THE NORWEGIAN NORTH POLAR EXPEDITION 1893—1896

SCIENTIFIC RESULTS

EDITED BY

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VOLUME V

PUBLISHED BY THE FRIDTJOF NANSEN FUND
FOR THE ADVANCEMENT OF SCIENCE

CHRISTIANIA
JACOB DYBWAD

LONDON,
NEW YORK, BOMBAY
LONGMANS, GREEN, AND CO.

LEIPZIG
F. A. BROCKHAUS

1906

Nansen, F., 1906. Protozoa on the ice-floes of the North Polar Sea. In: F. Nansen (Editor), The Norwegian North Polar Expedition 1893 1896. [Scientific Results, 5 (16)] Longrnans, Green and Comp., London, 22 pp.

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XVI.

PROTOZOA ON THE ICE-FLOES OF THE NORTH POLAR SEA

BY

FRIDTJOF NANSEN.

(WITH 8 PLATES.)

INTRODUCTORY REMARKS.

During my first visit to the East Greenland Sea in 1882, I noticed that in the summer, when the surface of the ice-floes was much melted, it got a very dirty and often brownish colour[1]. This was especially noticeable on thick and very old ice-floes — what I call the real polar ice — which evidently came drifting southward along the East Greenland Coast from very high latitudes, probably after having crossed the then unknown sea near the North Pole. I supposed that this dirty brownish colour was chiefly due to dust from the atmosphere brought down on the ice by falling snow. To some smaller extent I thought it might also be due to impurities or organisms in the sea-water which had been frozen into the ice, and which were now aggregated by the gradual melting of the ice at the surface. During this voyage I also noticed another feature, viz. that the thinner and comparatively new ice, one or two feet thick was frequently coloured reddish brown on the under side[2]. By examination under the microscope on May 9, 1882, I found that the colour was due to a layer of *algae*, chiefly *diatoms*[3], adhering to the underside of the ice, I had, however, no opportunity, nor the knowledge then sufficient to pay more attention to these highly interesting features.

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[1] See "*Naturen*", vol. XI, Bergen 1887, p. 214.

[2] This ice with a red underside was called "seal-ice" by the sealers, because they said that the seal preferred to lie on floes of that kind. This might not be improbable; for where there are so many diatoms in the water, there are probably also many crustacea, which form the food of the seal (*Phoca groenlandica*).

[3] According to the drawings I then made, the diatoms seem to have been *Coscinodiscus, Fragilaria, Navicula directa,* and others.

In 1888, I again saw the North polar ice in the Denmark Strait, on my way to the crossing of Greenland. I then used the opportunity of collecting a few samples of the mud on the ice-floes. One sample was taken from a thick layer of mud which had evidently somewhere come from the neighbourhood of land, whilst another smaller sample was collected from a greater area of the ordinary ice-surface, which had the common dirty appearance. The ice-floes from which the samples were taken were very old and thick; they had evidently drifted in the sea for several years, and had probably crossed the North Polar Basin. These samples were afterwards examined and described by Dr. A. E. Törnebohm and Professor P. T. Cleve[1].

Dr. A. E. Törnebohm found the samples to be largely composed of mineral grains of different kinds. But the mineral grains in the smaller sample, collected from the greater area of the dirty ice-surface, were extremely small and difficult to determine. In this sample a great many diatoms also occurred, which were examined by Professor Cleve who found 16 species and varieties, which were all of them identical with species of diatoms collected by Kjellman, during the Vega Expedition (in 1879), on an ice-floe near Cape Wankarema on the north-east coast of Siberia, near Bering Straits. These diatoms had been described by Cleve in 1883, and twelve of the sixteen species, found in my samples from the Denmark Strait, were hitherto only known from the ice-floe near Cape Wankarema. This seemed to indicate that the ice I had seen in the Denmark Strait, had actually come from the Siberian side of the North Polare Basin; as I had already assumed for other reasons. But how the diatoms had come on to the surface of the ice, or where they had originally lived neither Cleve nor I could tell[2].

During the Expedition with the Fram, I had my attention directed towards all kinds of dust on the ice-floes. In the summer of 1894 the snow and ice on the surface of the floe-ice was melted by the sun, and ponds of fresh water were formed on the floes round the Fram. This began in the first part of June. On June 11th, 1894, I noted in my diary that the ice was rapidly

[1] H. Mohn and F. Nansen, Wissenschaftliche Ergebnisse von Dr. F. Nansens Durchquerung von Grönland 1888. *Petermann's Mitteilungen*, Ergänzungsheft No. 105, 1892, pp. 104—108.

[2] Professor H. H. Gran, has given a full account of what has been written about diatoms from the polar ice, in vol. IV, No. 11, pp. 5 *et seq.*, of this Report. Most of the papers there cited by him were, however, published after our departure in 1893.

melting on the surface, and many great and small fresh-waterponds had been formed on the floes, so much so that it was not even agreeable to walk about without water-tight shoes. We were then in about 81° 39′ N. Lat. and 122° 9′ E. Long.

In July I observed that numerous small brownish specks or, as it were, small accumulations of sediment were beginning to form on the ice-bottom of most fresh-water-ponds, especially on the thick floes which had been formed before the previous winter. Similar brownish spots were also formed on the socalled "ice-foot" in the channels along the margin of the floes[1]. By examing these brownish accumulations, from the bottom of the ponds and from the "ice-foot", under the microscope, I found in the midle of July, to my aston-

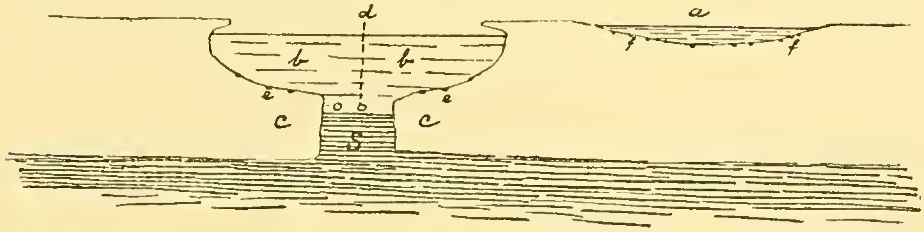

Fig. A. Diagram illustrative of the melting of the ice. *a*, Pond of fresh water on the ice-floe. *b*, Layer of fresh melting-water, resting on sea-water (*S*). *c*, Ice-foot. *d*, Lumps of algæ floating near boundary between fresh-water and sea-water. *e*, Small accumulations of algæ on ice-foot. *f*, Small accumulation of algæ in the pond on the ice.

ishment that they were composed of algæ, chiefly diatoms, living and multiplying in this water on the ice; to some smaller extent they were also composed of a little mineral dust and of dead fragments of diatoms, *Chætoceras*, *Coscinodiscus* etc., which had evidently been frozen into the ice on its formation; and their shell-fragments had now when the surface layers of the ice melted, been set free again and gathered on the bottom of the ponds and on the ice-foot. But among the living diatoms I also observed a good many moving organisms of various kinds. The biggest and most conspicuous

[1] By the melting of the snow and of the upper layers of the floe-ice a good deal of nearly fresh water (with a salinity of 1 or 2 per mille) is formed during the warmest summer months, June, July and the beginning of August. This water either accumulates in hollows in the floes to form ponds (Fig. A, *a*), or runs off into the channels and cracks between the flows where it forms a layer (Fig. A, *b*), 1 or 2 metres thick (see Memoir No. 9, vol. III pp. 305—309) of nearly fresh water resting on the cold sea-water (Fig. A, *S*). This surface layer of water becomes comparatively warm and has therefore a corrosive effect upon the edges of the floes by melting away the ice near the water level, whilst the lower part of the ice situated in the very cold sea-water is not affected, and it consequently projects, often several feet (see Fig. A, *c*), and is called the ice-foot.

were *Infusoria*, but numerous smaller organisms of great mobility belonging to the *Flagellata* or similar groups, were also observed and studied. In nearly all samples of these brownish accumulations I also very frequently observed a comparatively big bassilum, of a simple rodlike appearance, rapidly oscillating, and often forming long chains.

The brown spots on the bottom of the ponds (Fig. A, *f*) and on the ice-foot (Fig. A, *e*) grew gradually larger from day to day; but owing to their dark brownish colour they absorbed more heat from the sun than the surrounding white ice, and then the ice under them was more rapidly melted away, and they sank deeper and deeper into the ice, and formed small cylindrical holes (Fig. B) often several inches deep and perhaps an inch or more in diameter, with very sharp and square edges. The bottom of these vertical holes, was gradually quite filled with a brownish mass of diatoms, which could easily be sucked up with a glass tube.

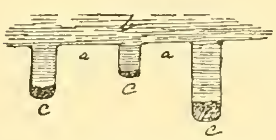

Fig. B. Diagram illustrative of the accumulation of algæ in holes on the bottom of ponds on the ice. *a*, Ice. *b*, Fresh-water. *c*, Holes.

In the channels between the ice-floes, especially in the narrow ones, where there was very little movement in the water, both Dr. BLESSING and myself observed in July, 1894, numerous small globular lumps, generally of a reddish colour, or sometimes with a more bleaked whitish colour. These floating lumps grew rapidly larger from day to day; they began as small, hardly visible specks, but eventually attained considerable size, one or two inches in diameter, or even much more.

In my diary for July 18th, 1894, I find the following remarks about these lumps floating in the channels between the floes: First I mention mucous greenish brown masses composed solely of a brown alga, *Melosira*[1], which occurred often in great abundance at a certain depth (of about 1 metre or more) "almost in every small channel, especially the more enclosed ones, and one could see, that on the sides of the ice-floes, at a certain depth, a greenish brown layer spread over the surface of the ice, and far down into the water. It looked as if it was the same alga which here grew on the ice". I then

[1] In 1882 I found quantities of this alga in the stomach of a bear, who seems to eat them as vegetable food.

state that "in the water a great deal of smaller mucous lumps were also floating; they were partly white partly yellowish red, and I collected many of them. Under the microscope they appeared to be composed of accumulations of diatoms and a great many round red cells (see Pl. VIII, Figs. 7 & 8) filled with round refractive red globules". This large, globular alga (Pl. VIII, Fig. 7 & 8) gave the lumps their reddish colour, where, however, this alga had died and become colourless, the lumps got a white appearance externally. "These lumps of diatoms and algæ were all of them floating at a certain depth, about 1 metre[1] under the water-surface, where in some small channels they might occur in great quantity. At the same depth the above mentioned greenish brown alga (*Melosira*) was also chiefly distributed, whilst parts of it rose to the surface. These parts were often greenish brown as usual, but also often whitish and were evidently dead. It is clear that the lumps of diatoms as well as the *Melosira* keep themselves floating just at the depth where the upper layer of fresh-water (melting-water from the ice) rests on the underlying salt sea-water. The water on the surface was perfectly fresh[2] (*i. e.* it could be used as drinking water) and the lumps of diatoms sank in it, whilst they floated when they came lower down". (Fig. A, *d*).

