This article was downloaded by: [University of Florida]
On: 16 February 2015, At: 15:06
Publisher: Taylor & Francis
Informa Ltd Registered in England and Wales Registered Number:
1072954 Registered office: Mortimer House, 37-41 Mortimer
Street, London W1T 3JH, UK

Annals and Magazine of Natural History: Series 5

Publication details, including instructions
for authors and subscription information:
<http://www.tandfonline.com/loi/tnah11>

XLI.—Investigations upon some Protozoa

Dr. August Gruber

Published online: 07 Oct 2009.

To cite this article: Dr. August Gruber (1883) XLI.—Investigations upon
some Protozoa , Annals and Magazine of Natural History: Series 5, 11:65,
315-326

To link to this article: <http://dx.doi.org/10.1080/00222938309459158>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of
all the information (the "Content") contained in the publications
on our platform. However, Taylor & Francis, our agents, and our
licensors make no representations or warranties whatsoever as
to the accuracy, completeness, or suitability for any purpose of
the Content. Any opinions and views expressed in this publication
are the opinions and views of the authors, and are not the views
of or endorsed by Taylor & Francis. The accuracy of the Content
should not be relied upon and should be independently verified
with primary sources of information. Taylor and Francis shall not be
liable for any losses, actions, claims, proceedings, demands, costs,
expenses, damages, and other liabilities whatsoever or howsoever

caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

XLI.—*Investigations upon some Protozoa.*

By Dr. AUGUST GRUBER.

[Plate XIII.]

[Continued from p. 276.]

II. ON SOME INFUSORIA.

1. *Spongomonas guttula*.

In his comprehensive and exceedingly meritorious general work upon all the known Infusoria, Saville Kent* has made known a new species of the genus *Spongomonas*, which is chiefly distinguished by the circumstance that it constructs larger sac-like colonies. In a small aquarium, in which the water had been putrid for some time, I accidentally found a large quantity of brownish spheres, which, on closer examination, also proved to be produced by small Flagellata.

The colonies of *Spongomonas guttula*, as I shall name the Infusorium, are vesicles, either quite spherical or folded by the falling-in of the surface, which adhered partly to the walls of the glass, partly to all sorts of objects contained in it, and in part also hung from the surface of the water.

At the side by which they are attached there is an aperture through which we can see into the interior of the hollow ball. Their size was very various; but I have never found one larger than that represented of the natural size in fig. 8.

As in Kent's *Spongomonas sacculus*, the brown colour is due to small granules, which, held together by gelatinous matter, form the principal mass of the colony. The individual Infusoria are not irregularly distributed over the surface of the ball, but planted at regular distances in the jelly.

Each of the minute Flagellata is placed at the end of a tube which it has itself secreted. These tubes, however, are not separated from each other, but firmly amalgamated together, as in the gelatinous spheres of the Ophrydinæ. These canals are most distinctly seen at that part of the vesicle where the aperture is situated; for there we may trace them throughout their whole length. In proportion as they become longer the whole vesicle also increases in dimensions.

The origin of these colonies is not easy to explain; and it seems to me the most probable supposition that the Flagellata dispersed in great quantities through the water, settled upon air-vesicles which adhered to the walls of the aquarium or floated at the surface of the water. In somewhat putrid

* 'A Manual of the Infusoria' (London, 1880-81), pp. 288, 289, pl. xii. figs. 17-23.

water such sources of oxygen will of course be preferently sought by the Infusoria. This would also explain why the colonies form hollow spheres. The Flagellata may have constructed their tubes from the periphery of the air-vesicle outwards, and subsequently the air in the interior may have disappeared. Besides the settlements constituted as above, there were also very frequently unions of only a very few individuals; and in these no indications of the tubes were to be observed.

