Annals and Magazine of Natural History

Series 2

ISSN: 0374-5481 (Print) (Online) Journal homepage: <http://www.tandfonline.com/loi/tnah08>

XX.—On Actinophrys Sol.

E. Claparede

To cite this article: E. Claparede (1855) XX.—On Actinophrys Sol., Annals and Magazine of Natural History, 15:87, 211-217, DOI: [10.1080/037454809496399](https://doi.org/10.1080/037454809496399)

To link to this article: <http://dx.doi.org/10.1080/037454809496399>

Published online: 23 Dec 2009.

Submit your article to this journal [↗](#)

View related articles [↗](#)

branipora, or *Flustra*, which is impressed on the outer surface of the Oyster; and thence a further proof is afforded that the *Pholas* was external, and served as a mould to the Oyster-shell, and is not enclosed within its substance.

"Yours truly,
"J. E. GRAY."

Greenwich, Feb. 17, 1855.

XX.—On *Actinophrys Sol.* By E. CLAPARÈDE*.

[With a Plate.]

It can scarcely be doubted that nearly all true Infusoria, that is to say, all animal Infusoria, possess at least an indication of a circulation, by which expression we would refer to the so-called *contractile vesicles*, without however at present deciding as to the kind of circulation, or whether it be a circulation of blood or water. Nevertheless this structure has hitherto remained undiscovered in many Infusoria, apparently of animal nature; in one very pretty animalcule, the *Actinophrys Sol*, especially, it has been overlooked by nearly all observers. As, however, I recently met unexpectedly with a considerable number of this *Actinophrys* in a bottle where I had not previously observed them, I was struck by a peculiar organ possessed by all the individuals, which puzzled me at first, but soon showed itself to be undoubtedly a contractile vesicle placed in a very remarkable position.

Ehrenberg, in describing *Actinophrys Sol* in his great work on the Infusoria, of course endeavoured to discover in it the stomach cells, mouth and anus required by his theory. Accordingly, as might be expected, *Actinophrys* was said to capture animalcules and microscopic plants by means of a proboscis, digest them in connected stomachal cells, and get rid of the indigestible portions through an anal opening. Later observers (Dujardin, Kölliker, &c.) could find nothing of this, and affirmed either that the animal did not eat, or that it converted any part of its body at pleasure into a mouth or an anus. Kölliker, in particular, conjectured that Ehrenberg had seen a process, which would gradually have formed a tentacle, and had taken it for a protrusible proboscis. Nevertheless Ehrenberg's assertions as regards the mouth are by no means groundless; his observations are perfectly correct, but his explanation of them quite inadmissible, as will be seen from what follows.

When seen from above (Pl. VIII. fig. 1), *Actinophrys Sol* ap-

* Abridged from Müller's Archiv for December 1854.

Fig. 2

Fig. 1.

Fig. 3.

Fig. 3.

Fig. 4.

Fig. 6.

B

C

pears circular, but its general form is spheroidal, with a great number of radiating processes, which are sometimes very long. No distinct nucleus is to be recognized. What Kölliker describes under this name scarcely deserves to be so called, for this supposed nucleus passes gradually into the general substance of the body, as indeed Kölliker himself perceived. Apparently the substance of the body becomes condensed by degrees towards the centre or in the opposite direction, producing a difference in appearance between the central and peripheral parts. The names "inner layer" and "outer" or "cortical layer" are therefore preferable. From time to time a globular prominence rises slowly and gradually from a particular point on the surface of the animal (fig. 1 o); this increases more or less in different cases, sometimes, especially in small individuals, attaining nearly a third of the size of the entire body, but generally reaching only $\frac{1}{8}$ th or $\frac{1}{10}$ th of that size. The margin of this projection is always well defined, much more so than the other parts of the body, especially when it has attained its greatest evolution. At this moment it contracts suddenly and disappears entirely, so that a flattening of the outline is often to be observed at the point previously occupied by this remarkable elevation; the margin soon becomes rounded again, the globular projection gradually rises, attains its previous highest development, and then suddenly disappears again.

