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XXXIV.—*Zoological Notes and Observations made on board H.M.S. Rattlesnake.* By Thomas H. Huxley, F.R.S., Assistant Surgeon R.N.

[With a Plate.]

III. *Upon* Thalassicolla, *a new Zoophyte.*

In all the seas, whether extra-tropical or tropical, through which the "Rattlesnake" sailed, I found floating at the surface the peculiar gelatinous bodies which are the subject of the present communication. They were the most constant of all the various products of the towing-net, which was rarely used without obtaining some of them, and which sometimes, for days, would contain hardly anything else.

The extreme simplicity of structure of these creatures was more puzzling to me than any amount of complexity would have been. The difficulty of perceiving their relations with those forms of animal life with which I was familiar, gave me rather a distaste to the study of them, and, as I now perceive, has rendered my account of their organization far less complete than I could wish it.

However, these forms seem completely to have escaped the notice of voyagers, and therefore I hope to do some service by directing the attention of future investigators to them, and by endeavouring to show what seem to me to be their relations in the scale of being.

It may not be out of place at the same time to examine what are the *positive* characters of those lowest classes of animal life of which this is a member.

The *Thalassicolla** is found in transparent, colourless, gelati-

* Θάλασσα, *the sea*; κόλλα, *jelly, glue.*

nous masses of very various form;—elliptically-elongated, hour-glass-shaped, contracted in several places, or spherical, varying in size from an inch in length downwards; showing no evidence of contractility nor any power of locomotion, but floating passively on the surface of the water.

Now of such bodies as these there were two very distinct kinds: the one kind, consisting of all the oval or constricted, and many spherical masses, is distinguished to the naked eye by possessing many darker dots scattered about in its substance; the smaller kind, always spherical, has no dots, but presents a very dark blackish centre, the periphery being more or less clear. I will adopt the provisional name of *Th. punctata* for the former kind, and that of *Th. nucleata* for the latter, as a mere matter of convenience, and without prejudging the question as to the existence of specific distinctions.

Th. punctata. (Pl. XVI. figs. 1, 2, 3.)

The mass consists of a thick gelatinous crust containing a large cavity. The crust is structureless, but towards its inner surface minute spherical, spheroidal or oval bodies are imbedded, from which the appearance of dots arises. These are held together merely by the gelatinous substance, and have no other connexion with one another. Each "spheroid" is a cell, with a thin but dense membrane, $\frac{1}{200}$th to $\frac{1}{250}$th of an inch in diameter, and contains a clear, fatty-looking nucleus $\frac{1}{1400}$th to $\frac{1}{800}$th of an inch in diameter, surrounded by a mass of granules which sometimes appeared cellæform.

This fundamental structure—a mass of cells united by jelly—like an animal *Palmella*, was subject to many and important varieties.

Very commonly the central part of each mass, instead of containing a single large cavity, consisted of an aggregation of clear, large, closely-appressed spaces, like the "vacuolæ" of Dujardin (figs. 2, 3, 2 *a*, 3 *a*).

Very frequently also each cell was surrounded by a zone of peculiar crystals somewhat like the stellate spicula of sponge, consisting of a short cylinder, from each end of which three or four conical spicula radiated, each of these again bearing small lateral processes (figs. 3 *a*, 2 *b*).

In another kind, much more rarely met with, the spherical cell contained a few prismatic crystals about $\frac{1}{1000}$th of an inch in length; it was of a bluish colour, and enveloped in a layer of densely packed minute granules not more than $\frac{1}{1500}$th of an inch in diameter. Outside these there was a number of spherical bright yellow cells $\frac{1}{1600}$th of an inch in diameter, and inclosing the whole a clear, transparent brittle shell perforated by numerous

rounded apertures, so as to have a fenestrated appearance (fig. 6). There were no spicula in this kind.

In a single specimen I found a similar shell, but its apertures were prolonged into short tubules (fig. 5).

Frequently the connecting substance in which the cells were imbedded appeared to be quite structureless, but in some specimens delicate, branching, minutely granular fibrils were to be seen radiating from each cell into the connecting substance (fig. 2 *b*).

I have mentioned certain minute bright yellow spherical cells contained within the shell of the fenestrated kind; such coloured cells are contained in all kinds either diffused through the connecting substance or more or less concentrated round each large cell (figs. 3 *a*, 2 *b*).

Th. nucleata. (Pl. XVI. fig. 4.)