The Infusoria themselves do not differ from the species allied to them. Generally the body, which measures 0·01–0·015 millim., is globular; but it may assume a more oval form. Imbedded in the granular protoplasm are the vacuoles and nucleus, which latter is not visible in the living animal, but becomes very distinct by staining with carmine solution. Lastly, at the anterior end of the body arise the flagella, two in number, as is the character of the genus *Spongomonas*.

2. The Genus *Stichotricha*.

While most of the hypotrichous Infusoria have not the habit of secreting a protective envelope around their bodies, we find in one genus of this section such a practice fully developed, namely in the genus *Stichotricha*. The other Hypotricha, indeed, can very well dispense with any protective arrangement, as they usually possess a firm, often carapace-like cortical layer; but this is not the case in *Stichotricha*, in which the body is extremely soft and flexible. Under the name of *Stichotricha socialis* I formerly made known a form* which constructs dendritically branched tubes, while Stein† has figured and described *Stichotricha secunda*, which is possibly only a variety of the above species, and which lives solitary, and constructs a somewhat flask-shaped carapace rounded at the bottom. I have since observed other forms of carapace- and colony-construction in *Stichotricha*; and these I would now describe.

I may remark that to two of these Infusoria I have not given new names, because I cannot say with certainty whether they are distinct species or only varieties of the same species. This applies especially to one form which was coloured green by the presence of chlorophyll-corpuscles‡. This *Sticho-*

* "Neue Infusorien," Zeitschr. für wiss. Zool. xxxiii.

† Der Organismus der Infusionsthier, Bd. i.

‡ I say chlorophyll-corpuscles without in any way wishing to decide whether we have to do here with true chlorophyll-corpuscles, or, according to Brandt and Entz (Biol. Centralbl. Bd. i. pp. 524 and 646), with unicellular Algae.

tricha occurred in great abundance in a basin in my father's garden in Genoa, in which a number of green Flagellata were also living.

The colonies consisted of long repeatedly bifurcating filaments, which were sometimes attached to the bottom or the side walls of the vessel in which I kept the animals, and sometimes hung down from the surface of the water. These filaments themselves appeared to be coloured green by the innumerable *Stichotrichæ* which were seated upon them. In fig. 6 I have endeavoured to represent the end of such a filament magnified 40 diameters.

The filament itself consists of nothing but the gelatinous material of the numerous tubes which the *Stichotrichæ* have formed, and which have gradually become amalgamated into a common mass, to which quantities of all sorts of foreign bodies (Diatoms, fæces, and the like) have attached themselves. It shows the same analogy with the colony of a Flagellate Infusorian (*Spongomonas*) figured by Stein (Organismus d. Infusionsth. Bd. iii. i. Taf. vi. fig. 11) as the carapace of my *Stichotricha socialis* with those of other Flagellate Infusoria, e. g. *Rhipidodendron* and *Phalansterium*. The Infusoria are seated at the periphery of the filament or tube; and then we see that each of them inhabits a tube of its own, in which it slips to and fro. The tubes may often be pretty long; but they never ramify, which must be due to the fact that in the division of the *Stichotricha* one half emigrates and settles itself between the other Infusoria. The more the settlement takes place at the apex the longer does the filament become.

As regards the *Stichotricha* itself, it shows nothing at all remarkable, on which account I have not investigated it more particularly. The animal measured about 0.1 millim., and was distinguished from others of its genus only by the green corpuscles in the interior*.

A second variety of the genus *Stichotricha* I found in a small aquarium of the Zoological Institute here. While *Stichotricha secunda* produces regular tubes, *Stichotricha socialis* dendritically branched tubes, and the form just described filiform or cylindrical colonies, the last-mentioned Infusorian constructs irregular domiciles, usually hand-shaped, in which the individual tubes issue like fingers from a broad flat surface. Frequently, also, we find *Stichotrichæ* which do not live in societies, but in separate irregular tubes formed amongst all sorts of decomposed matters. The Infusorian

* I have a recollection of having found a notice somewhere of a green variety of *Stichotricha*; but unfortunately I cannot cite the passage.

itself measures about 0.15 millim., or at least its larger forms, and has the same structure as the other *Stichotrichæ* referred to.