These floating lumps composed of diatoms and the unknown red globular alga (Pl. VIII, Figs. 7 & 8) were very fragile and fell to pieces as soon as they were touched. They therefore had to be collected with great care. In these lumps I also found numerous *Infusoria*, and other small protozoa moving about between the diatoms; they were very similar to those found in the accumulations of diatoms in the ponds on the ice-floes.

The diatoms found in these free-floating lumps, as well as on the "ice-foot" and in the ponds on the ice have been described by Professor H. H. Gran in a special memoir (No. 11, in vol. IV of this Report).

I studied on the spot, as well as I could, the Infusoria and other Protozoa found along with these diatoms, and at the same time I made numerous drawings of them, some of which have been reproduced on Pls. I—VIII.

Not being conversant with the subject and having no literature of the kind at hand, I could not determine the species, but could only make

[1] Somewhat later in the season, the thickness of the layer approached 2 metres, at least in some channels.

[2] It contained between 1 and 2 per mille salt.

drawings and notes of what I saw; I hoped however that I should later get an opportunity of studying them more closely. My time was taken up in many ways, so that I could not give much time to them then, and before the middle of August, 1894, the ponds and channels between the floes were covered all over with ice, and I finally got no further opportunity of studying them at all, as I left the Fram on a sledge journey before the next summer.

Since my return from the expedition I have been occupied with other investigations, and have not been able to give any time to the matter.

Miss KRISTINE BONNEVIE has, however, done me the great favour of looking through my drawings and notes and of selecting those figures which may be of most interest. They are here reproduced on Pls. I—VIII. I owe her much gratitude for her very valuable assistance. We both agree, that the material at hand is hardly sufficient for the determination of the species even in the hands of an expert on the subject.

As it appeared possible, however, that my observations, imperfect though they are, might be of some interest to future students of this matter, I publish them in the form they were brought home. They may at least serve to draw the attention of future travellers to this interesting life on the drifting ice-floes of the North Polar Sea.

It might seem puzzling, how these organisms have got into the ice in the first place. The probability is that they, or rather germs of them, have been frozen into the ice when it was formed at the surface of the sea. When the ice again melted the germs developed in the ponds on the ice in the same way as the diatoms, and were also carried by the melting water into the channels between the floes.

It seems probable therefore that these infusoria were of marine origin like most diatoms found in the same ponds. The water of these ponds contained, however, only between 1 and 2 ‰ salt.

It seems hardly probable that the infusoria could have been carried by the wind through the air. Some of them were found on comparatively white and clean floes, which had been formed during the previous autumn and winter, far from any sea-shore or open water.

LACRYMARIA, sp.

Pl. I, Figs. 1—14; Pl. II, Figs. 5—7.

This infusorium occurred very commonly both in the free-floating lumps of algæ, in the channels between the ice-floes, and in the accumulations of diatoms in the ponds on the ice. The individuals were as a rule transparent and colourless, but in some ponds on the ice I also found numerous animals of exactly the same external appearance and shape, but which were dark-green, or almost black. The normal, transparent form will first be described.

When it moved actively about, as was generally the case, it had a more or less elongated form (Pl. I, Figs. 1, 2, 14). The body was very mobile and could be stretched out and become rather slender (Figs. 2 and 14) or it could be shortened and become thicker (Figs. 1 and 3, Fig. 1 is the same individual as Fig. 2) or it could even be contracted into a spheroidal, motionless globe (Fig. 10). When the body was stretched out, it could bend in a worm-like manner (Fig. 2) and then it could rapidly wind its way between the diatoms, or could swim freely through the water while its body generally rotated slowly round its longitudinal axis. The length of the body of well developed individuals might, under these conditions, be 0·10 mm. (Fig. 1) or more.

At the anterior end there was a *proboscis*-like protuberance, which during activity could be pushed out and bent vigorously to the sides whilst, in a more quiescent state when the animal was contracted into a spheroidal form, the proboscis was partly retracted. This proboscis was provided with numerous long cilia, which were in perpetual active motion. Whether these long cilia were actually fixed to the proboscis, or merely situated at its base, surrounding it, was not ascertained. The surface of the body was provided with somewhat shorter not very dense cilia. They were somewhat more numerous at the posterior end.

In most individuals furrows could be seen, winding in left handed spirals along the outside of the body (Figs. 3—7, 13—14).

As far as I could make out, the spirally wound ribs thus produced, were seven in number (at least on the anterior part) and ended in seven(?) lobes round the proboscis (see Fig. 5, where four of these lobes are seen). These ribs could sometimes also be seen on the posterior end (Fig. 3).

On several occasions I believed I was able to make out that the eilia on the surface of the body, were situated along the spirally wound furrows.

Some individuals did not, however, show any indications of these spirally wound furrows. This was, for instance, the case with the one, illustrated in Figs. 1 and 2. This specimen was on the whole very big and well fed, and it is possible that the furrows may have apparently disappeared, owing to the abundance of food which had dilated the outer membrane. I consider this explanation more feasible than that this was another species. It behaved othervise in every respect, like the other specimens.

The nucleus of the animal was situated in its central region, and was, as seen in individuals killed with osmic acid, sometimes oblong (Figs. 6—8), and sometimes extended into four branches (Figs. 4—5).

A vacuole was very frequently seen in the posterior region (Figs. 4, 5, 14). It was sometimes divided into three smaller vacuoles (Fig. 10).

The cell-contents were as a rule, at least in the outer layer, filled with numerous globules (see Figs. 1 and 2), which were probably drops of oily substance (nourishment) dispersed in the protoplasm. These globules were more sharply defined by the effect of a very thin solution of osmic acid (Fig. 9). After the specimens, having been stained, had been transferred to Canada Balsam the globules had entirely disappeared; they (Figs. 4—6) had probably been dissolved. The oily globules were in the transparent specimens colourless, or they might have a slightly greenish tinge.

In the interior of specimens transferred to Canada Balsam, refractive grains were often seen (Figs. 4 and 5). They were evidently mineral grains or debris of diatom-shells, which had been taken in with the food. In Fig. 4 a good many such grains are seen accumulated in the vacuole near the posterior end. In Fig. 5 similar grains outside the individual are also seen adhering to the cilia round the proboscis.

When the animals were killed with osmic acid or chromo-aceto-osmic acid, they sometimes retained more or less of their elongated shape (Figs. 4—7). But sometimes they contracted into a more or less spheroidal form like Figs. 8 and 9, and the spirally wound furrows then often disappeared. Fig. 9 was an individual which while alive, had the same appearance and was in the same preparation as Fig. 3.

The dark specimens. I mentioned above that among the diatoms in some ponds on the ice, I sometimes found numerous individuals actively moving about; they had externally exactly the same shape and appearance as the above transparent forms, and behaved in the same manner, but they had a dark green, or almost black colour (see Pl. II, Fig. 5). I do not think that this was a different species, but rather believe that the dark colour might be due to the food which the animals had eaten; and the stain might probably be contained in the oily globules. For the colour was evidently due to dark grains or globules dispersed in the otherwise colourless protoplasm (see Pl. II, Fig. 5). Unfortunately I did not get an opportunity of examining whether these dark grains or globules were dissolved by transferring the specimens to Canada Balsam[1].

When individuals of this infusorium, either of the transparent form (Figs. 1 and 3) or of the dark form just mentioned, were followed under the microscope for some hours, they were generally seen at last to contract into spheroidal almost motionless globes shown in Pl. I, Figs. 10—12, and Pl. II, Figs. 5—7. Figs. 10 (Pl. I) represents a colourless individual which was followed from the very beginning, when it had the normal shape, like Figs. 5 and 3, and moved actively about, until it had contracted as represented, and remained nearly motionless. The proboscis was now much reduced, and merely formed a short protuberance. In the posterior region three vacuoles were seen. (The figure is drawn with comparatively small magnification.)

On July 28, 1894, I followed the formation of the quiescent globular form of several dark individuals. The process was quite the same as observed on transparent, and colourless individuals. I have given the following description of it in my note-book:

[1] In my note-book, July 24, 1894, I find the following remarks about these dark specimens: "Individuals of exactly the same shape, appearance, and size as Figs. 6 & 7, but perfectly dark or almost black, are seen in great number in the samples of diatoms from this ice-floe. Whilst the transparent form, Fig, 7, is, as a rule, colourless, some individuals from this floe were greenish brown, I presume owing to chlorophyll obtained from digested algae. I also presume that the dark colour mentioned above, may be due to particles of food. The dark stain seemed to occur in the form of lumps or globules, situated very near each other but still with transparent intervals between them (*cf.* Pl. II, Figs. 5 and 6). On one of these dark specimens I saw a dark sausage-shaped body being pushed out of the posterior pointed end, the animal was then in rapid motion. This dark body adhered for some time to what I consider to be the anal opening, but soon dropped away. The oral opening I have not been able to ascertain".

"In the beginning of the observation the animal had the same regular shape as the ordinary transparent and colourless form (Pl. I, Figs. 3, 4 and 5). The animal now began to swim about rapidly backwards in the open spaces of water, continually rotating round its longitudinal axis the same direction as the spiral-windings which are left-handed. The proboscis was stretched far out, being dragged after, apparently in an inert state. Neither in this nor in a later individual did I see the proboscis move while in this state. The body was now gradually shortened and finally assumed a perfectly globular shape as in Fig. 6, *a*. Whilst this happened the proboscis disappeared to same extent, and only a short protuberance (Fig. 6, *a*) remained. It seemed to me as if the rest of it might have been dropped, but it may probably have been contracted into the body. In certain positions of the animal, *e. g.* in a lateral aspect when the proboscis and anal region were seen simultaneously, it looked as if the cilia were situated several together at certain intervals (Pl. II, Fig. 6, *a*). This was very often the case only on one side of the animal (see Fig. 7, *c*, under side). I sometimes was able to count 9 such small tassels of cilia on one side between the anterior and posterior end. In other positions of the animal, when it was seen more from one of the ends, and had a perfectly round appearance (Pl. II, Fig. 7, *a*) the cilia were more uniformly distributed along the whole circumference of the body. I got the impression that the cilia were chiefly situated along the furrows of the spiral windings, *e. g.* in Pl. II. Fig. 7, *e* there seemed even to be indications of such small depression, in which the cilia were situated, along the under margin of the animal. In the oral and anal region the cilia were more densely distributed, and were also longer, especially in the oral region.