This form consists of a spherical mass of jelly as large as the middle-sized specimens of the last variety, with an irregular blackish central mass. Enveloping this and forming a zone about half the diameter of the sphere there is a number of clear spaces—vacuolæ—varying in size from $\frac{1}{62}$nd to $\frac{1}{2500}$th of an inch, the smallest being innermost. Scattered among the vacuolæ of the innermost layer, there were many of the yellow cells, and a multitude of very small dark granules. Delicate, flattened, branching fibrils radiated from the innermost layer, passing between the vacuolæ, and in one specimen these fibrils were thickly beset with excessively minute dark granules, like elementary molecules, which were in active motion, as if circulating along the fibrils, but without any definite direction. In this case the whole body looked like a moss agate, so distinct were the radiating fibrils (4 *a*). Left to itself for less than an hour, however, this appearance as well as the circulation of granules vanished, and only a few scattered radiating fibrils were to be observed, the rest seeming to have broken off and become retracted.

By rolling under the compressor the outer mass could be completely separated from the central dark body, which then appeared as a spherical vesicle $\frac{1}{63}$th of an inch in diameter (fig. 4 *b*), showing obscurely a granular included substance.

The membrane of the vesicle was very strong, resisting and elastic. When burst it wrinkled up into sharp folds (fig. 4 *c*), and gave exit to its contents (fig. 4 *d*). These were—

1. A very pale delicate vesicle (nucleus?) without any contents, and measuring (but when much compressed) about $\frac{1}{60}$th of an inch (fig. 4 *d*).

2. A heterogeneous mass consisting of (*a*) a finely granular base, (*b*) oil-globules of all sizes, (*c*) peculiar cells $\frac{1}{800}$th to $\frac{1}{1000}$th

of an inch in diameter (4 *e*). Some of these had a solid greenish red nucleus about $\frac{1}{3500}$th of an inch in diameter. Others resembled the nuclei in colour and appearance, but were larger ($\frac{1}{2500}$th of an inch), and had no cell-membrane:—were these granule cells?

Altogether the *Thalassicolla nucleata* might readily be imagined to be a much-enlarged condition of single cells of the *Th. punctata*; but I have no observations to show that it was so, nor can it be said from which of the varieties of *Th. punctata* the *Th. nucleata* arises.

The question may readily arise, Are these perfect forms? I can only say, as negative evidence, that I have never observed any trace of their further development, and that the spicula and 'shells,' and the capacity of fission, appear to afford positive grounds for believing that they are not mere transitional stages of any more highly organized animal. If, further, it can be shown that their structure is closely allied to that of known organisms, this probability will, I think, almost amount to a certainty.

What animals are there then which consist either of simple cells or of cells aggregated together, which hold the same rank among animals that the Diatomaceæ and Desmidiæ, the Protococci and Palmellæ hold among plants?

Ten years ago the general reply of zoologists would have been —none. The researches of the celebrated Berlin microscopist, Prof. Ehrenberg (wonderful monuments of intense and unremitting labour, but at least as wonderful illustrations of what zoological and physiological reasoning should *not* be), led to the belief that the minutest monads had an organization as complicated as that of a worm or a snail. In spite, however, of the great weight of Prof. Ehrenberg's authority, dissentient whispers very early made themselves heard, from Dujardin, Focke, Meyen, Rymer Jones, and Siebold. To these Kölliker, Stein and others —in fact, I think I may say *all* the later observers—have added themselves, until it really becomes a matter of duty on the part of those interested in the progress of zoology to pronounce decidedly against the statements contained in the 'Infusionsthierchen,' so far as regards anatomical or physiological facts*.

It has been shown in the first place, that a great mass of the so-called Polygastria are plants—at any rate are more nearly allied to the vegetable than to the animal kingdom. Such is the case

* That the above assertions will be considered by the majority of English readers to be unwarrantably severe, and considering the relative standing of the Professor and his critic, possibly impertinent, is no more than is to be expected.

I can only beg to disclaim all mere iconoclastic tendencies, and refer to a comparison of Prof. Ehrenberg's works with facts for my justification.

with the Diatomaceæ and Desmidiæ, the Volvocina, the Monadina, the Vibriones, and to these we must very probably add the Astasiæa.