While hitherto only such representatives of the genus *Stichotricha* have been known as secrete domiciles consisting of a gelatinous material covered with granules of all kinds, one species, which I shall name *Stichotricha urnula*, behaves quite differently. It lives in a transparent membranous capsule of a flask-like shape, closed throughout except a narrow anterior opening (fig. 7), and scarcely ever quits it. The edges surrounding the aperture have a tendency to fall together when the Infusorian is entirely retracted within the carapace. The envelopes of *Stichotricha* differ from those of many peritrichous Infusoria (*e. g.* the *Cothurnice*) in that they are not attached to any support; hence the bottom of the flask is completely rounded off. They have a greater resemblance to those capsules which many Heterotricha (such as the species of *Freia*) construct for themselves. The length of the capsule is about 0.07 millim. in the full-grown forms. The animal which dwells in this envelope differs notably from the previously mentioned species of *Stichotricha*, but, it seems to me, not sufficiently to necessitate the creation of a new genus for it.

The difference becomes especially perceptible when the Infusorian stretches the anterior or neck part far out of the carapace, in order to procure food by the action of its cilia (fig. 7). In this state the hinder part of the body is not pointed, as elsewhere in this genus, but rounded off in the form of a ball or club; *i. e.* it assumes exactly the form of the bottom of the flask, from which it is separated by a small interval. This thick part of the body then narrows suddenly to form the neck, which is protruded far out of the carapace, and bends towards one side, as is proper to all *Stichotrichæ*. It may also happen that nearly the whole animal is drawn out in length, by which means the neck acquires a still further extension. This shows how extraordinarily contractile the body-substance of *Stichotricha urnula* is. When the Infusorian retracts itself into the capsule it loses this peculiar form, and then exhibits the ordinary structure of an Oxytrichine.

The protoplasm of the body is very rich in granules and consequently opaque, so that I have never succeeded in detecting any thing of the nucleus in the living animal. By staining with carmine solution, however, it immediately appears distinctly. It consists of two bean-shaped bodies, such as are typical of the family. Very frequently both of them are not placed perpendicular to the longitudinal axis of the

animal, but one of them is placed horizontally. This is probably due to the fact that the hinder part of the body, having assumed the rounded form, has suffered a displacement of its inner parts. It is remarkable that I could not succeed in detecting the nucleoli.

The ciliation is that characteristic of the genus *Stichotricha*. I do not enter here into such details with regard to it as I have already done elsewhere*, but confine myself to describing the particularly prominent cilia. There are, in the first place, the three long, stout, somewhat curved cilia at the extreme summit of the neck, which are followed by the peristome with its regularly arranged row of cilia. At the posterior extremity of the peristome there is the fine membranous seam (see fig. 7) which is here much more distinct than in *Stichotricha socialis* for example. It stands much further out from the neck, and thus forms a sort of frill, such as has frequently been described in other Infusoria.

On the neck we see, further, the separate rigid setæ standing regularly wide apart, as in the other *Stichotrichæ*. Besides these, flexible cilia, arranged in rows, cover the body, although here, on account of the carapace, they are difficult to observe. They are most distinctly perceptible at the posterior end of the Infusorian, where they also present remarkable peculiarities. *Thus they can act alternately as cilia and as pseudopodia*. In the former capacity they move in the well-known manner, beating to and fro; in the latter they serve to attach the body to the carapace, to which they adhere like the pseudopodia of a monothalamous Rhizopod. The posterior end of the *Stichotricha* is, in this case, not rounded off, but drawn out into irregular lobes; and these conditions may follow one another alternately and quickly—a further proof of the analogy (in this case *identity*) of the cilia and pseudopodia.

