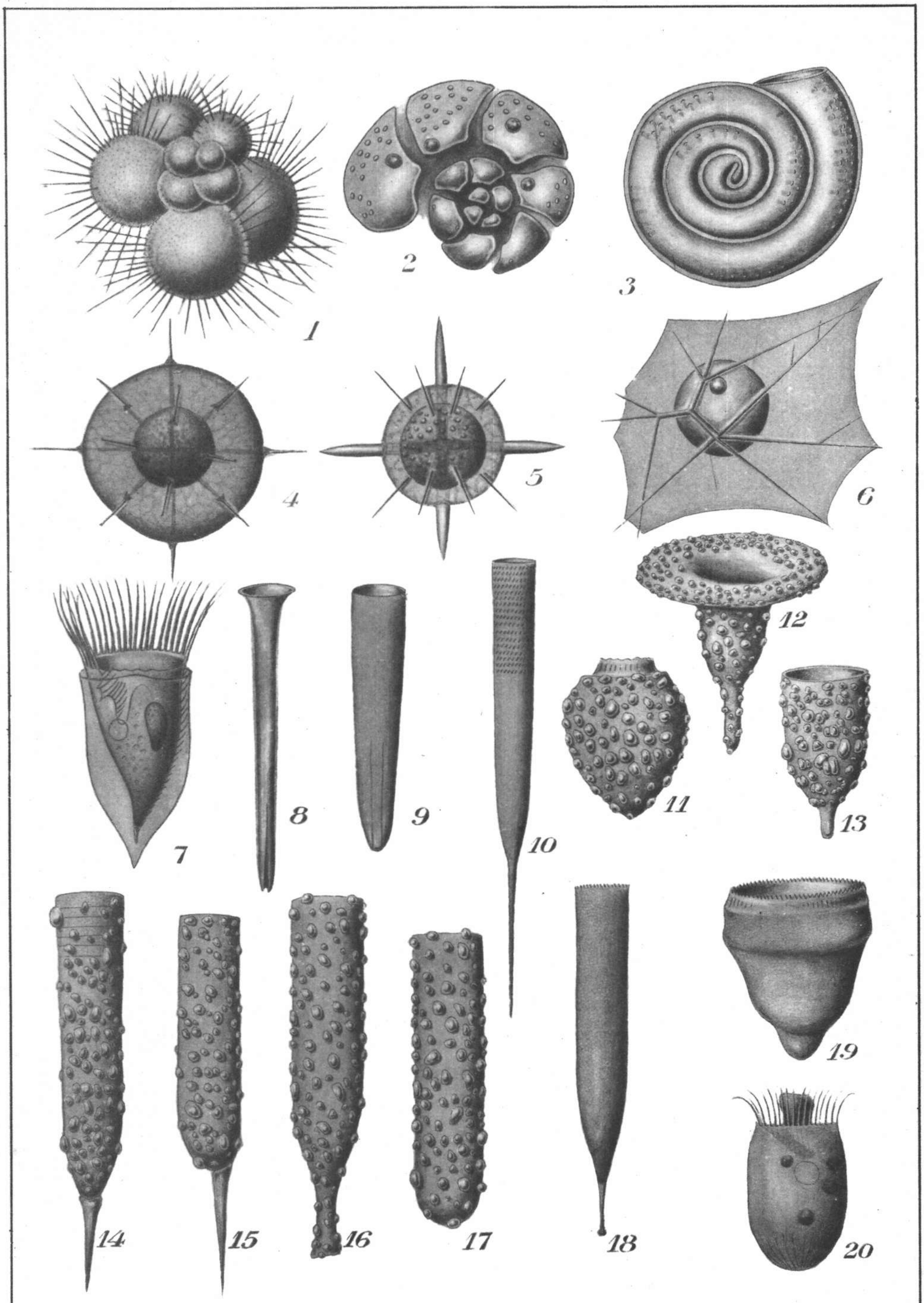
J. R. G. Murray after sketches by R. Ramsay Wright.

PLATE III.