"After a while the globe, (Pl. II, Fig. 6, *a*) burst, and parts of the contents were spread outside the membrane (Fig. 6, *b*). There were a great number of rapidly oscillating, dark green grains, of exactly the same colour as the cell contents. They seemed to be the cause of the dark colour of the animal. By means of their oscillating movement these grains swam far away in all directions[1]. After about half an hour they became mostly quiet, until finally the whole mass seemed perfectly dead. The observation was made in a drop of water, hanging under a cover-glass, in a microscope aquarium. The

[1] This oscillatory motion may probably have been due simply to the surface tension.

bursting of the cell could not therefore be due to pressure of the cover-glass, as I had thought possible on other previous occasions. Neither was dessication the cause, for as far as I could see there was plenty of water in the drop. But something may probably have been wrong with the water, because another infusorium that lived in the same drop, also seemed to die after a while."

"Pl. II, Figs. 7, *a*, *b*, *c*, and *d*, are drawings of another individual of the same kind, which I observed under the microscope for 12 hours, on July 28, 1894. Fig. 7, *a* was drawn at noon, and the last drawing, Fig. 7, *d*, was made at midnight on the same day. The animal was living all the time, and the cilia were in rapid motion, especially during the first six hours. The long cilia round the proboscis were especially active, and were bent far towards all sides. After 9 hours (Fig. 7, *c*), the cilia were still in constant motion in the anal region, but perfectly quiet in the anterior portion of the animal. The proboscis had now almost entirely disappeared, only a small protuberance being left. After 11 hours no cilia moved. The form of the animal was during the first six hours almost perfectly globular, even in a lateral aspect (see Fig. 7, *b*). It became then more oblong, like a short egg (Fig. 7, *c*), thus it remained for four hours (Fig. 7, *d*); but then (after eleven hours) it again became perfectly globular.

"In the anal region at the posterior end, a colourless, limpid space often occurs (Figs. 7, *b*, *c*, *d*); which is sometimes larger sometimes smaller, but always with the same locality in the anal region, where the latter is slightly pointed. Small dark grains frequently occur inside this clear space, and are seen to move. They sometimes pass from the dark cell-contents into the limpid space approaching the cell-membrane. A little later the limpid space is suddently and entirely closed by the dark mass; which after a while begins to withdraw slowly from the membrane, to give room for the limpid space again. While this is going on the cilia outside are in active motion[1].

[1] On one such occasion I saw a spore-like body come out from these moving cilia, and it appeared to have come through the anal opening, but might nevertheless have come from the surrounding water. It had an oblong form, narrow in the middle like an hourglass or the figure eight; of yellowish colour, it was extremely small, and hardly visible with the magnification used (Zeiss *CC* and 5). It had a rapid oscillating motion; it moved about for a while, and then became quiet. Several similar corpuscles were seen in the neighbourhood. Half an hour later a perfectly similar corpuscle came out from the cilia.

This colourless space is evidently a vacuole. At the posterior, slightly pointed extremity of the body, I believe I have seen a small opening in the membrane of the animal; but I have never with certainty seen anything being pushed out through it".

"The contents of the cell have the same dark green granular appearance in all these dark individuals. Near the margins single grains can be distinguished, of the same size and appearance as the oscillating grains seen in Fig. 6, *b*".

"Here and there small colourless vesicles occur, which might be vacuoles if it had not been for their small size — they are not much greater than the dark grains or globules — nor have I seen any contractile movement in them, although they seem to change slowly".

Pl. 2, Fig. 5 represents a similar spheroidal, motionless form of dark individual seen on another occasion (July 24, 1894). But here the cilia were apparently longer and more numerous than in most other individuals observed, and no indication of the spirally-wound furrows was to be seen.

Pl. I, Figs. 13 and 14 probably represents another but nearly allied species of this same genus of Infusorium. It was observed on August 2nd, 1894, amongst diatoms from a pond in a floe. In its mobile state (Fig. 14) it was conspicuously more extended and slender than the above described form. "I followed it for a long time, and there was a striking difference between the elegant worm-like movements with which it moved through the narrow passages between the algæ, and those of the thicker form above, in both dark and transparent modifications. It was never seen to contract to a shape approaching that of the latter, and the body seemed to be also more "muscular", as the spirally wound furrows became more conspicuous on contraction (Fig. 13).

After a while, it contracted into the motionless stage; but this did not occur in the same manner as often observed (see description above); it took place more gradually and quietly: It did not run about in long circuits backwards through the water; the "muscles" were more and more energetically contracted, the spirally-wound ribs became more prominent and protruded (Fig. 13). They are possibly somewhat more numerous than in the above form. As in the latter there is a vacuole near the posterior end, and this is conspicuously visible both in the mobile and in the quiescent state. In its quiescent state it is not as globular as is the above form, and further the spiral-windings are very prominent".

To this description from my note-book I may add that it may be possible that this was simply an individual of the same species as above, only less filled with foot.

In the reproduction of Fig. 13 there are a few mistakes. On my original drawing there were many cilia pointing backwards in the anal region, which have been forgotten here. The cilia on both sides of the body are in my original orawing situated in the spiral furrows, and not on top of the ribs.

Both figures (13 and 14) are drawn without the aid of camera lucida, and with comparatively small magnification.

CHILODON(?) sp.

Pl. II, Figs. 1—4; Pl. III, Figs. 1—7, 9, 14.

This form seemed allied both to *Orthodon* and *Chilodon.* It was not, as far as I could see, uniformly covered with cilia, but had its cilia arranged in a double series round along the length of the amind (Pl. III, Fig. 5). This infusorium was very common in the accumulations of algæ in the ponds of fresh-water on the ice-floes where it moved rapidly about. As it occurred sometimes in ponds on comparatively clean and white ice-floes, it seems probable that the animal did not originate from anywhere near the land, for such ice-floes had been formed on the sea, during the previous autumn and winter, far from the coasts.

For a description of this infusorium the reader is referred to Pls. II and III and the Explanations of these Plates.

It is perhaps doubtful whether several species were observed. Pl. II, Fig. 4 was much larger than the species reproduced in Pl. II, Figs. 1—3 and Pl. III, Figs. 1—7, and possibly belonged to a different species. The usual length of the individuals was about 0·05 mm. or a little more, whilst Pl. II, Fig. 4 was 0·099 mm. long.

Pl. III, Figs. 9 and 14, were somewhat smaller than the above individuals, they were about 0·043 mm. long but possibly belonged to the same species or a similar species.

Pl. IV, Fig. 6 probably also represents a species allied to the above infusoria (Pl. II, Figs. 1—4). It was taken from free-floating lumps of algæ, in a channel between the floes, and was of about the same large size as Pl. II, Fig. 4 which it resembled much. Its length was 0·1088 mm.

Pl. III, Figs 10—13 and 15—16 represent small animals which were often seen in preparations from accumulations of algæ in the ponds. They possibly belong to similar species as the above infusoria. For description see Explanation ot the Plate.

STYLONYCHIA(?) sp.

Pl. IV, Figs. 1—5.

This infusorium was often seen moving rapidly about both in the accumulations of algæ from the ponds on the ice, and in the yellowish red lumps or communities of algæ floating at a certain depth (about one or two metres) in the channels between the floes. For description see Explanation of the Plate.

The species seems to be at least nearly allied to the genus *Stylonychia* but it does not perfectly agree with the descriptions of the latter.

ORGANISM REPRESENTED PIS. V AND VI.

While I was examing the big organism represented in Pl. VIII, Figs. 1—3, a small organism came slowly "padling" into the microscopic field. It was oblong and, with the small magnification I then had, seemed to resemble exactly, the individual reproduced in Pl. V, Fig. 7, *A*. I changed objectives to look at it under higher magnification (Zeiss *F*, oc. 4) but it was imposible to find it. Instead, I found on the same spot the organism reproduced Pl. V, Fig. 1. At first this individual did not move; but gradually the protoplasmic part, *b*, began to contract (Figs. 2 & 3), and then to separate from the more refractive part, *a* (see Fig. 4). It soon separated entirely and moved away from *a* (Fig. 5). Then a cilium also suddenly became visible, which had not been seen proviously. At the same time *b* got a more regular oval form (Figs. 5, 6), and a longitudinal line was seen along the the middle, dividing the contents into two parts with a round corpuscle or vacuole in each (Fig. 6, *b*).

By means of the cilium, *b* now took a small circuit, all the while in rapid motion, while the movements had previously been slow and more amoeba-like. It returned, however, to *a* and vibrated round it, as though linked to the spot. After having observed this stage for some time, I was interrupted by other observations (see below).

When I returned I found the organism Fig. 8, whilst *a* had apparently disappeared, it had probably again been enclosed by *b*. A stalk was also visible by which the organism was affixed to the glass slide. Whether this stalk had existed before under *a* (in Figs. 1—6) without being seen, it is difficult to say, but it is hardly probable. The individual was vibrating rapidly on its stalk by means of the cilium *p*.

I had not observed it for very long before it began to divide (Fig. 9), *b* being, as it were, skinned off from *a* by reversing. The *a* in this figure had a striking resemblance to *a* in Figs. 1—6, it had the samme clear, refractive and sharply defined contents, in which three small globules or grains were visible. After a while *b* had entirely separated from *a* except only for a slender thread (Fig. 10). At the same time another immobile thread or tail (*h*) was seen adhering to *b* besides the cilium.

The thread fixing *b* to *a* was stretched and lengthened (Fig. 11)[1], *b* moving rapidly towards different sides; but then the thread was again shortened, and *b* enclosed *a* (Fig. 12), as it were, for a last intimate embrace, before finally parting. *a* was now entirely enclosed in *b* (Figs. 13—16; Fig. 15 drawn from above, and the stalk (*s*) not visible) and at last it could not be distinguished any more; apparently it dissolved in the protoplasm of *b*. In certain attitudes two threads (Figs. 16 and 17, *h* and *h'*) could now be seen attached to it; one of which may later have again disappeared. A longish body now became visible in the interior of the cell (Figs. 17—20, *k*). This body became more distinct and gradually changed somewhat in shape (Pl. V, Figs. 17—20, *k*, Pl. VI, Fig. 1, *k*) at the same time as the organism changed its outer form. Suddenly *a* reappeared inside the cell, and *b* again began to separate from it (Pl. VI, Fig. 2); soon after to leave it finally (Fig. 3). At the same time a drop-like protuberance was formed on the side of *a* (Fig. 2 *d*). I believed at first that it was simply a viscous drop, as a similar globule was

[1] The figures Pl. V, Fig. 11—Pl. VI, Fig. 10 are drawn with smaller magnification (Zeiss obj. *F*, oc. 2) than Pl. V, Figs. 1—10 and Pl. VI, Figs. 11—19 (Zeiss obj *F*, oc. 4).

seen close by (Fig. 2, *x*), but I now rather think that it was the first beginning of the bud-like formation which was further developed later (Figs. 13—19).

