HARTIG *on the* PHYTOZOA *of* ANTHERIDIA. By F. CURREY, Esq., M.A.

Was wird aus der Schwamfaden der Antheridien? Dr. Hartig has devoted a section of his essay on the development of the vegetable cell, now in course of publication in the 'Botanische Zeitung,' to a consideration of the above question, and the results he has arrived at are highly curious and interesting. Should further investigation lead to a confirmation of Dr. Hartig's views, the consequence will be that several genera of the Infusoria must be transferred to the vegetable kingdom. Dr. Cohn's lately-published observations, will have already prepared the minds of the friends of the Infusoria for such a result, and will cause the blow aimed by Dr. Hartig at the animal nature of some of Professor Ehrenberg's favourites to be less keenly felt. In the following pages we purpose giving the substance of Dr. Hartig's paper, which is of great interest to microscopical observers; the experiments are such as may be repeated without difficulty.

The author commences by observing that the phytozoa of the *Characeæ* are best suited for the observations in question, inasmuch as, when placed upon a slide in water, they are then in their natural element; but numerous observations made upon the Antheridia of *Chara*, *Nitella*, *Polytrichum*, and *Marchantia*, have led to the same results, and the last-named plant has the advantage of affording the easiest opportunity of procuring a large quantity of phytozoa free from the admixture of foreign bodies. To effect this, the disk in which the Antheridia are imbedded should be washed repeatedly with distilled water, its upper surface removed, and fine transverse sections taken from beneath. If these sections be placed upon a slide in a drop of distilled water, a vast number of phytozoary cells will escape from the segments of the Antheridia into the surrounding water.

A dozen, at least, of such sections should be prepared, and in order to prevent evaporation they must be placed upon clean oiled-silk, and covered with bell-glasses lined with moist blotting-paper. If these preparations be examined twice or three times a day, certain changes will be observed to take place in the phytozoa; and since these changes run through the whole mass of the phytozoa in each preparation, they must be considered as *normal*.

The above experiments constantly repeated have led uniformly to the following results.

The free phytozoa are very soon drawn to the edge of the drop of water (probably by the effect of evaporation), and

form there in the first instance a skin which covers the surface of the water. The form of the phytozoa is distinguishable in the granulated and serpentine disposition of the granules of this skin. Beneath this skin other phytozoa are seen in the state of motion peculiar to them. In the course of a few hours these latter phytozoa assume the form of Ehrenberg's genera *Spirillum* and *Vibrio* differing from that of the phytozoa only in the manifest articulation, and in the absence of cilia. At a later period the granulated skin extends from the margin over the whole surface of the drop of water, and the phytozoa underneath this skin are now seen, without any cessation of their motion, to assume forms similar to those of the *Spirilla* and *Vibriones*. The forms of *Vibrio rugula* and *V. prolifera* are most frequent.

After the first twelve hours all the phytozoa disappear, and there remain only the *Spirilla* and *Vibriones* in number proportionate to that of the original phytozoa.

The *Spirilla* and *Vibriones* exist for a very short time. After twenty-four hours most of them, after forty-eight hours all of them, have become disarticulated. The whole drop is now rendered milky and turbid by numberless globules similar to *Monas crepusculum* in a state of active motion.

The observer may be fully convinced that the forms of *Spirillum*, *Vibrio*, and *Monas*, do not originate from extraneous germs, and that they are not formed out of shapeless matter, but that they originate from the undecomposed substance of the phytozoa. The unusual rapidity of the transformations by which the process is kept, as it were, continually before the eye of the observer is a favourable circumstance in these observations.

It is an important circumstance that *Spirillum* does not originate from *Monas*, but always *Monas* from *Spirillum*.

After forty-eight hours, it frequently happens that amongst the moving monads which have hitherto been uniformly distributed through the water, small groups consisting of several hundreds of them are to be seen in which the primary active motion has ceased. Shortly afterwards a sharply-defined hyaline skin is formed round these groups, and, as it would seem, by the amalgamation or conjunction of the exterior molecules; by this means the young *Amœba* (Proteus) is formed. This transformation takes place pretty regularly towards the end of the third day.