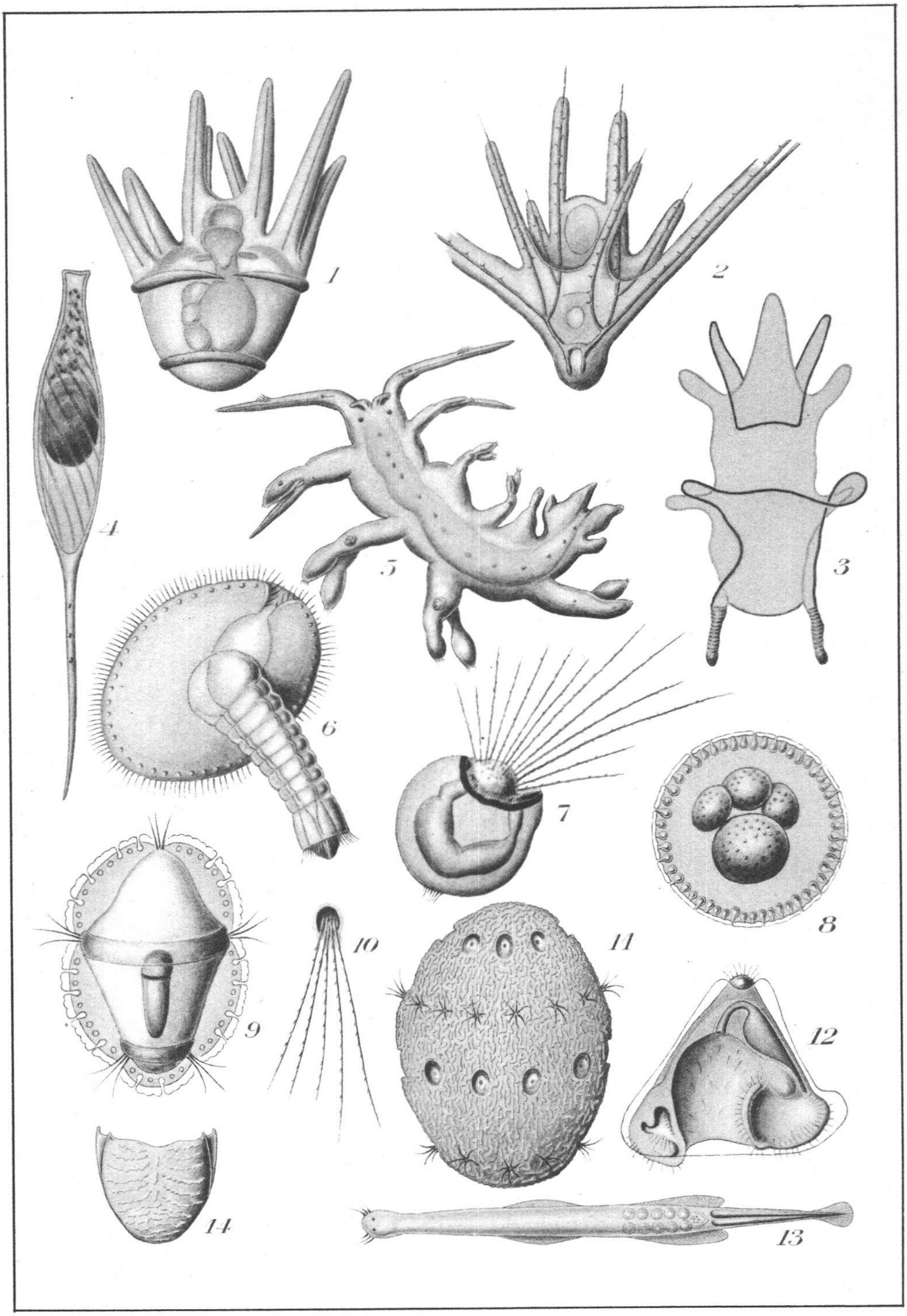
J. R. G. Murray after sketches by R. Ramsay Wright.

PLATE IV.