I followed *b* (Fig. 4) on its wanderings for some time. It moved forwards by means of the cilium (*p*) and dragged the tail (*h*) after itself, exactly in the same way as the organisms in Pl. V, Fig. 7. It gradually changed its shape (Figs. 4—9). The longish body or nucleus inside, which was at first situated athwart it (Figs. 4—6) in the posterior end, gradually took a more longitudinal position (Figs. 7—6) and the organism itself became more oblong. At the same time the "nucleus" began to narrow in the middle (Figs. 6—7) just as though a division were being prepared, but it came to nothing during the time of observation. At last it became fixed to the glass slide by the tail or stalk (*h*). The motion which had hitherto been rather rapidly vibrating, now became quieter, and at the same time, the exterior shape of the body became more spheroidal (Fig. 10). I observed this stage for a long time, but no changes were seen. At last I had to break off for dinner. When I came back dew had formed on the cover-glass, and when this had been removed I sought in vain for the organism Fig. 10. I then returned to *a* in Fig. 3, which had remained almost unaltered all the time (Fig. 11)[1]. The two corpuscles or grains in Fig. 3, *a* had now united into one (Figs. 11, *k*), and this globule which I called "nucleus", moved slowly towards the end where the stalk adhered (Fig. 12). The bud-like protuberance (*d*) remained in position but gradually increased in size (Fig. 12). Near the "nucleus" (*k*) one or sometimes two grains were seen. In the evening (Fig. 13) a drop was being secreted from the cell. The protuberance, *d*, now gradually increased in size very slowly (Figs. 13—19. In fig. 15, the body is turned over so that *d* is seen on the under side, whilst in Fig. 12, it was on the upper side). In the meantime the "nucleus" underwent several changes. In Fig. 16 it had ejected a grain (*x*) which moved towards the protuberance, but again returned to the "nucleus" (Fig. 17). In Fig. 17 the "nucleus" was lengthened and constricted, and a grain or "nucleolus" was thus given off (Fig. 18, *β*. The grain *β* is somewhat too small in this figure). After this, two grains were always

[1] This and the following figure (Figs. 11—12) are drawn under much greater magnification (about 1800 diameters, Zeiss *F*, 4. and long tube) than Figs. 1—10 (Zeiss *F*, 2; magnified 760 diameters) Fig. 11 was drawn with the aid of the camera lucida. Figs. 13—19 were drawn somewhat smaller magnification (Zeiss *F*, 4, and medium long tube, about 1500 or 1600 diameters), Figs. 13 and 14 with the aid of the camera lucida.

seen, one on each side of the "nucleus" (Figs. 18—19), β being the larger. Other small dark grains (Fig. 18, α) were seen moving slowly round in the cell, and keeping near to the membrane.

The observation was now interrupted by an accident.

While I was studying the above organism, the organism Pl. V, Fig. 7, *A* came into the microscopic field. Thinking it was the same kind of organism in an earlier stage I followed it for some time. It moved forwards by means of the cilium *p*, and dragged a long thread or tail (*h*) after it, which was perhaps destined to become a stalk. For some time no apparent changes took place. The anterior part, somewhat resembling Fig. 1, *a*, was very mobile towards both sides (see Fig. 7, *B*). I saw also another individual of the same kind, but in this case the anterior part was still more loosely connected with the posterior part; and it was still more mobile. At last this organism disappeared entirely from sight between some diatoms. While hunting for it I also came across another similar individual which was, however, less elongated (Fig. 7, *C*), and with no indication of anterior or posterior parts. In the interior two corpuscles or possibly nuclei(?) were, however, visible.

SUCTORIA gen.? sp.

Pl. VIII, Figs. 1—3.

When this organism was first seen under the microscope, in the morning of July 30, 1894, it was spheroidal tentacles like Pl. VIII, Fig. 2 and with radiating filiform tentacles. A nucleus(?) in the centre and a great vacuole (v_1) on one side were visible. While I was observing it, it ejected at its left hand side a part of its grained cellular contents (see Fig. 1). As, however, the water began to diminish under the cover-glass, a fresh drop was added; at the same instant the individual contracted energically and got the appearance of Fig. 1. I could not decide whether this contraction was due to the new water, or to ejection of the cellular contents. After a while it again assumed its regular spheroidal form (Fig. 2). During the contraction of the animal the great vacuole, v^1, was partly divided into three vacuoles; a similar division sometimes happened, when the vacuole contracted while the body had the regular form. After some hours another vacuole (v^2) also appeared on the other side of the nucleus. It may possibly have been there before, as it was on the under side of the body; but I had not seen it. At the same time the first vacuole (situated on the upper side of the body, nearest the eye) was considerably reduced. The contractions of the vacuoles occurred curred at long intervals. The *tentacula* were slender, straight, apparently rigid, and ending in a slight knob. I did not see them move, but there was occasionally a slight vibration in them.

The interior of the body was filled with big refractive globules (Fig. 3, *b*) which may be reserve nourishment. They do not approach close to the surface. In the outer layer a great mumber of small grains occur (Fig. 3, *a*) which have a rapid, half oscillating movement, while swimming about. What I assumed to be the nucleus, was situated near the upper side of the body, and there were i Fig. 2 no refractive globules but only small oscillating grains between it and the outer membrane or surface. It appeared as an oblong granular mass. The granular appearance might have been due to threads.

The *colour* of the organism was slightly yellowish green, which seemed to be due to the refractive globules (Fig. 3, *b*).

Length of individual about 0·095 mm.

I kept this organism under observation during the whole day (July 30) till interrupted by a bear in the evening.

When I came back after a few hours, the water had been much reduced by evaporation, and the organism had become much contracted on the one side. When fresh water was added it again expanded, and then I left it for the night.

The next morning, July 31, 1894, it had about the same appearance, but was slightly contracted, and somewhat reduced in size. Later on in the day, while I was following the developement of the organism illustrated on Pls. V—VI which was in the same preparation, the cover-glass was several times touched by the microscope, and great masses of the cell contents were twice squeezed out. The first time the organism was much contracted and of irregular shape (like Fig. 1) but after a while it returned to its regular, spheroidal form. After the second time I could observe no motion in the organism. The big globules (Fig. 3, *b*) which had been spueezed out into the surrounding water appeared at first to have a nearly homogeneous structure, but the contents of rome began in the evening to be differentiated into one or two "nuclei" and a granular mass (Pl. VI. Fig. 20, c). Some of them also began to show a slightly vibrating movement, see Pl. VI, Fig. 20, *b* and *c*. Whether *a* (Fig. 20) had also originated from the above organism, I could not say for certain; it was lying between some of these globules and had the same appearance, but gradually began to move away by means of its cilium.

The small grains (Fig. 3, *a*) which had been squeezed out with the cell contents, appeared to have grown in size during the afternoon, and were darker than the bigger globules. I did not directly see, that any of them began to move, but they had a striking resemblance to many small dark globules which were seen vibrating between the greater globules.

Pl. VI, Figs. 20, *d*, was a body which was in rapid vibration near some of these globules.

GLOBULAR ALGA.

Pl. VIII, Figs. 7–8.

I have mentioned above (p. 7) that, in July and first days of August, 1894, numerous globular lumps of algæ were floating in the channels between the ice-floes, at a depth of about 1 metre; somewhat deeper in August, perhaps nearly 2 metres. These lumps were composed of diatoms, and to a large extent, also of a yellowish-red globular alga, of considerable size. This alga, when alive, gave the floating lumps a reddish colour, and the colour was the deeper the more numerous were the algæ.

The diameter of this alga (Pl. VIII, Fig. 7) was generally between 0·10 and 0·16 mm.

Its cell contents were surrounded by a layer of yellowish red refractive globules (see Fid. 7), situated near the membrane. These globules varied somewhat in size. They gave the alga its reddish colour, and were formed by an oily substance, which was blackened by osmic acid. While Fig. 7 was being drawn, and when the alga probably began to die, the oily globules united and became continually larger until they fused into one mass which left the cell as big reddish drops; the cell-contents then became entirely colourless. These globules, were as already mentioned, dispersed in the outer layer of the cell-contents, while its interior was transparent and colourless. The red globules were, however, as a rule lying so close together, that it was impossible to see through them into the interior of the cell. Only at one place on the upper side of the cell, near x in Fig. 7, was there an opening not covered by the globules where it was possible to see into the interior. Here a small oblong body (x) was seen. When the under side of the cell came into focus the red globules were again seen, as indicated by the grey dots in the figure. Whether the open space (at x) was a vacuole, could not be decided, as no movement was observed in it.

The cell was surrounded by a membrane.

No *nucleus* could be seen in the living specimens, as the oily globules covered the interior from sight. It seems hardly probably that the open space at x, could indicate the situation of the nucleus, as it was not defined by any membrane.

In a specimen killed with chromo-aceto-osmic acid, and stained with para-carmine an oblong nucleus, about 0·037 mm. long, 'was seen near the outer membrane, on one side side of the cell.

Forms of this alga like Fig. 8 (Pl. VIII), with a furrow on one side, were often seen. The structure was the same as in Fig. 7, but the oily globules were more closely situated, and made the cell still less transparent. The globules near the furrow were colourless in this specimen. The diameter of the cell was 0·11 mm. It is possible that this form with the furrow has been produced as the result of violence from outside.

I got no time for studying the life of this alga, and can therefore say nothing about its development. or process of multiplication.

PL. I.

Fig. 1. *Lacrymaria* sp. Living individual, from a lump of algæ floating in a channel between the ice-floes. July 20, 1894. Transparent and colourless. Magnified about 760 diameters (Zeiss obj. F, oc. 2; cam. luc.).

— 2. *Lacrymaria* sp. Same individual as Fig. 1; while moving. Less magnified (Zeiss obj. F, oc. 2; freehand sketch).

— 3. *Lacrymaria* sp. Rough sketch of moving individual; from same place as above. July 20, 1894. The globules of the cell-contents are in the figure only indicated in the anterior part (Zeiss obj. F, oc. 2; freehand).

— 4 and 5. *Lacrymaria* sp. An individual of the same species as Fig. 3, and probably also, as Fig. 1, but with the spiral-furrows very distinct. Killed with Osmic Acid, stained with Borax-Carmine, and transferred to Canada Balsam. From a pond on the ice. July 24, 1894. In Fig. 4 the specimen is seen somewhat obliquely; the anterior end being lifted slightly upwards. Fig. 5 represents the same specimen turned over on one side and at full length. Magnified about 1150 diameters (Zeiss Hom. Im. $^1/_{18}$, oc. 2; cam. luc.).

— 6 and 7. *Lacrymaria* sp. An individual killed with Osmic Acid (Fig. 7) and afterwards stained with Borax-Carmine (Fig. 6). From a pond on the ice. July 24, 1894. Magnified 760 diameters (Zeiss obj. F, oc. 2; cam. luc.).

— 8. *Lacrymaria* sp. From the same sample as the previous individual. Killed with Chromo-Aceto-Osmic Acid.