Stichotricha, of course, propagates by division; and then for a time there are two individuals in the same capsule. One portion wanders forth and immediately secretes a new capsule, either at a distance from the original one, or, should circumstances be favourable, in its vicinity. In the latter way large aggregations of *Stichotrichæ* are gradually produced. The intertwined flaskets, from which the long necks of the Infusorians look forth, present a pretty appearance.

I found *Stichotricha urnula* at the surface of the water in a small glass vessel in which, for a particular purpose, I had mixed fresh water with artificial sea-water. The latter was obtained from our marine aquarium, the former from the spring-conduit; so that there can hardly be any doubt that the

* "Neue Infusorien," Zeitschr. für wiss. Zool. xxxiii.

Stichotricha had been introduced with the sea-water. On two occasions, also, I succeeded in detecting one of them in a sample from the aquarium. Evidently the conditions in the small vessel filled with brackish water were very favourable to the *Stichotrichæ*, as they had rapidly increased to a considerable extent.

Lastly, it still remains for me to say something about the resemblance which *Stichotricha urnula* has to the genus *Chaetospira*. I have already* put forward the supposition that the *Chaetospira* which Lachmann† has figured may be identical with *Stichotricha*. This has become to me a certainty since *Stichotricha urnula* came under my observation. A glance at Lachmann's figure 7 will show that the figure represents a form which is not to be distinguished from my *Stichotricha urnula*.

Recently Saville Kent, in his 'Manual of the Infusoria' (London, 1880 and 1881), has cited the genus *Chaetospira* and figured a species of it (pl. xxix. figs. 37, 38). He also refers it to the Heterotrichous Infusoria—an error which is easily explained, as the numerous cilia of the rows running over the body often produce the impression that the Infusorian is entirely covered with cilia. I think, however, that I have sufficiently proved that this is not the case, and that the Infusorian possesses all the characters of an Oxytrichine, and particularly of a *Stichotricha*.

Although Lachmann's and Kent's figures scarcely leave any doubt that their species are the same as my *Stichotricha urnula*, I have preferred not to retain the name *Chaetospira*, because this generic name has hitherto been applied among the Heterotrichous forms. Moreover it seems to me, as already stated, justifiable to refer the Infusorian to the previously existing genus *Stichotricha*.

In conclusion, I must call attention to an Infusorian, to which its discoverer, Hudson‡, has given the name of *Archimedeæ remex*, whilst he appends the designation *Chaetospira* in brackets with a note of interrogation. Kent (*loc. cit.* p. 603) quite correctly regards this form as a *Stichotricha*; and as the domicile differs essentially from those of allied species, it must be named *Stichotricha remex*§.

* "Neue Infusorien," *loc. cit.*

† "Ueber die Organisation der Infusorien &c.," Müller's Archiv, 1856, Taf. xiii. figs. 6, 7.

‡ Monthly Micr. Journ. vol. xiv. p. 165.

§ The last part of Kent's 'Manual' only reached me after this memoir had been sent to the editors. In it the above-mentioned form is also cited as *Stichotricha remex*; but, on the other hand, a new genus, *Schizosiphon*, is created for my *Stichotricha socialis*, which seems to me not to be necessary.

III. ON PROCESSES OF FUSION IN *ACTINOPHRYS SOL* *.

It is well known, as a phenomenon frequently observed and described, that an intimate union of two or more individuals occurs among the Heliozoa. In this way regular syncytia may be produced, often consisting of more than twenty individuals. As regards the signification of this process, it appears to be certain that it stands in no relation to reproduction. The Heliozoa usually separate again without our being able to observe any alteration either in the nucleus or in the soft body. Hence it has been supposed that the sole purpose of these unions was to facilitate the reception of food, in favour of which we have also the circumstance that in this state the Heliozoa generally contain much nutritive material.