So utter has been the want of critical discrimination in the construction of genera and species, that Cohn, in his admirable memoir upon *Protococcus pluvialis*, enumerates among the twenty-one forms (to which distinct names have been given by authors) assumed by the *Protococcus*, no less than *eight* of Prof. Ehrenberg's genera. The family "Polygastria," thus cut down to less than one-half its original dimensions, contains none but animals which are either simple nucleated cells, or such cells as have undergone a certain amount of change, not sufficient however to destroy their real homology with nucleated cells.

A nucleus has been found in *Euglena, Arcella, Amœba, Amphileptus, Trachelius, Bursaria, Paramœcium, Nassula, Chilodon, Oxytricha, Stylonichia, Stentor, Vorticella, Euplotes, Trichodina, Loxodes*, and other genera. It may be brought out by acetic acid just like any other nucleus in *Vorticella* and *Euglena*.

The animal is an unchanged cell in *Euglena*, in *Amœba* and in *Opalina*. In others, as the *Vorticellæ*, there is a more or less distinct permanent cavity in the interior of the cell which opens externally, an occurrence not without parallel among the secreting cells of insects. Certain genera, such as *Nassula*, have an armature of spines, but so have some of the Gregarinidæ which are unquestionably simple cells.

Contractile spaces,—cavities which appear and disappear in different parts of the Infusoria, and sometimes become filled with the ingesta,—are found no less commonly in the component cells of the tissues of many of the lower animals, and according to Cohn in the primordial cells of plants also.

The "Polygastria," then, may be justly considered to be simple cells, and to form a type perfectly comparable with *Thalassicolla*.

The researches of Henle, Stein, and Kölliker have made us acquainted with another form of cellular animals—the Gregarinidæ.

These are nucleated cells, without cilia, but with contractile walls, which lead an independent parasitic life in the intestines of many of the Invertebrata, principally insects.

The Gregarinidæ, like the Infusoria, are generally, if not invariably, single, solitary cells.

A third type is formed by the Foraminifera. The fate of these animals is somewhat singular. Considered to be Cephalopoda by D'Orbigny; Bryozoa by Ehrenberg; rudimentary Gasteropods by Agassiz; all careful observation tends to confirm the opinion of Dujardin, that the fabrication of their remarkable shells is

essentially similar to *Amœba* and *Arcella*, both of which have been shown to be nucleated cells.

Lastly, we have the Sponges. That the tissue of the Sponges breaks up into masses, each of which is similar to an *Amœba*, has been pointed out by Dujardin, and confirmed by Carter and others. Dujardin, however, believing that a peculiar formless substance, "Sarcode," constitutes the tissues of the Sponges (as well as of the Infusoria and many other of the lower animals), fails to point out that they are mere aggregations of true cells.

This is not the place to discuss the important question, whether the great law developed by Schwann does or does not hold good among the whole of the lower animals. I believe that there is evidence to show that it does; that everywhere careful analysis will demonstrate the nucleated cell to be the ultimate histological element of the animal tissues; and that the "sarcode" of Dujardin, and the "formless contractile substance" of Ecker, are either cells or cell-contents, or the results of the metamorphosis of cells. Be this as it may, however, I can say positively, as the result of recent careful examination, that *Spongilla*, *Halichondria*, and *Grantia* are entirely composed of nucleated cells.

The Foraminifera and Sponges then, no less than the Infusoria and Gregarinidæ, are "unicellular" animals—animals, that is, which either consist of a single cell, or of definite aggregations of such cells, none of which possesses powers or functions different from the rest.

Using the word "unicellular" in this extended sense (as it has been used by Nägeli and others with regard to the Algæ), it may be said that there are four families of unicellular animals; in two of these, the Infusoria and Gregarinidæ, the cells are isolated; in two, the Foraminifera and Sponges, they are aggregated together.

From these considerations it appears to me that the zoological meaning and importance of the *Thalassicolla punctata* first become obvious. It is the connecting link between the Sponges and the Foraminifera. Allied to the former by its texture and by the peculiar spicula scattered through the substance of some of its varieties, it is equally connected with the latter by the perforated shell of other kinds. If it be supposed that a *Thalassicolla* becomes flattened out, and that a deposit takes place not only round the cells, but between the partitions of the central "vacuolæ," it becomes essentially an *Orbitoides**.

* Dr. Carpenter, to whom I communicated these observations, writes to me: "As far as I can understand them, the bodies described (if perfect non-embryonic forms) seem to constitute that kind of connecting link between Sponges and Foraminifera, which the relative position I have assigned to them would lead me to expect. It is interesting to remark that the cullen-

To come to a similar understanding of the nature of the *Thalassicolla nucleata*, it is necessary to recur again to certain general characteristics of the reproductive processes in the unicellular animals.