At first I felt inclined to adopt Ehrenberg's statements as to the presence of a mouth in *Actinophrys*, as the description of the so-called proboscis agreed exactly with my own observations, especially as Kölliker had entirely overlooked this peculiar phenomenon, and his descriptions of the mode in which the animal eats did not appear to me to be quite clear. In fact this regular protrusion and contraction of the proboscis, as Ehrenberg called it, rendered the admission of foreign bodies into the substance of the *Actinophrys* far more intelligible than the mode of inception supposed by Kölliker, by the mere pressure of the processes*. But if this organ were not a proboscis in Ehrenberg's sense, nothing appeared to me more natural than to consider it as a contractile vesicle, on account of its regular contractions, especially as this view was supported by Prof. J. Müller.

This opinion, however, is not new; it has already been put forward in Von Siebold's 'Comparative Anatomy,' but has not been referred to by the generality of observers. Siebold says, "In this respect (the contractile vesicle), *Actinophrys Sol* is very remarkable; its contractile vesicles are situated so close under the general integument, that the fluid flowing to them from the

* Kölliker, Ueber *Actinophrys Sol*, Zeitschr. für Wiss. Zool. 1849.

parenchyma dilates the integument into the form of a pellucid bladder; the latter, however, still retains sufficient elasticity to drive the nutritive fluid again into the parenchyma by its contraction." There is, however, no general integument in this animalcule, so that the nutritive fluid cannot be driven back into the parenchyma by its contraction. In his classification Siebold placed *Actinophrys* amongst his *Stomatoda*, or Infusoria with a distinct mouth and œsophagus, and close to *Prorodon* and *Leucophrys* amongst the true Ciliata, which are evidently far higher in organization, and some of which possess a well-developed dental apparatus, in addition to a ciliated mouth and œsophagus, whilst there can be no doubt that the natural position of *Actinophrys* in the system is near *Amœba* and *Arcella*, amongst the Rhizopoda.

Siebold ascribes two contractile vesicles to *Actinophrys*, whilst I have never seen more than one. Several vesicular elevations often occur on the margin, but only one of these is contractile. I have, however, observed two contractile vesicles in several individuals (fig. 2), but in these cases the form always gave rise to a suspicion of fission or of an amalgamation of two individuals (*Act. difformis*, Ehr.). The presence of a single contractile vesicle does not, however, appear to be universal amongst the Rhizopoda: I have observed two in *Arcella vulgaris*. Stein* also has recently called attention to the vesicles in question, and also mentions the existence of two, which furnishes an additional support to Siebold's assertion. It is still a question, however, whether he saw them in undoubtedly *simple* individuals.

It is surprising that Kölliker, who was acquainted with Siebold's observations, should have characterized them as incorrect, and as arising from an illusion. According to him, Siebold had mistaken accidental expansions and contractions of the substance enclosing the vacuoles, in which the latter were persistent, for phenomena indicating the existence of contractile reservoirs. This, however, is not the case; the size, the unchanging position, and the regular expansion and contraction of this organ, resembling the systole and diastole of a heart, will prevent its being confounded with a vacuole. That Kölliker should have overlooked it is particularly unintelligible, as the phenomenon is immediately presented by nine out of ten specimens of *Actinophrys*. I have often admired this charming spectacle for hours, without observing the least irregularity.

* * * * *

Before quitting the consideration of the contractile vesicle, we

* Die Infusionsthier, auf ihre Entwicklung untersucht von Stein. Leipzig, 1854.