I have long had it in view to go carefully into this question, but could never obtain sufficient material. In this I only succeeded quite recently, when an abundance of *Actinophrys sol* had become developed in a small aquarium of the Institute here. Nevertheless I found it impossible to throw any more light by my investigations upon the significance of the colony-formation among the Heliozoa. But some other remarkable processes came under my observation, upon which I may report briefly. These are phenomena of fusion in which, in contrast to the formation of colonies, the two parts passed completely into each other (that is to say, one of them, namely the smaller one, was devoured by the other), and from which it appeared that separated fragments of *Actinophrys* or small individuals *without a nucleus* are able to perform their normal functions.

A full-grown normally formed *Actinophrys sol* had approached a much smaller specimen furnished with only a few pseudopodia, had been suddenly attacked by it, and in a short time passed entirely into it. After the union had become complete, so that the larger *Actinophrys* had again assumed its rounded form, I killed it with chromic acid, stained it with carmine, and mounted it in Canada balsam, when it appeared that only a single nucleus was to be seen in the centre of the Heliozoan. Hence I thought it must be supposed that the nuclei as well as the protoplasmic bodies of the two individuals had passed into each other.

To arrive at a certainty upon this point I endeavoured to observe the process again; and by shifting the covering-glass and drawing off and adding water under it, I succeeded in

* The essential parts of the following results have already been published in the 'Zoologische Anzeiger,' no. 118.

causing one of the numerous small *Actinophryes* present to approach a full-grown one in such a manner that it remained attached to its pseudopodia. Immediately it quickly approached the larger specimen or was drawn in by the latter; the pseudopodia partially fused together, and a bridge of protoplasm began to unite the two individuals (fig. 9). In about five minutes they were already for the most part fused together. At this moment the Heliozoa were killed as above described, stained, and mounted. During this it appeared that the smaller individual *had possessed no nucleus at all*. While in the larger *Actinophrys* the nucleus stands out from the surrounding protoplasm in the centre as distinctly as possible, no trace of any thing of the kind is to be recognized in the smaller one *. This explained why, in the previously cited process of fusion, only *one* nucleus was to be detected in the coalesced Heliozoa.

I have since frequently repeated this experiment, and always with the same result. I also succeeded in causing large *Actinophryes* furnished with nuclei to unite by bringing them artificially into contact. In this case, however, the union only took place slowly, while in the former it was rapidly effected; and although in the latter cases the outer contours did not indicate that two individuals were united, this could be clearly discerned from the two nuclei. Frequently the two approximated Heliozoa repulsed each other again—a proof that the union takes place consciously, if we may use such an expression. In favour of this we have also the circumstance that even the small individuals of *Actinophrys* are not always incepted. I once succeeded in conveying to a large specimen three small ones one after the other, all of which were absorbed by it, notwithstanding that several green food-particles were also received. I have represented the individual in question in fig. 10, and indeed at the moment when two of the small parts were almost amalgamated, while the third had already passed entirely into the protoplasm of the large *Actinophrys*, in which the above-mentioned green bodies were also imbedded. This individual now persistently refused to take up a fourth small Heliozoan which was brought close to it, always pushing the latter away from it, evidently because it was not disposed to undergo any further increase of substance.

It seems to me therefore that the observed processes have really no other signification in the case of *Actinophrys* than

* I may remark here that the difference of size between the coloured and living *Actinophryes* is always considerable, as the former are strongly contracted by the absolute alcohol.

an augmentation of substance, and that in this way the assumption that we have to do here with an act connected with reproduction, such as a conjugation, is completely excluded.

Perhaps, however, the fact that the above-mentioned small individuals (as I have called them) possess no nuclei is directly opposed to this view. This latter fact is remarkable enough; and I must enter upon it in further detail. The first question is, How are the organisms described by me as small individuals to be conceived? as perfect organisms or not?