If we except *Tethya*, a sponge*, the ordinary reproductive elements have as yet been found in no unicellular animal.

Fission occurs in all except perhaps the Gregarinidæ. Gemmation appears to take place in the Foraminifera and Infusoria. In the Sponges the so-called ova or gemmules seem to be only a temporary locomotive condition of the cells, such as occurs in the *Vorticellæ* among the Infusoria, and the *Protococci* among plants.

But in all (except the Foraminifera) a process of multiplication by endogenous development occurs, and would seem in some cases to represent sexual propagation. Now the mode of this endogenous multiplication presents remarkable features of similarity in the Infusoria, the Gregarinidæ, and the Sponges.

There is a certain period in the existence of *Vaginicola crystallina*, when, gorged with food stored up in the shape of fat granules, &c., within the cavity of its cell-body, it becomes sluggish and eventually still. The body contracts and becomes rounded, and the transparent case closes in and seals up its inhabitant. Eventually long processes are developed from the body, and it takes on the form of the genus *Acineta* of Ehrenberg. After a while a new life stirs within this chrysalis-like form, and the contained mass gives rise successively (by a sort of fission) to young ciliated bodies, which leave the *Acineta* and become *Vaginicolæ*.

In a similar manner *Vorticella microstoma* becomes *Podophrya fixa*; but sometimes the changed *Vorticella* has no stalk, and then is the *Actinophrys* of some authors (not *A. Sol*). It is not known in what way the embryos are brought forth here, but it is a very significant fact that both the stalked and unstalked forms have been observed to conjugate.

Epistylis presents similar phænomena.

The *Actinophrys Sol*, to which more particular reference will be made by and by, has been observed to conjugate, but it is not absolutely known to arise by the metamorphosis of any *Vorticella*, though there is every probability in favour of the supposition that it does.

The Gregarinidæ pass through similar changes. Two forms

der-like skeleton of certain Foraminifera is extremely like in its appearance to a fragment of the shell of an Echinus, or to the plates contained in the integument of a Holothuria, and we know that these begin with a network of spicules. Consequently there is not by any means so great a distinction between the spicular skeleton of a sponge and the cullender-like skeleton of an Orbitolina as might at first sight appear."

* See Annals of Nat. History, S. 2. vol. vii. p. 370.

of these creatures are known; the one consisting of protean nucleated cells, the other of motionless spherical sacs, containing a vast number of minute bodies resembling *Naviculæ* in shape, and thence called "Navicella-sacs." Now, according to Stein, although the fact has been doubted by others, the "Navicella-sacs" result from the conjugation of two *Gregarinæ*, which have become motionless and filled with an accumulation of granules.

Certain it is that the Navicellæ are developed within the granular mass like embryo-cells within the yelk, and that when freed by the bursting of the Navicella-sac they become *Gregarinæ*.

Lastly, in the freshwater sponge (*Spongilla*), which consists of an aggregation of nucleated protean cells like a mass of *Gregarinæ*, a certain number of the cells at various points scattered through the substance of the *Spongilla* become motionless and distended with granules, and receiving first a membranous and then a siliceous investment, constitute the "seed-like bodies."

From Mr. Carter's account it would appear that when the "seed-like body" germinates its cells burst, and their granular contents become mixed. Subsequently protean cells, like the ordinary sponge-cells, make their appearance *pari passu* with the disappearance of the granules.

Supposing this account to be correct, the conjugation in *Spongilla* would be perfectly analogous to that of the Desmidiæ and Diatomaceæ, while in the Infusoria and Gregarinidæ it would resemble that of *Zygnema*.

Generalizing the above details (full authority for which may be found in the appended list of works), we may say that with the exception of the Foraminifera, about whose reproductive processes nothing is as yet known, the Protozoa all reproduce their kind by a process of endogenous development which is accompanied by greater or less changes in the structure and powers of the reproducing cell. We may add that in many cases these changed cells have been observed to conjugate, previous to the occurrence of the endogenous development.