may glance at the part it plays in the œconomy of the animal. Ehrenberg's hypothesis of a seminal vesicle emptying itself regularly every minute, or even more frequently in most Infusoria, is quite indefensible. There remain, therefore, only two different views as to the nature of the contractile vesicles,—they are either true hearts, like those possessed by most animals furnished with blood-vessels, or heart-like organs allied to the Polian vesicles of the Echinodermata, or to the pulsating dilata-tions of the aquiferous vessels of the Cestode and Trematode worms, and of the Rotifera. O. Schmidt has maintained the latter view, and the great similarity of the contractile vesicles of the Infusoria and Rotifera is certainly in its favour. Nevertheless we cannot adopt this opinion, as these contractile vesicles are deficient in the leading characteristics of an aquiferous system, namely the existence of ciliary movement in its smaller branches, and especially of an immediate connexion with the surrounding medium. We cannot indeed deny the existence of the former of these characters, as no vessels have hitherto been discovered amongst the Infusoria, but the other indispensable condition is certainly wanting. It might be supposed that the openings of the aquiferous system, if present, had escaped us from their small size, but such a supposition is rendered exceedingly improbable by the position of the contractile vesicle in *Actinophrys*. If an opening existed at that point, it must be visible, or at all events currents would be observed in the water during the reception and expulsion of fluid. As this is not the case, the contractile vesicles of the Infusoria can only be compared with the heart-like organs of the sanguiferous systems of other animals.

Ehrenberg can never have seen the animal feeding, otherwise he would have recognized the true destination of the so-called proboscis, for the reception of food certainly takes place at quite another part of the body. Stein has also, as already stated, mentioned the contractile vesicle of *Actinophrys*, but he rejects Siebold's explanation, merely because "he is acquainted with no infusorial animal in which the contractile space can be protruded externally." He recurs therefore to an opinion not far removed from Ehrenberg's, and endeavours to explain the reception of food by the action of this organ. Thus, according to Stein, the prey when captured by the tentacles is brought in contact with one of the protruded vesicles, to which it adheres; this then suddenly disappears into the cortical layer, drawing the prey with it, which at first lies in a funnel-shaped pit formed by the contraction of the vesicle, but is afterwards drawn into the interior of the cortical layer by the rolling over of the margins of the pit, and thence passes to the medullary layer. Stein con-

siders that Kölliker's observations are in accordance with this, as he also first saw the food lying in a pit on the surface of the cortical layer, and supposes that Kölliker has overlooked the previous moment in which the place of the pit is occupied by a cæcal prominence. Kölliker's statement that any portion of the surface may be employed indifferently as mouth or anus, is got over by the supposition that although in general only two opposite vesicular spaces in the cortical layer are protrusible, under certain circumstances any other vesicular space at the surface of the body may be more or less distended so as to be brought into contact with any object that may be seized by the tentacles. We shall, however, satisfactorily prove that this view is untenable, and that the mode in which the reception of nourishment takes place is not reconcilable with any such office of the protrusible process. We have been fortunate enough repeatedly to witness the feeding of *Actinophrys*, a phenomenon which has escaped Stein, in spite of his careful observations, and can therefore assert that the reception of food is never effected by means of the expansion and contraction of the vesicle. The contractile vesicles (*vesicular spaces* of Stein) cannot be employed for any other purpose, than, like a heart, to drive the nutritive fluid into the substance of the body. Stein also wishes to prove that the movements of the animal are produced by these vesicles; this is also untenable.

Kölliker, on the contrary, is perfectly right in stating that "*Actinophrys* can convert any part of its body at pleasure into a mouth, and employ it for the reception of food," and that it can "also evacuate the indigestible portions at any point." Nevertheless I cannot entirely agree with his description of the process of ingestion. According to his account, a pit forms itself for the food in the substance of the body, and after the entrance of the object, the margins of the pit approach and unite. It is not, however, the food that penetrates into the substance of the body,—it is rather the latter that approaches and embraces the food. When an animal or plant comes accidentally within reach of the tentacles of an *Actinophrys*, it remains adhering to the sticky substance of which these appear to be composed. The *Actinophrys* then slowly contracts the tentacle or tentacles with which the prey is in contact, and before the latter has touched the surface of the body, it is seen to be enveloped in a kind of mucus. This mucus is completely undistinguishable from the parenchyma of the *Actinophrys*; it appears as though the substance of which it is composed had suddenly drawn itself over the captured object. The elevation thus produced then slowly flattens, and by this means the food is gradually drawn into the body (fig. 3). *Astasia*, which I frequently saw sucked in