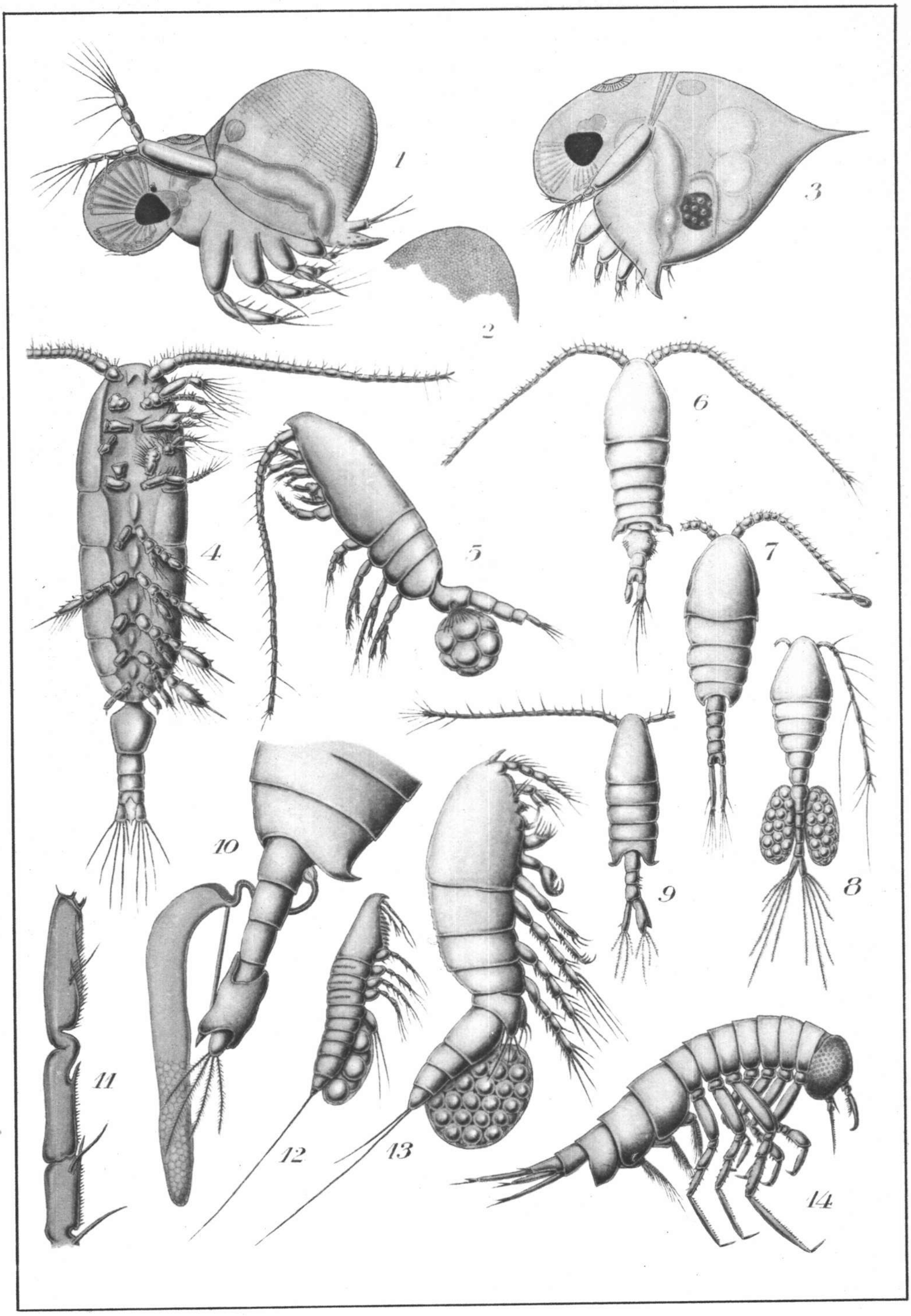
J. R. G. Murray after sketches by R. Ramsay Wright.

PLATE V.