— 9. *Lacrymaria* sp. From the same samples as Figs. 1 and 3. July 20, 1894. Killed with Osmic Acid. Magnified about 760 diameters (Zeiss obj. F, oc. 2; cam. luc.).

— 10. *Lacrymaria* sp. Living specimen, in contracted, motionless state. From a pond on the ice. July 28, 1894. (Zeiss obj. F, oc. 2; freehand sketch).

— 11 and 12. *Lacrymaria* sp. Living specimen, of the same species as above, in contracted motionless state. From a pond on the ice. July 28, 1894. Fig. 12 was drawn 6 hours later than Fig. 11; the individual was then possibly dead; there was no movement of the cilia, and a great many of them had disappeared. Magnified 460 diameters (Zeiss obj. CC, oc. 5; cam. luc.).

— 13 and 14. *Lacrymaria* sp. Living individual, from a pond on the ice. Aug. 2, 1894. Magnified about 500 diameters. Length of animal in Fig. 13 0·044 mm. Freehand sketches; Fig. 13 drawn after Fig. 14.

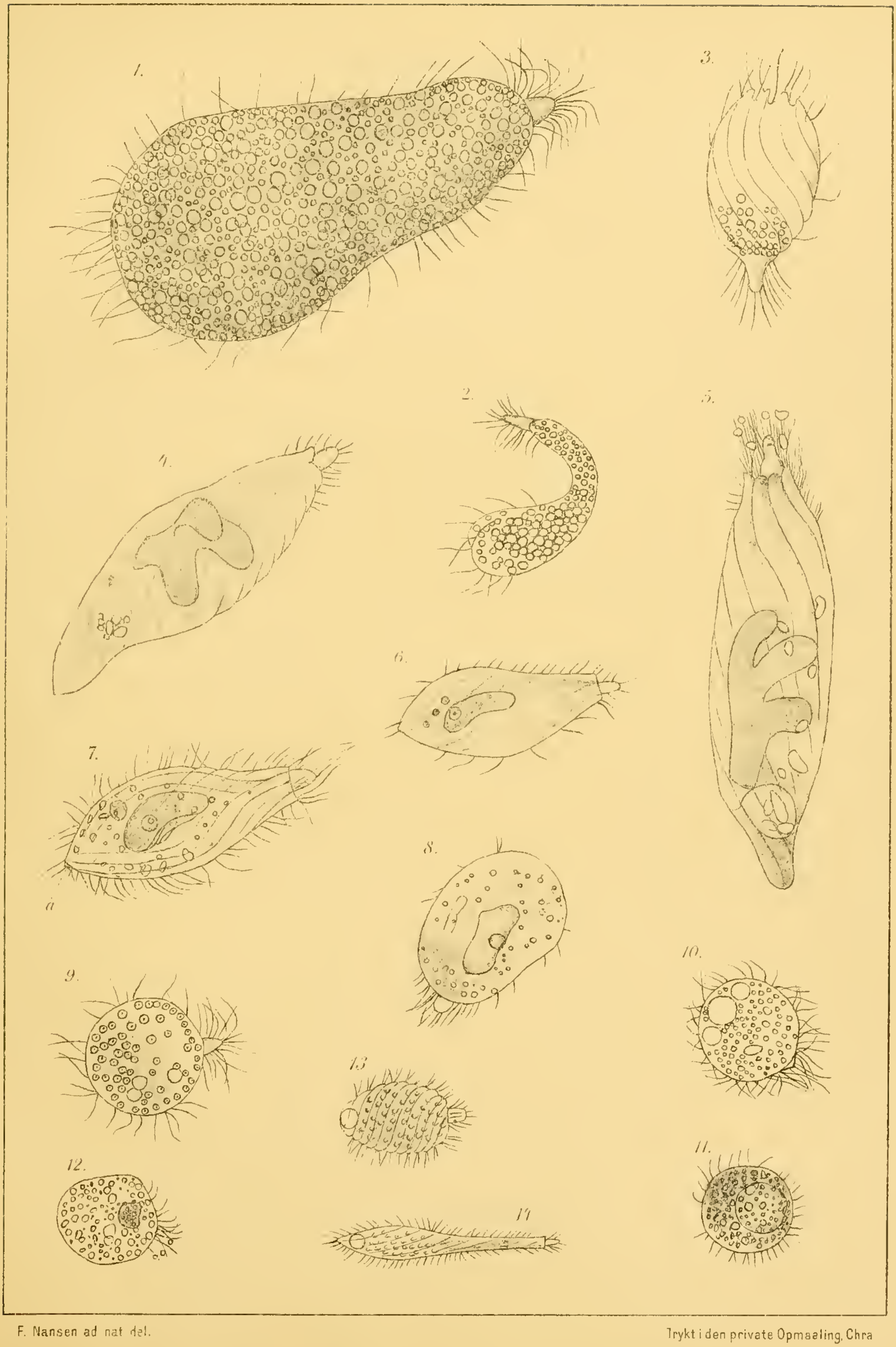

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Fig. 1. *Chilodon* (?) sp. Living, from a pond on the ice. August 1, 1894. It was just brought under the microscope, but remained motionless, and there was no motion of the cilia. The small corpuscles, *a*, in the protoplasm (ectoplasm) were in rapid oscillation. The animal showed no change of form or structure as long as it remained under observation. Magnified about 1600 diameters (Zeiss obj. F, oc. 4, with lengthened tube, cam. luc).

— 2. *Chilodon* sp. Living but motionless, from a pond on the ice. August 1, 1894. Probably same species as above; seen from the side. The small grains in the protoplasm were in rapid oscillation. *m*, Mouth. *a*, Anal opening. A vacuole is seen in the posterior end on the dorsal side. The animal was much contracted and probably died while being drawn. The great accumulation of food (?) on the anterior dorsal side was sharply defined as if by an apparent membrane. This accumulation, was externally surrounded by a layer of refractive globules. Apparently dark spots, looking like grains or even like a reticulum (see Fig. 2), were formed by refraction between the globules. These globules formed only a layer in the exterior part of the formation, for when the microscope was focussed on its central part a more homogeneous mass was seen, filling the interior, whilst only a layer of globules was seen along the margin under the apparent "membrane" (see Fig, dorsal side). This accumulation of globules changed after a while. The stripes passing along the animal are possibly contractile fibres. They also seemed to pass towards the place in the posterior end, which is presumably the anal opening. A distinctly defined, tract or belt passed towards this place, and looked as if it might be a canal. Magnified about 1600 diameters (Zeiss obj. F, oc. 4, with lengthened tube, cam. luc.). Length of animal was 0·049 mm.

— 3. *Chilodon* sp. Living but motionless, from a pond on the ice. Aug. 1, 1894. Seen from the right-hand side. The animal was possibly dying, as the body seemed more contracted and rounder than was generally the case. In this individual there were six greater and smaller accumulations of globules of the same kind as the one in the previous figure. (I have also seen similar accumulations in other individuals in the same sample). Even here the layer of refractive globules surrounded a more homogeneous mass. Some similar globules were seen dispersed in the protoplasm of the animal as in Fig. 1, either single or united, some few together. After a time some of the great accumulations of globules began to dissolve and the globules were dispersed singly in the protoplasm, in the same way as usual (Fig. 1). Both in this and the previous specimen only a few oscillating small grains were seen, but the refractive globules were in slow motion. In the anterior end of the animal several longer cilia were seen situated near the margin and on the ventral side. The right margin of the animal is seen as a dark streak or belt along the figure. *m* Oral opening.

Magnified about 1600 diameters (Zeiss F, 4, with lengthened tube, cam. luc.). Length of animal 0·054 mm.

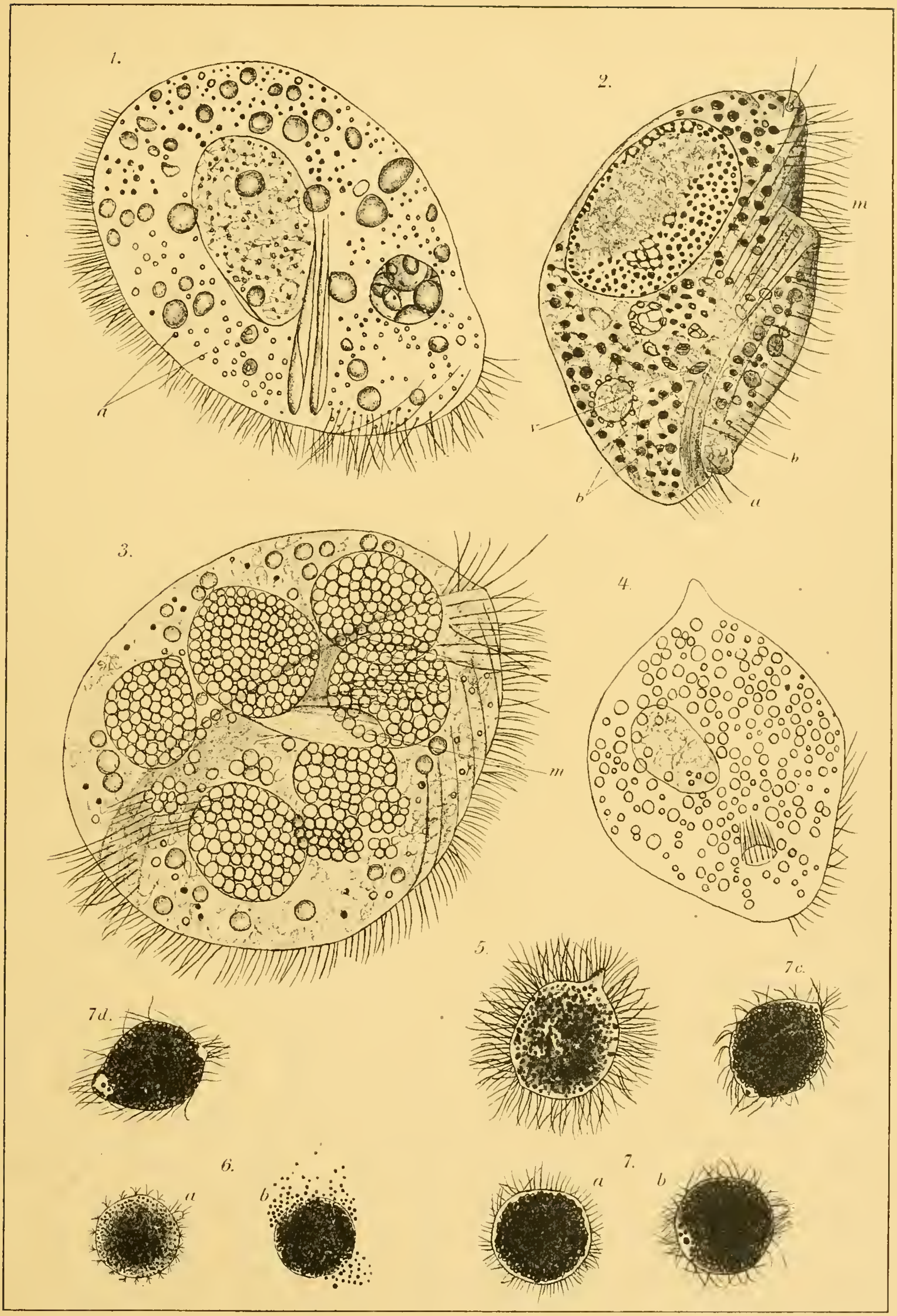
— 4. *Chilodon* sp. Living, from a pond on the ice, Aug. 1, 1894. Probably a species different from the above. This specimen was somewhat more oblong before it was sketched. Its exterior form was much like the above, only that it had a more pointed posterior end, and the oral opening was perhaps somewhat differently situated, being directed more towards the anterior end (?).