To this it may be answered that they are nothing more than products of the disintegration of larger *Actinophryes*, and not the offspring of a Heliozoan by regular division. This may perhaps be quite correct; and a breaking-up into irregular fragments does occur here, and, as I intend hereafter to show, also among the higher Protozoa, namely the Infusoria. This, however, furnishes no reason why these disintegration-fragments should not in the present case be regarded as really individuals.

Thus, if we examine one of these so-called small *Actinophryes* more closely, we find that in truth it does not differ essentially from the perfect *Actinophryes*. At least there are specimens which are quite regularly formed; and, at all events, all of them are perfectly independent. Many certainly consist only of a few vacuoles surrounded by scanty protoplasm, from which one or two pseudopodia arise. But for the most part they were of an approximately round form. The vacuoles and protoplasm were distributed as in the full-grown animal; and numerous pseudopodia, often regularly arranged, radiated from the margin.

Further, the functions of these creatures are the same as those of the nucleated *Actinophryes*. They move spontaneously from place to place; they show rapid changes in the pseudopodia; in their interior we see nutritive bodies; and even the large vacuoles in which large food-particles are digested are frequently to be seen. Finally, very often the contractile vesicle is not wanting, and it pulsates rhythmically in the same way as in the normal animals. Must we not therefore designate these non-nucleated forms as independent individuals? It may be objected that even in the mode in which the fusion takes place the imperfect independence of the small parts is demonstrated, as they are actually swallowed just like other prey. But the latter statement is not quite correct; for, until it has entirely passed into the other, the small animal retains the faculty of extruding pseudopodia, and, further, two non-nucleated *Actinophryes* may approach each other and unite.

I first of all brought together two small animals, and observed that they attracted each other very quickly and fused into a single mass, which of course when prepared proved to be destitute of nucleus. Another time I brought about the union of two Heliozoa of unequal size, of which I regarded the smaller as non-nucleate, the larger as normal and nucleated; in both the vacuoles pulsated very distinctly. The fusion took place here exactly as in the case previously described. I waited until the small animal had passed entirely into the larger one and the latter had resumed the round form, and then stained it with carmine. To my astonishment no nucleus appeared; therefore even the larger of the two Heliozoa, which had all the characters of a normal individual, had also been without a nucleus. Illusion by insufficient action of the reagents cannot have occurred in this observation, seeing that other examples and all sorts of other Protozoa were lying together under the same glass cover, and in these the nuclei became intensely coloured. A further demonstration is furnished by another case, in which two *Actinophrys* of exactly similar form and with very abundant vacuoles had united and begun to fuse together; but I interrupted the further continuance of the process, and stained the mass when it had about assumed a biscuit-shape; and it turned out that only one of the animals possessed a nucleus, while no trace of one could be observed in the other.

From all this we may therefore assert the proposition that the absence of the nucleus in *Actinophrys* does not prevent the protoplasm from performing its functions in the normal fashion.

In the Monera, although they possess no nucleus, we are accustomed to see all vital phenomena pursue their course in the protoplasm; but among the Protozoa, in which the presence of a nucleus is normal, one might have expected from the latter a greater influence upon the protoplasm.

It follows from this, therefore, *that the nucleus has no importance for those functions of the cell-body which are not directly connected with reproduction—that is to say, movement (pseudopodium-formation), inception of food, excretion (pulsation of the contractile vacuole), and growth; it may also be without influence on the external form.*

As regards the fusion-process here noticed itself, I have already remarked that it can hardly have any other significance for the *Actinophrys* than that of an increase of substance by the inception of the non-nucleated individuals contained in the water—just as upon one cosmical body there fall the ruined fragments of another like it, which revolve in the cos-

mical space, if this comparison be permitted. And, indeed, they would seem to be ruined fragments with which we have here to do—that is to say, fragments of Heliozoa not produced by regular division, but by the breaking-up and repeated fission of normally formed individuals.

I shall perhaps hereafter have occasion to notice that such a breaking-up into small pieces is a very frequent if not even a regular periodical phenomenon among the Infusoria*; and this applies also, according to my observations, to *Actinophrys* among the Heliozoa. I have previously made the same observation, but without going further into it.

