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On the systematic position of the Volvocineæ, and on the limits of the vegetable and animal kingdoms

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Up to this point the author reared the larvæ in small glass tubes like thimbles, corked and turned bottom upwards; and it was upon the surface of the cork that the above changes took place. He now employed a glass tube about 4 inches long and 1 inch in diameter, stopped at the bottom with a piece of sponge, and filled with earth, upon which he placed the Scarabæoid larva (as Riley has called the same stage in *Epicauta*). The larva immediately buried itself and formed, a little above the sponge, against the wall of the tube, a small chamber or cavity. In five days more a fresh change of skin took place, producing a pupa like that of a Muscide, having four small mamillæ at the apex, and three pairs of small mamillæ at the part where the legs were. Its colour is horny white; and it is motionless, looking exactly like a chrysalis. This state lasts through the winter, the only sign of life being the issuing from its pores, from time to time, of a transparent colourless liquid, which remains for some days at the surface of the body.

On the 15th April this pupa burst its envelope, and gave issue to a white grub, very like the Scarabæoid larva, but without its robust claws and jaws, only presenting rudimentary feet, each composed of three short and thick pieces. This grub moves slowly in its cell, but does not go out of it or eat. On the 30th April there is a fresh change, producing a nympha of the regular coleopterous type, having all the limbs recognizable. It is at first white, but soon becomes coloured; on the 17th May it was already very dark; and on the 19th the beetle was visible in the cell ready to make its appearance. The complete development of the insect thus occupies a year. The author believes that in nature the insect preys upon burrowing bees, such as *Halictus* and *Andrena*.—*Comptes Rendus*, May 26, 1879, p. 1089.

On the Systematic Position of the Volvocineæ, and on the Limits of the Vegetable and Animal Kingdoms. By M. E. Maupas.

Since the publication of the memoirs of F. Cohn upon the Volvocineæ, it seemed that the old debates respecting the systematic position of those Microphytes were closed for ever. Every one, in fact, had adopted the opinions of this naturalist; and in all the general treatises the Volvocineæ are arranged with the Algæ. Stein, in his fine volumes recently published upon the Flagellate Infusoria, recurs to the old view of Ehrenberg, and reclaims the Volvocineæ for the animal kingdom, placing them among the Infusoria. As this question affects important problems of cellular morphology and goes to the very heart of the controversy on the limits of the two organic kingdoms, I have thought it useful to make known to the Academy some observations and considerations opposed to the conclusions of the learned professor of Prague.

With Stein, the true criterion which enables a Protozoon to be distinguished from a Protophyte is the simultaneous presence of vibratile cilia or flagella, of contractile vacuoles, and of a nucleus in one and the same creature. The Protozoa alone, according to him, combine these three organs; no well-characterized plant pos-

sesses them together. He insists repeatedly upon this character, especially at pp. 37, 47, and 51 of the work above cited. It is on account of the simultaneous existence of these three organs, ascertained by all observers, and particularly by F. Cohn, in the Volvocineæ, that Stein has excluded them from the vegetable kingdom, and placed them among the Flagellate Infusoria. We shall find that this character is of no importance, and that it occurs in Algæ, upon the vegetable nature of which Stein himself would not venture to cast a doubt.

In the first place, it is useless to dwell upon vibratile cilia; every one knows that all zoospores are furnished with them.

I pass to the contractile vacuole. And here I cannot refrain from expressing my astonishment to see a naturalist so exact, and generally so well informed, as Stein still denying the existence of this organ (p. 47) in well-characterized plants. It has been seen by Leitgeb, De Bary, Fresenius, Strasburger, Dodel-Port, and Cienkowski in the zoospores of Saprolegnieæ, of *Cystopus*, of Myxomycetes, of Palmellaceæ, of *Ulothrix*, of *Hydrurus*, of *Chætophora*, &c.; I have myself indicated it in *Microspora floccosa* and *Stigeoclonium tenue*; and I am convinced that it will be found in many other zoospores if it is sought with high magnifying-powers and under good conditions of observation. At any rate, the numerous facts already ascertained are sufficient to refute the assertion of the celebrated professor of Prague.