This individual is evidently somewhat contracted, perhaps in the act of forming a cyst, as after a while some colourless mucuous substance was secreted from the left side (on the right hand side of the drawing). At this period the cilia seemed to have nearly disappeared. The refractive globules were in active oscillation. Magnified about 760 diameters (Zeiss obj. F, oc. 2, cam. luc.). Length of animal 0·099 mm.

— 5. *Lacrymaria* sp. Living but contracted and motionless. From a pond on the ice, July 24, 1894. Magnified about 760 diameters (Zeiss obj. F, oc. 2, cam. luc.).

— 6, *a* & *b*. *Lacrymaria* sp. Living, but contracted and motionless, only cilia moving in Fig. 6, *a*. From a pond on the ice. July 28, 1894. *b*, some time after *a* with membrane burst, and oscillating grains spread towards all sides. Magnified 460 diameters (Zeiss obj. CC, oc. 5; cam. luc.).

— 7, *a*—*d*. *Lacrymaria* sp. Living, from a pond on the ice. July 28, 1894. The individual was observed during twelve hours from noon (Fig. 7 *a*) till near midnight (Fig. 7 *d*). The cilia were seen moving the whole time, but ceased to move near midnight. Magnified 460 diameters (Zeiss obj. CC, oc. 5; cam. luc.).



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PL. III.

Fig. 1. *Chilodon* (?) sp. Fresh state, probably dead. From a pond on a comparatively clean ice-floe. July 24, 1894. Magnified about 760 diameters (Zeiss obj. F, oc. 2, cam. luc.).

— 2. *Chilodon* sp. Fresh state, probably dead. From another pond on the same ice-floe as above. July 24, 1894. Magnified about 760 diameters. (Zeiss obj. F, oc. 2; cam. luc.).

— 3. *Chilodon* sp. Living. Conjugation of two individuals probably of the same species as above. From the same place as above. July 24, 1894. They were observed in this situation, unaltered for a long while. The vacuoles were the whole time pulsating. They were moving rapidly, being dragged along by the one individual. At last they died (Zeiss F, 2, freehand).

— 4. *Chilodon* sp. Killed with Chromo-Aceto-Osmic-Acid. From same place as above. July 24, 1894. *v* Vacuoles. Magnified 760 diameters. (Zeiss obj. F, oc. 2; cam. luc.).

— 5. *Chilodon* sp. Fresh state, probably dead. From the same ice-floe as above. July 24, 1894. Individual of the same species as above seen from the end. The pointed (anterior) end is near the margin at *a*, and would have become visible, outside the margin, by a slight turn of the animal. The double series of cilia wind round the body and meet at its end, at *c*. Magnified about 760 diameters. (Zeiss F, 2; cam. luc.).

— 6. *Chilodon* sp. Fresh state, just dead. From the same sample as Fig. 3. Magnified about 760 diameters. (Zeiss obj. F, oc. 2; cam. luc.).

— 7. *Chilodon* sp. Killed with Chromo-Aceto-Osmic-Acid, stained with Borax-Carmine. From pond on the ice. July 27, 1894. Same species as Figs. 1—6, the specimen is seen from the anterior pointed end which is at *a*. *v* Vacuoles, a third vacuole is seen on the other side. The oral opening was very distinct. Magnified 1000 diameters. (Zeiss F, 3; cam. luc.).

— 8. *Stylonychia* (?) sp. This is probably a cyst of the same form as Pl. IV, Fig. 1. It was quite motionless. Thick stiff hairs at both ends.
Magnified 460 diameters (Zeiss obj. CC, oc. 5; cam. luc.).

— 9. *Chilodon* (?) sp Living, in active motion. From a pond on the ice, seen with specimens of the dark and the transparent forms of Lacrymaria. July 28, 1894. Magnified about 460 diameters (Zeiss obj. CC, oc. 5, freehand sketch).

— 10. Living, in active motion. From a pond on the ice. July 28, 1894. Small animals of this kind were often seen amongst the algæ from the ponds on the ice. It is possibly the same species as Fig. 12; but as far as could be seen the cilia were chiefly situated on the one side only. They had a twitching and one-sided motion. Half an hour later all movement had ceased, and two colourless water-clear refractive drops were secreted from each side (Fig. 11). During this process the animal was reduced to a small globule (Fig. 11); its protoplasm became less transparent and the grains closer together.
Magnified perhaps about 460 diameters (Zeiss obj. CC, oc. 5; freehand sketch).

— 11. Same individual as Fig. 10. (Zeiss CC, 5; freehand sketch).

— 12. Living, in active motion. From a pond on the ice together with specimens of *Chilodon*. July 28, 1894. Animals of this small kind were often observed. They were always as small as this individual. They seemed to be round in transverse section and covered with cilia all over. Magnified about 460 diameters. (Zeiss obj. CC, oc. 5; freehand sketch.

Fig. 13. *a–c*. Living. From a pond on the ice. July 29, 1894. Conjugation (?) of small oscillating infusoria, of a similar appearance as Figs. 15, but they were smaller so that no cilia could be distinguished. They united during rapid oscillating movements, the one athwart the other, with the flat ventral (?) sides against each other. Thus united they walzed rapidly around for a while; then the movements ceased, and the one assumed a rounder shape in longitudinal aspect (see Fig. 13 *c*, the upper individual). *a* and *c* are seen from the side, *b* from above (Zeiss obj. CC, oc. 5; freehand sketches).

– 14. *Chilodon* (?) sp. Living, but motionless. From a pond on the ice. July 28, 1894. Perhaps the same or nearly allied species as Figs. 1–6 (?).
Magnified 460 diameters. (Zeiss obj. CC, oc. 5; cam. luc.).

– 15, *a–c*, and 16. Living. From a pond on the ice. July 29, 1894. An individual seen in different positions: *a* obliquely from behind, *b* from the side, and *c* from above. This figure should be more regularly oval than it is here reproduced. The animal had apparently a flat ventral side, and a vaulted dorsal side. Ventral side densely covered with long cilia; on the dorsal side shorter cilia were also visible. One apparent vacuale was visible. At first the animal was in active motion, affixed, as it seemed, by some mucuous threads or cilia to the silica spicule of a diatom, and it could therefore advance only slowly. After some time the movement ceased gradually, and its shape become more rounded (Fig. 16). Several refractive drops were then secreted (Fig. 16, *d*), and its size was reduced. After a while the motion became again more rapid, and during its rotations it was now seen that the flatness on the ventral side had nearly disappeared and it had got a more oval or nearly globular shape.
Magnified 460 diameters (Zeiss obj. CC, oc. 5; cam. luc.).

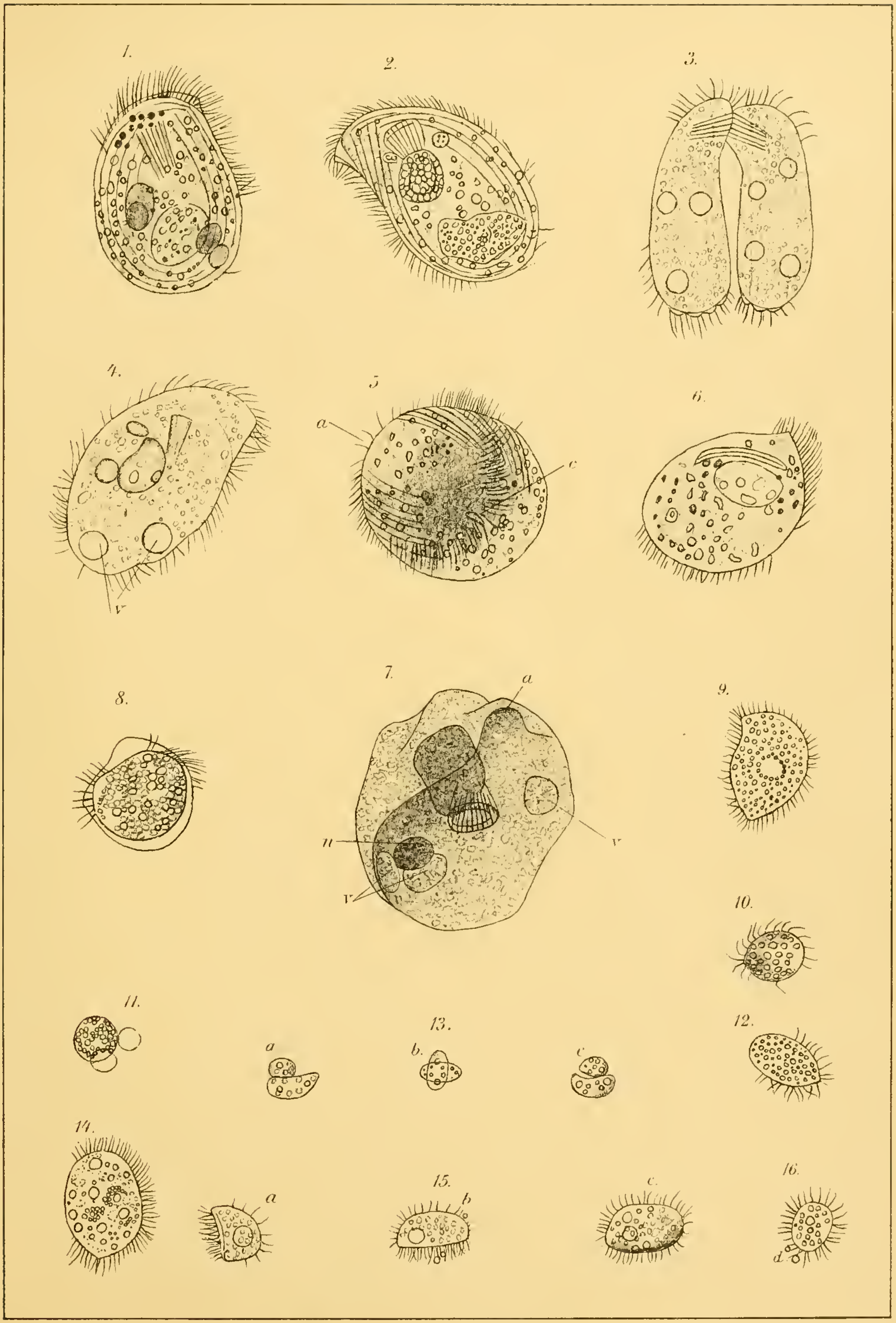

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Fig. 1. *Stylonychia* (?) sp. Living, but motionless. From a lump of algæ floating in a channel between the floes about 2 metres deep. August 4, 1894. The small corpuscles inside the animal oscillated rapidly. During the drawing of it the animal contracted, and the notch at the anterior end (left hand side of the drawing), disappeared almost entirely. Then it again expanded and got the same appearance as before, only the caudal bristle, pointing straight backwards in Fig. 1, had now got a spiral winding as in Fig. 1, A. This twisting may possibly be due to the drop of Osmic Acid which was added to the preparation a couple of hours before.