Bearing all these facts in mind, let us return to *Thalassicolla nucleata*. If the *Th. punctata* answer to a mass of sponge-cells or an aggregation of *Gregarinæ*, is it not possible that the *Th. nucleata* may answer to the altered reproductive cell? I have shown that the *Th. nucleata* may very possibly be nothing more than a separated and enlarged cell of *Th. punctata*, and this possibility upon structural grounds becomes, I think, converted into probability, if *Th. nucleata* be compared with *Actinophrys Sol*, which there is every reason to believe is the reproductive stage of one of the Vorticellinæ.

Actinophrys Sol is a spherical gelatinous mass consisting of an internal dark granular portion and a clearer external zone from which many radiating threads are given off. Vacuolæ are scat-

tered through the substance, larger in the external zone, smaller and more irregular in the interior.

If the animal is much compressed, nuclei and nucleated cells are forced out from its interior.

Finally, two specimens of *Actinophrys* have been observed to fuse together and become one.

It is unnecessary to point out the perfect analogy between *Actinophrys* and *Thalassicolla nucleata*, with one exception, that the large internal cell was not observed in *Actinophrys*—a circumstance which might readily occur if it were delicate, even though it existed.

The argument derived from this analogy becomes still more strengthened if we turn to the excellent account of *Noctiluca*—a marine phosphorescent body which has long been a zoological puzzle—by M. de Quatrefages. For the details I must refer to that observer's paper in the 'Annales des Sciences,' but I may state that its structure is essentially similar to that of *Thalassicolla nucleata*, supposing that the latter had given exit to its central cell by a depression at one point of its surface. *Noctiluca* however appears to feed after the manner of *Actinophrys*, and perhaps conjugates also, as M. de Quatrefages "has met with double individuals two or three times." This he considers an evidence of spontaneous fission; but further observation might have reversed this judgement, as it did that of Kölliker with regard to *Actinophrys*.

From the invariable adhesion of grains of sand to one part of the surface of *Noctiluca*, it would seem to be set free from some unknown fixed form which is probably analogous in its structure to *Thalassicolla punctata*.

To sum up the different lines of argument it may be said—

1. That the *Thalassicolla punctata* is not an exceptional form of animal life, but belongs to the same great division as the Sponges, Foraminifera, Infusoria, and Gregarinidæ,—the Protozoa or unicellular animals.

2. That the Protozoa have definite characters as a class, which are—

   a. That they are either simple nucleated cells or aggregations of such cells, which are not subordinated to a common life.

   b. That they have a mode of reproduction consisting in an endogenous development of cells, preceded by a process analogous to the conjugation of the lower plants.

3. That the *Thalassicolla nucleata* closely resembles *Actinophrys Sol*, which is known to conjugate, and which there is great reason to believe is the reproductive stage of one of the Vorticellinæ.

4. That as *Th. punctata* is one of the Protozoa, it most probably has a reproductive stage.

5. That *Th. nucleata* might readily be derived from such an alteration in one of the cells of *Th. punctata* as occurs in the sponge-cells when they go to form the seed-like body, or in the Gregarina-cells when they become "Navicella-sacs."

6. That *Thalassicolla nucleata* is essentially similar in structure to *Noctiluca.*

Finally, I may be permitted to say, that no one can be more fully conscious than myself of the slender and hypothetical grounds on which some of these conclusions rest. My chief purpose has been merely to show the tendency of the evidence now extant as clearly and broadly as possible;—rather to draw out a brief than to pronounce a judgment.

The following are the authorities referred to in the text:—

Von Siebold. Vergleichende Anatomie d. Wirbellosen Thiere, p. 7–25.

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Hogg. Upon Spongilla. *Trans. Linn. Soc.* vol. xviii.

Carter. On Spongilla. *Annals of Nat. Hist.* 1849.

XXXV.—*A Catalogue of British Spiders, including remarks on their Structure, Functions, Œconomy and Systematic Arrangement.* By John Blackwall, F.L.S.

[Continued from p. 339.]

87. *Theridion nervosum.*

Theridion nervosum, Walck. Hist. Nat. des Insect. Apt. t. ii. p. 301; Hahn, Die Arachn. B. ii. p. 48. tab. 58. fig. 133.

—— *sisyphus,* Sund. Vet. Acad. Handl. 1831, p. 115.

Theridium sisyphus, Koch, Uebers. des Arachn. Syst. erstes Heft, p. 8; Die Arachn. B. viii. p. 73. tab. 273. fig. 644.

Titulus 13, Lister, Hist. Animal. Angl. De Aran. p. 51. tab. 1. fig. 13.