There remains the nucleus; and Stein, in denying its existence in the zoospores of the Algæ, is in accord with everybody. All the observers who, since Thuret, have studied these organisms have been unable to discover a nucleus in them; and Strasburger, quite recently ('Botan. Zeitung,' April 25, p. 274), assumes that the nucleus of the zoospores of *Ulothrix* does not exist during its wandering period, and is reconstructed afresh at the moment of germination. I have tried to verify these assertions by the aid of very precise methods of observation, which I have long employed in the investigation of the nucleus and nucleolus of the Infusoria; and in the zoospores of *Microspora floccosa* and of an undetermined *Œdogonium* I have found a very distinctly characterized nucleus.

I placed upon the glass plate a small drop full of zoospores of *Microspora*, covered it with the thin glass, and drew away the water by aspiration, so that the zoospores were slightly compressed and rendered nearly motionless. I then cemented two of the opposite edges of the covering-glass with paraffin; and when it was well fixed I caused a drop of alcohol to penetrate beneath it by drawing off the water with bibulous paper. The zoospores were quickly killed, and retained by compression between the two plates of glass. I then replaced the alcohol with water, and the latter with saturated picrocarminate. In a few minutes, the action of the reagent being sufficient, I drew it off and replaced it by water, always by means of bibulous paper, and then replaced the latter by crystallizable acetic acid. This last reagent immediately clears the object; and there is then seen, in the rostral region of the zoospores, a small

spherical nucleus of an intense red colour and very distinctly defined, the rest of the body remaining very pale. As the acetic acid is very volatile, one has only to place at the edge of the covering-glass a drop of glycerine, which penetrates and replaces the evaporated acid, preserving the form of the zoospores. We thus obtain a preparation which only requires luting to be rendered permanent.

With the zoospores of *Œdogonium*, of which I had only a small number, I followed a rather different method. I killed them by exposing the drop of water for a minute to the vapours of osmic acid of 1 per cent.; I then cemented them under the covering-glass by means of paraffin, coloured them with the picrocarminate, and afterwards cleared them with the acetic acid and glycerine. The action of the picrocarminate requires to be continued longer than in the method with alcohol. The nucleus, situated in the middle of the body, rather a little behind than in front, appears like a small red sphere.

These zoospores were killed during their period of mobility. The nuclei could not be confounded with the amylaceous corpuscles which are met with in many Volvocineæ besides the true nucleus. The amylaceous corpuscles never acquire a red colour in preparations made in accordance with the methods here employed. We have therefore to do with true nuclei, combined with vibratile cilia and with contractile vacuoles, in zoospores of Algæ. The two Algæ studied have zoospores belonging to two different types, those of *Microspora* being flagellate, and those of *Œdogonium* furnished with a circlet of vibratile cilia. I am persuaded that if the zoospores of the other Algæ are suitably investigated a nucleus will be found in in all of them.

The new criterion proposed by Stein for distinguishing the two organic kingdoms is therefore of no value. Moreover, to seek a well-defined boundary between plants and animals seems to me to be a search very little in harmony with all the recent progress of biological studies. The latest works all tend more and more to demonstrate that all the barriers which it had been attempted to raise between these two groups have nothing fundamental or real in them. From the physiological point of view, Claude Bernard has established incontestably the biological unity of the living world. The same conclusion springs from all the morphological results that we have attained. At present neither physiology nor morphology furnish any exclusive character belonging to one or the other of the two kingdoms. When we study the amphibiological creatures which swarm in the lower grades of the living world we may therefore sometimes be puzzled where to class them. It is necessary then to consider the totality of the characters; and, without having recourse to a third kingdom, we may almost always succeed in finding in them tendencies and affinities which enable us to assign them a place in the existing categories. It is by the consideration of these general characters that I am in complete accord with Cohn and other writers in classing the Volvocineæ among the Algæ, side by side with the Palmellaceæ, the Conjugatæ, and the Zoosporeæ.—*Comptes Rendus*, June 16, 1879, p. 1274.