Magnified 1280 diameters (Zeiss obj. F, 4; cam. luc.).

— 2. *Stylonychia* (?) sp. Killed with Osmic Acid. From the same place as above. August 4, 1894. The same species as above seen from the side.

(Zeiss obj. F, oc. 4; cam. luc.).

— 3. *Stylonychia* (?) sp. Living. From a pond on the ice. Taken July 28, 1894, and kept alive in a bottle till August 6, 1894 when it was sketched. Same species as above. *a* seems to be small accumulations of food (small algæ). *b* is a small vacuole just under the outer membrane; the small refractive grains were in a strikingly rapid motion inside this vacuole. No longitudinal furrows could be seen on this side of the body. v_1 and v_2 big, clear vacuoles, but no pulsation could be observed. A third vacuole could also be seen inside v_3, when the animal moved, but it was not visible in this position; it seemed to be situated more on the other side of the body. It was of about the same size as v_2. While the animal was being drawn, the thick bristles at *c* dissolved, as far as could be seen into numerous slender threads or hairs. The two thick bristles at *d*, which at first were undivided and pointed, now dissolved near the end into several threads as is seen in the figure, and was finally transformed into a bundle of threads or hairs. The thick bristles near *a* and v_2 gradually disappeared, and this was also the case with the hairs or cilia near the margin between *e* and v_3. At *e* and on the right hand side of v_3 some dilapidated remains of hairs remained. While this was going on the animal contracted somewhat in length, and assumed a rounder shape; simultaneously two colourless water-clear drops were secreted, one in the posterior end at v_1 and one opposite v_2, on the right hand side of the drawing. The vacuole v_2 had in the mean time disappeared, and so had the small vacuole *b*, or it had been much widened, for many of the small refractive grains were seen oscillating and dispersed over a wider area.

The animal is transparent and colourless with refractive, greenish globules dispersed chiefly in the exoplasm as usual.

(Zeiss obj. F, oc. 4; cam. luc.).

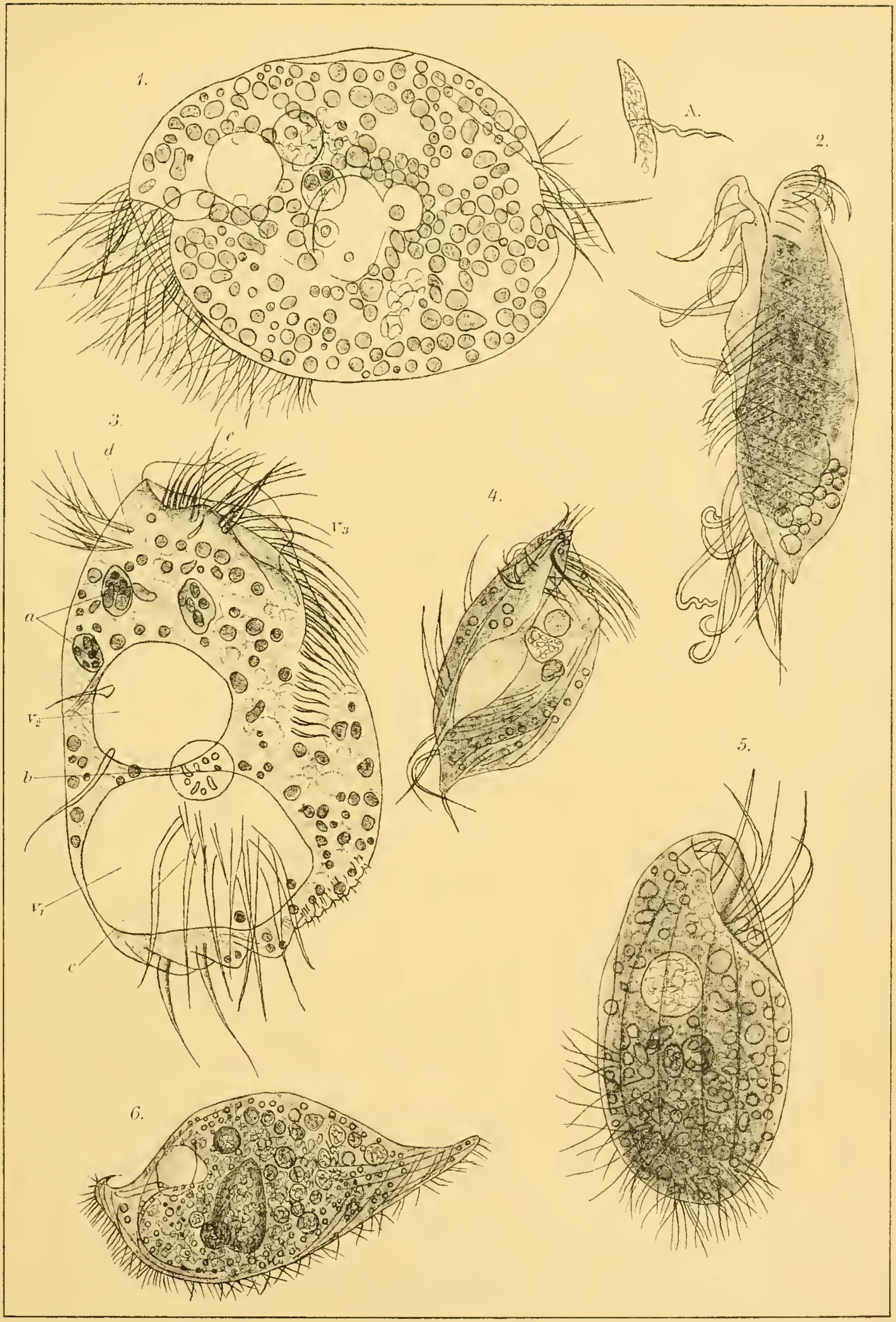
4. *Stylonychia* (?) sp. Same species as above, and from same place as Fig. 1 Aug. 4, 1894. Killed with Osmic Acid.

Magnified about 1280 diameters (Zeiss obj. F, oc. 2; lengthened tube; cam. luc. Length of specimen 0·040 mm.

— 5. *Stylonychia* (?) sp. Same species as above, and from same place. Aug. 4, 1894. Killed with Osmic Acid.

Length of specimen 0·038 mm. (Zeiss obj. F, oc. 1, cam. luc.).

— 6. *Chilodon* (?) sp. Probably a species similar to Pl. II, Fig. 4. From a lump of algæ floating nearly 2 metres deep in a channel between the ice-floes. Killed with Osmic Acid. Length of specimen 0·1088 mm. (Zeiss obj. CC, oc. 5; lengthened tube; cam. luc.).



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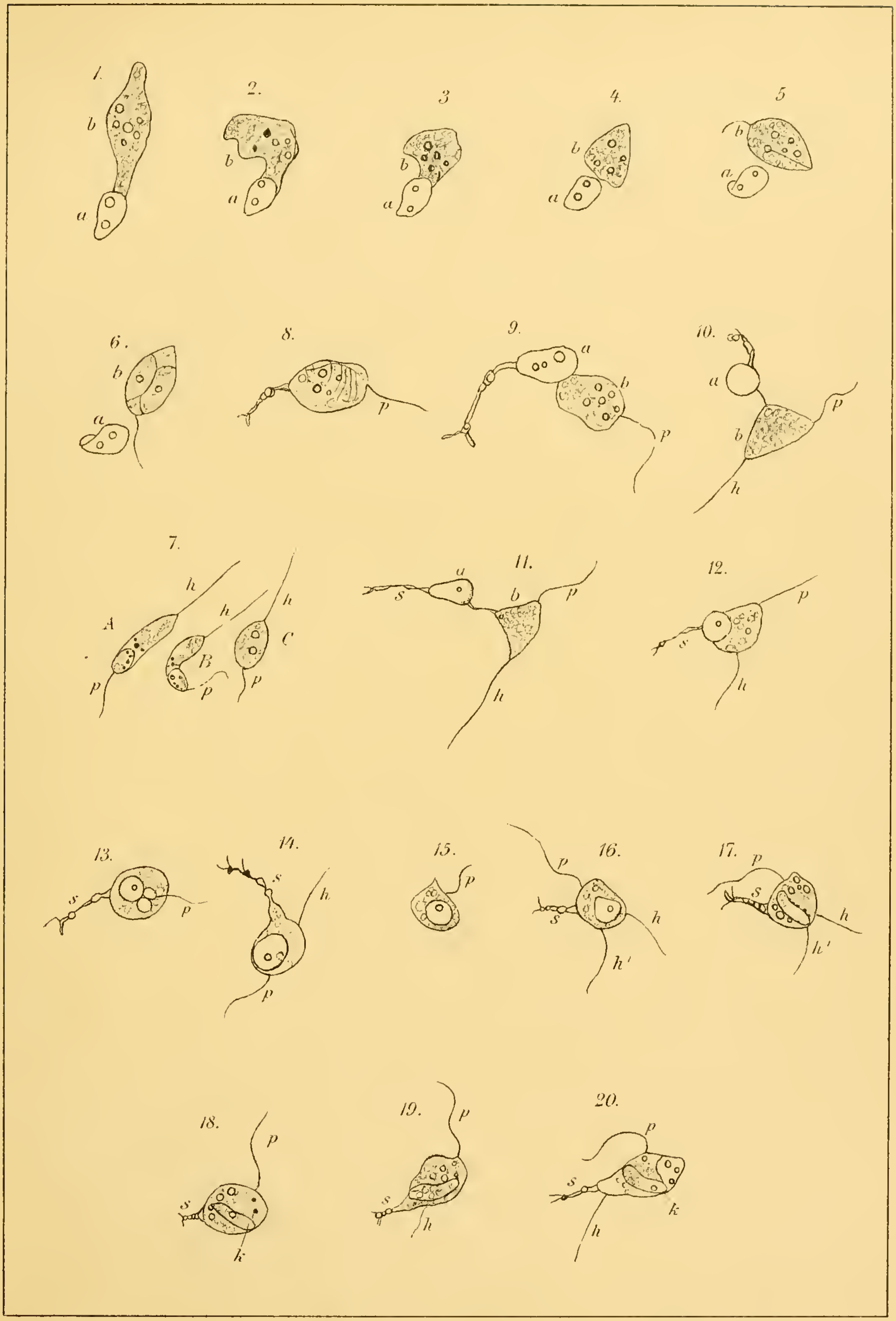
All figures with exception of Fig. 7 represent the same individual in different stages. From a pond on the ice, taken July 30, 1894.