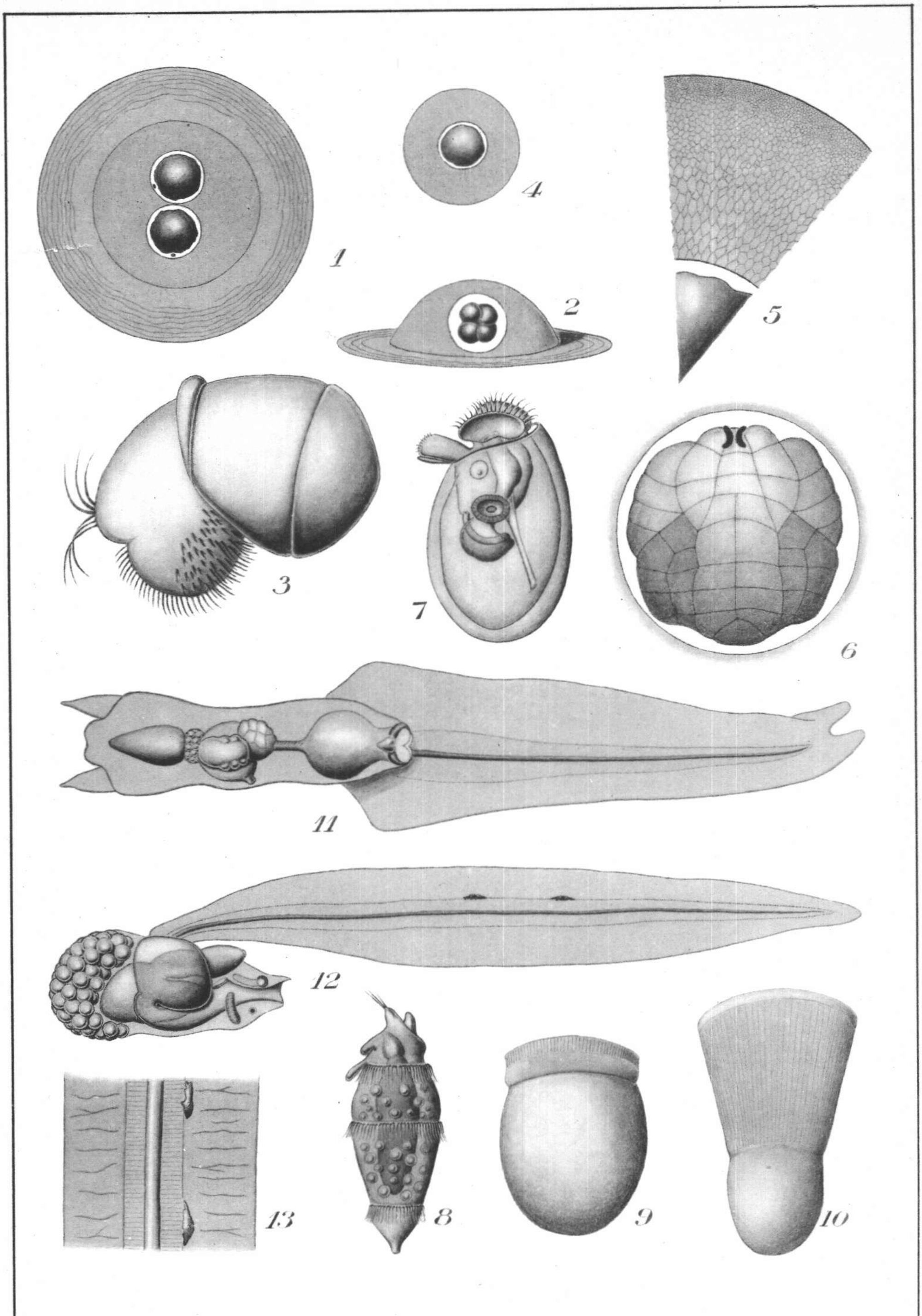
J. R. G. Murray after sketches by R. Ramsay Wright.

PLATE VI.



J. R. G. Murray after sketches by R. Ramsay Wright.

PLATE VII.



J. R. G. Murray after sketches by R. Ramsay Wright.