In the present case it would appear that these disintegration-fragments, which, as we have seen, may possess a high degree of individuality, do not perish, but gradually become converted into perfect *Actinophryes* or pass into the body-substance of others.

Unfortunately the difficulties in the treatment and preparation of these objects is too great to permit one to hope ever to arrive at perfect certainty about them, and to decide such a question as whether the non-nucleate individuals are able to produce a nucleus endogenously. It seems to me that this hypothesis is not to be absolutely rejected out of hand, especially in the case of a Heliozoan which is pretty nearly allied to those Rhizopoda in which the first nucleus must at some time have originated freely. We certainly can hardly give a satisfactory explanation of the breaking-up of the Heliozoa (unless we regard it as pathological), except that thereby a more rapid multiplication may be attained. The whole process has some resemblance to histolysis during the embryonic development of some of the higher animals. Just as in the latter process we see many layers of cells dissolve completely, to be afterwards built up again out of the ruins, so here unicellular organisms break up into small fragments, which again become formed into new individuals, partly by fusion with others and partly by their proper growth.

In conclusion, I must still mention that frequently the small non-nucleate elements, on coming into contact with the pseudopodia of the normal animals, suddenly burst asunder and break up into a mass of granules, which, however, are nevertheless incepted. In one case a small individual had approached an *Actinophrys*; and when it was involved in the pseudopodia of the latter, it broke up suddenly, so that nothing

* These investigations have not yet reached that completeness which would allow me to cite them here.

more than an irregular mass of granules was to be seen. These, however, were held together by the pseudopodia of the large individual; a capsule of protoplasm formed around the mass of ruins; and it was then gradually drawn into the body of the *Actinophrys*, into which it had soon completely passed.

EXPLANATION OF PLATE XIII.

(This plate contains only a selection from the numerous figures given by Dr. Gruber. His numbers are given in parentheses.)

Figs. 1-4. Pachymyxa hystrix.

Fig. 1 (1). A middle-sized *Pachymyxa* with extended pseudopodia, alive. We see the little bacilli of the envelope which give the Rhizopod a brown colour by transmitted light. Regularly distributed over the surface are the pores for the issue of the processes.

Fig. 2 (4). A living specimen which has rolled itself spirally in the middle part. Pseudopodia issue from the two extremities.

Fig. 3 (6). A small portion of the surface of a *Pachymyxa* killed with osmic acid and stained with picrocarmine. The protoplasm shows two layers—an inner lighter one, with granules and nucleiform bodies, and an outer hyaline deeply stained one, from which the pseudopodium issues.

Fig. 4 (7). The supposed naked variety of *Pachymyxa hystrix*. Two specimens fused together, living; the larger is absorbing the nutritive mass of the smaller one. The larger one is characterized by the sharp separation of an outer and an inner layer of protoplasm and by the regularity of the former. At the periphery pseudopodial cones with pseudopodia appear at uniform distances apart.

Fig. 5 (12). An *Amæba oblecta*, living, in its brownish envelope, from the orifice of which pseudopodia issue.

Fig. 6 (17). *Stichotricha*, sp. The extremity of a filamentous colony with a great number of Infusoria which project from the gelatinous mass.

Fig. 7 (22). *Stichotricha urnula*. A specimen in its flask-shaped carapace, with the anterior part of the body prolonged into a neck. At the peristome the membranous seam is distinctly perceived.

Fig. 8 (31). A large vesicle of *Spongomonas guttula* of the natural size.

Fig. 9 (41 *b*). A large and a small *Actinophrys* artificially brought together, with the pseudopodia mingling. The union has commenced, a plasma-bridge extending between the two individuals.

Fig. 10 (42). An *Actinophrys* which has taken up three small individuals, two of which are still visible; besides these it has taken in some green food-particles.