For description of figures see pp. 16—19.

Figs. 1—6. Living. Freehand sketches drawn with Zeiss obj. F, oc. 4, on July 31, 1984 morning.

Fig. 7, A—C. Living. Two similar organisms (A and B is the same individual). Freehand sketches, Zeiss obj. CC, oc. 5. July 31, 1894, morning.

Fgs. 11—20. Living. Zeiss obj. F, oc. 2; freehand sketches. July 31, before aud after noon.


1. b a
2. b a
3 b a
4. b a
5 b a
6. b a
8. p
9. a b p
10. a p b h
7. h A h h C B p p p
11. a s b p h
12. p s h
13. s p
14. s h p
15. p
16. p s h h'
17. p s h h'
18. p s k
19. p s h
20. p s k h

All figures, with exception of Fig. 20, represent the same individual as Pl. V.

For description of figures see pp. 16–19.

Figs. 1–10. Living. Zeiss obj. F, oc. 2, freehand sketches. July 31, 1894, before dinner.

Fig. 11. Living. Magnified about 1800 diameters. Zeiss obj. F, oc. 4, long tube, cam. luc. July 31, 1894, 6 p. m.

— 12. Living. Same magnification as Fig. 11, freehand sketch.

— 13. Living. Magnified about 1500 or 1600 diameters. Zeiss obj. F, oc. 4, cam. luc. but tube somewhat shorter than in Fig. 11. July 31, 1894, 9 p. m.

— 14. Same magnification as Fig. 13, and cam. luc. at 9·15 p. m.

— 15. Freehand sketch. Same magnification. The organism is so turned that *d* has come on the under side of the body, and is seen through it. 9·30 p. m.

Figs. 16–19. Freehand sketches. Same magnification. (Zeiss obj. F, oc. 4). July 31, 1894, night.

Fig. 20, *a–d*. Formations seen while studying the organism Pl. VIII, Figs. 1–3, amongst its cell contents, squeezed out. (Zeiss obj. F, oc. 4; freehand sketch).

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PL. VII.

Fig. 1 *a*—*c*. Small flagellatum-like organisms (or germs?) of this kind were very common in most preparations taken from the accumulations of algæ in the ponds on the ice. The three figures represent the same individual in different positions, *c* is less magnified (760 diameters) than *a* and *b* (1280 diameters). It is from water taken on July 28, 1894, and kept for six days in a bottle in the laboratory. The refractive small globules in the interior, were generally situated near the one end, but in other, and greater individuals, they seemed to be more uniformly dispersed. Most of the globules were yellow, whilst some were reddish brown (see the greater, darker grain in Fig. 1, *a*). × is a protuberance on the side of the body. In another individual a similar protuberance was situated in the opposite end of the cilium.

The individual here represented was at first more elongated and oval, but when the movement began to cease it became more spheroidal as in the figures. The length of the specimen without the cilium was 0·0139 mm.

Fig. 1 *a* and *b*, Zeiss obj. F, oc. 4; cam. luc. Fig. 1, *c*, Zeiss obj. F, oc. 2; cam. luc.

— 2. Similar organism from a half percent solution of Sodium Chloride made by Dr. Blessing with water from a pond on the ice. and kept in his cabine for several days. Killed with Osmic Acid. Aug. 3, 1894. Length of body was 0·0087 mm. (Zeiss F, 4, medium long tube, cam. luc.). Other individuals were round, but had the same appearance and similar yellow or brownish globules inside.

— 3. Fresh state. Aug. 2, 1894. Bodies similar to this, of the same size and appearance, often observed in preparations of algæ from the pond on the ice. They were sometimes hexagonal like this, and sometimes approached the pentagon. They had a yellowish colour. While being drawn, it changed in shape to some extent, the hexagon became less regular, the two sides were curved inwards, and more corners were formed (*a*). Magnified 1280 diameters. (Zeiss obj. F, oc. 4, cam. luc.).

— 4, *a*—*c*. Living. Aug. 2, 1894. A great number of organisms of this kind were seen in all preparations taken from the same bottle as Fig. 1, (taken July 28, 1894). They are possibly individuals of the same kind as those illustrated Pls. V and VI. The appearance was much the same, they were perfectly colourless, and there was no distinct structure in the interior. The tail or stalk on all of them was, however, fixed to the side of the body (Fig. 4, *a* and *c*) and not to the end, opposite the cillium. Some had a more elongated body like Pl. VI, Fig. 7. only the anterior end, at the cilium, being more pointed (Fig. 4, *a*). Fig. 4, *b* is the same individual as *a*, drawn a little later; it was not possible to decide whether × had been developed as a protuberance or bud from the body, or had been fixed to it from outside; it was suddenly seen at the side of the organism. At the same time the vibrating movement ceased. It is not known whether the cilium then disappeared, but it could not be seen any more. At this moment the individual was unfortunately carried away by currents in the water, and the observation terminated.

Fig. 4, *a* and *b* magnified about 1200 diameters (Zeiss F, 4, freehand sketch) and *c* 760 diameters (Zeiss obj. F, oc. 2. freehand sketch).

The following organisms (Figs. 5—12) were all of them seen alive in preparations from the same water as Fig. 2, (a half percent solution of Sodium Chloride made by Dr. Blessing). The figures are rough freehand sketches made with the same magnifications (about 1400 diameters, Zeiss obj. F, oc. 2, long tube).

Fig. 5, *a*, *b*. A very refractive, almost structureless body, with no movement. *a* represents a later stage than *b*. The bud-like protuberance on the side was formed during the observation.

— 6, *a*, *b*. Very small bluish organism, fixed to the glass at the end opposite the cilium. *b* was later than *a*.

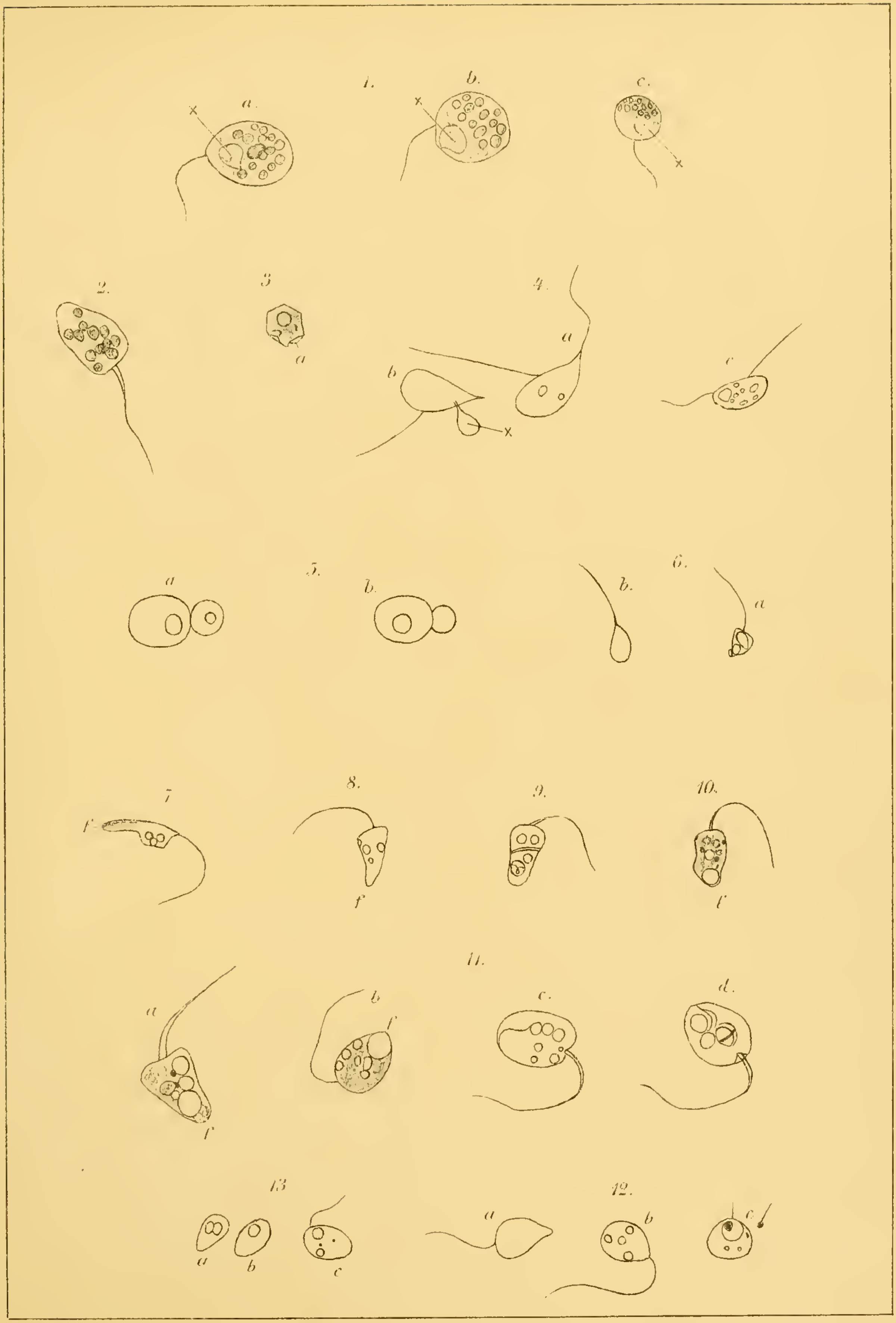
— 7. Very small organism fixed to the glass in the pointed end (*f*).

— 8. Came swimming, and fixed to the glass at *f*. This individual was much smaller than the following.

Figs. 9—11, and 13. Represent the same individual, but the order is wrong. Fig. 13 *a—c* was first drawn, and shows the individual as seen from different sides. The other sketches of this individual was drawn in the following order: Fig. 11, *d*, *c*, *b*, *a*, Fig. 10 and Fig. 9. The individual was the whole time fixed to the glass at the pointed end (*f*).

Length of body without cilium, 0·007 mm.

Fig. 12, *a—c* An individual which was at first fixed (Fig. 12 *c* and *b*); but then loosened itself and swam away (Fig. 12, *a*).



F. Nansen ad. nat. del.

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