The original size of the *Amœba* is 1-300‴ in diameter. In the course of three or four days it grows to about the size of 1-100‴. This species differs from the *Amœbæ* hitherto described in the fact that the inner portion of the body which

bears the granules is much smaller than a certain hyaline covering, which covering is closely attached to the hinder part of such inner portion, but extends far away from the anterior part, and, in addition to this, the progressive motion in this species originates in an alternate enlargement of the longitudinal and transverse diameters, and is so slow as to amount at the utmost to no more than 1-40″ per minute. The form of the body resembles that of *Amœba princeps* (Ehrenberg). The vesicle in the hinder part of the body, which was first described by Ehrenberg as a mouth, and afterwards as an ovarium, is also present.

After four or five days the *Amœba* assumes a spherical shape and becomes motionless, the vesicular body expanding and contracting rapidly as before, in a manner similar to what takes places in many *Vorticellæ*. These spherical motionless *Amœbæ* are then for the most part united by a mucilage into groups of from ten to twenty. The mucilage appears to be produced by the decomposition of a cast-off external skin.

In about a fortnight after the commencement of the experiment a green point appears in the interior of the spherical colourless body of the *Amœba;* this point gradually increases in size until it fills up the entire hollow of the *Amœba*, and after becoming covered with a cuticle it escapes in the form of an elliptical bright-green cell, 1-300″ in diameter, resembling a *Protococcus*. It exhibits a round transparent cavity, devoid of chlorophyll, corresponding in size and position to the vesicular body of the *Amœba*, and resembling at its colourless apex the motile gonidia of *Cladophora*. A few days later the elliptic or roundish cell lengthens, a formation of transverse septa commences, and the uni-cellular alga becomes an articulated one.

All these transformations of phytozoa into *Spirilla*, *Vibriones*, *Monads*, *Amœbæ*, unicellular and articulated *Algæ*, may be observed, not only in the detached phytozoa, but in those which remain in the interior of the sections of the Antheridia. In those Antheridia of which the phytozoa are not fully ripe, the *Amœbæ* are seen to originate in the middle of the internal mass of phytozoary cells; some of them make their way out through the softened mass of cellular tissue, but others remain in the interior of the Antheridium until their development into an articulated Alga.

Contemporaneously with *Amœba*, and often earlier, there may be seen amidst the mass of Monads bodies very similar in form and motion to the genus *Bodo* (*socialis*), and which increase by transverse division; they have the front end

furnished with a long whip-shaped antenna or cilium similar to that of *Euglæna*. At their first appearance, their motion, their change of form, and their whole exterior, differ so little from the earliest states of *Amœba*, that at this period they cannot be distinguished. In these early stages they both resemble *Chlamidomonas destruens* of Ehrenberg.

The above forms uniformly make their appearance, and always in the succession above described. It is true that other forms, such as *Uvellæ*, and even *Leptomiteæ* and *Periconiæ*, are sometimes met with, the germs of which may have been imported by the atmospbere during the observation, but these organisms, *which always appear singly* and after the commencement of the observation, do not interfere with the above results, when we consider the immense number of the phytozoa and their uniform and contemporaneous transformations. If about a dozen preparations are made, and if they are carefully covered with a bell-glass after each observation, and if care be taken not to extend the observations for too long a time at once, at least half of the preparations will be free from all admixture of foreign organisms.

Dr. Hartig proceeds to remark upon certain transformations similar to the above, which occur in the motile gonidia of *Cladophora*, and he also notices certain *Amœbæ* which originate from the phytozoa of the *Characeæ*. Want of space prevents us from entering into the details of these latter observations, but it may be observed that in the *Amœbæ* of the *Characeæ* a remarkable circulation is to be seen similar to that which occurs in the cells of *Chara*. *Diatomaceæ* have been observed to force their way into the interior of these *Amœbæ*, and to be carried round with the current of the cell-contents. In conclusion, the author puts the following questions:—Does *Amœba* belong to the animal kingdom, or is it a stage of vegetable development? Assuming the latter, does this development ultimately lead to the production of the same plant from which it took its rise, or is the final stage of development dependent upon external circumstances? Are the phytozoa endowed with impregnative powers, and do they only become converted into *Spirilla* in the absence of those organisms upon which their impregnative powers are ordinarily exercised?