by *Actinophrys* in this way, continued to move for a little time, endeavouring to break through the substance that enveloped them; their movements, however, soon ceased; they became converted into a globular mass, which circulated very slowly through the parenchyma with the so-called vacuoles. The particle of food always lies in a cavity filled with fluid (*vacuole* of Dujardin), but it could not be determined with certainty whether this fluid was a product of digestion, a secretion assisting in that function, or merely water sucked in with the food. As, however, the fluid always exhibited the same pale reddish colour as the contents of the contractile vesicle, indicating different refractive powers from those of water, the last supposition could not be supported. However this may be, the process of digestion always requires a considerable time. I once followed the changes of a *Chlamidomonas* which had been swallowed by an *Actinophrys*; small as the object was, three hours scarcely sufficed for its conversion into an unrecognizable gelatinous mass.

This mode of feeding is exceedingly remarkable, and it must be admitted, not very easy of comprehension. At first I thought that the substance which so suddenly enveloped the object to be swallowed, was produced by the mere bending, expansion and fusion of the tentacles. I could not, however, retain this opinion; an extension of a mucous substance, apparently the parenchyma, really takes place from the side of the *Actinophrys*, and this is afterwards drawn in with the prey. This expansion sometimes takes place very slowly. A thick, regularly lobed mass is seen to embrace the object (fig. 4 *a*), and I have once observed this extension without the presence of any prey (fig. 4 *b*). I can only compare this process with what takes place in *Amœba*. Dujardin indeed asserts that the *Amœba* are nourished by the mere imbibition of fluid, and that the particles of food found in them come there by accident. This statement, however, is not in accordance with facts. The *Amœba* really feed in a very remarkable manner; they glide slowly along, and draw themselves like a veil over the objects to be swallowed; one would suppose that the objects still lay beneath them, but they are already enclosed within the body. We may observe in passing that it appears almost absurd to attempt the distinction of species amongst the *Amœba* until we know something more of their intimate organization. Thus Ehrenberg's *A. radiosa* is characterized by the regularity of its processes and its generally stellate form; but when the creature creeps and feeds, it slowly expands, and its characteristic form disappears; it flows along like a cloudy veil or a drop of oil, and *A. radiosa*, Ehr. has become converted into *A. diffuens*, Ehr. *Arcella vulgaris* un-

dergoes an exactly similar change, under the same circumstances.

The mode of feeding of *Amæba* and that of *Actinophrys* are evidently two allied phenomena. This analogy has hitherto escaped notice, except by Kölliker, principally on account of the determinate form of *Actinophrys*, which contrasts strongly with the extremely changeable and almost formless *Amæba*. I have, however, frequently convinced myself that *Actinophrys* partakes of this wonderful alterability of form. They may be found with very long and very short tentacles, and these organs may even entirely disappear. They may acquire every possible variety of form (figs. 5 & 6), but these changes take place far more slowly than in *Amæba*, and the modification figured by Ehrenberg in his great work appears to be the typical form.

Even the changeable *Amæba* have their typical forms,—such as the stellate (*A. radiosa*, Ehr.) and globular. It is often difficult to determine whether we have to do with a globular *Amæba*, or with an *Actinophrys* that has contracted its tentacles. The most certain character in this case is furnished by the contractile vesicle, which in *Amæba* lies deep in the body, but in *Actinophrys* quite on the surface. Further observations soon settle the question, as the doubtful animal will either extend the usual thin processes of *Actinophrys*, or convert itself into an unmistakable *Amæba* by expanding its body, which I have never observed in *Actinophrys*. *Actinophrys Sol* is a very inactive creature, and I have never been able to ascertain how its movements are effected; nay, for some time I was even doubtful whether it was capable of any other movement than an extremely slow change of form, and the extrusion of the mucous substance. Nevertheless, the animal in its ordinary sun-like form is able to move slowly in a given direction, but during this movement no contraction of the body or bending of the tentacles is to be observed. I must therefore leave the nature of the movement undetermined, but the *Actinophrys* is far less active than its near allies the *Amæba*. Stein indeed thinks that the locomotion of *Actinophrys* is effected by the contractions of the contractile vesicle. But if this were the case, the movement must always take place in a direction opposite to the vesicle, a circumstance which I have not observed.

[To be continued.]