of its true nature, the only approach to a transitional state being suggested, rather than proved, by the occasional detection of a specimen in which the central mass with its investing capsule appeared to have escaped through an irregular orifice in the external gelatinous matrix. According to my notes written at the time of observation, these empty matrices showed the fibrillated structure, but no vacuoles or cyclosis of granules. Hence, notwithstanding their occurrence amongst the perfect forms, and their uniformity as to external appearance and dimensions, it is possible, although hardly probable, that they may have formed part of other organisms.

Lastly, as bearing on the identity in nature of *T. nucleata* with *Noctiluca**, I may mention that, according to my experience, there are no examples of phosphorescence amongst living animals holding so low a position in type of organization as the Rhizopods. As a negative character this absence of phosphorescence is of some value for the following reason. Both amongst the minute luminous Crustaceans proper, Entomostraca, and Ascidians of the open sea, I have found it easy, by means of a fine paint-brush, to detach a portion of a phosphorescent fluid from the living animal, and to communicate a luminous streak to any object by passing the brush so charged over it. It would seem, therefore, to be a true specialized secretion, and would furnish an explanation why creatures of such simple organization as the Rhizopods do not exhibit the phenomenon in question.

XVI.—*Notulæ Lichenologicæ*. No. XXVI.

By the Rev. W. A. LEIGHTON, B.A., F.L.S.

On the Change of the Gonidia of Lichens into Zoospores.

By MM. A. Famintzin and J. Boranetzky†.

IN a thin vertical section of a Lichen the gonidia occupy the middle layer of the thallus, and are partly attached to the medullary filaments and partly free and scattered. When the section is placed in water, the gonidia readily detach themselves in abundance, and present a perfect resemblance to a unicellular Alga.

M. Sperschneider, in 1853, placed thin slices of the thallus of *Physcia ciliaris*, DC., on pieces of decomposing wood in a confined humid atmosphere. At the end of two months the filaments of the thallus became decomposed, but the gonidia

* See paper on *Thalassicolla*, ut suprâ, pp. 441, 442.

† Translated from 'Ann. Sc. Nat.' ser. 5. vol. viii. p. 137.

remained alive, considerably increased in size, and multiplied by division. Some time after, minute punctiform bodies, of a beautiful green colour, appeared amid the decomposing thallus, which were gradually transformed into new thalli of *Physcia ciliaris*.

Our own researches on other lichens have fully confirmed those of M. Sperschneider in all particulars, except that we have not succeeded in recognizing the transformation of the free gonidia into new thalli.

Our own experiments were as follows:—Many thin slices of the thallus of *Physcia parietina* were placed on bits of bark of fir and lime which had been previously boiled in water for some minutes, and which were afterwards kept in a humid atmosphere. These bits of bark were placed in small salvers on the bottom of a large glass vase, into which we had poured a little water, and covered with a pane of glass. They were thus maintained in a moist state for many months.

Although this method was attended with good results, we preferred another, by which the gonidia were isolated. The entire thallus was, for many weeks, either immersed in water or kept continually moist by water dropping upon it. The filaments of the thallus decomposed rapidly, but the gonidia preserved their vitality. The entire mass was washed in pure water, and deposited on bits of lime-bark. The gonidia isolated by either of the above methods always exhibited the same changes.

Each gonimic cellule, whether enclosed in the thallus or isolated, presented a large central nucleus, as well as a large lateral vacuole. In this state it perfectly resembled a unicellular Alga called *Cystococcus*, described by M. Nägeli in his work 'Les Algues unicellulaires,' and figured on tab. 3, E. e. We succeeded in observing, at a later period, in these gonidia all the other phases of development of *Cystococcus* described by M. Nägeli, and have thus established the identity of this Alga with the isolated gonidia of *Physcia*.

During the first days the gonidia augmented their size, but preserved their spherical form; afterwards they underwent the changes corresponding to the metamorphoses observed in *Cystococcus* by M. Nägeli. The most remarkable of these changes consisted in the transformation of the contents of the gonimic cellules into zoospores. A portion only of the gonidia were thus changed, the rest became divided by partitions into a great number of cellules, which gradually became of a round form, and ultimately disunited by separation.

The formation of the zoospores is preceded by a change characteristic of the contents of the cellules. The outlines of

the nucleus and of the vacuole were gradually effaced and finally disappeared entirely, whilst at the same time the entire contents of the cellule became of a very fine, homogeneous granular structure. Finally the membrane of the cellule became torn, and the contents issued forth like a small circumscribed sphere, and resembled a small cellule still attached to the mother cell. The protuberance rapidly increased in size, and soon attained the dimensions of the primitive cellule, so that the contents became twice their original size. The cellule was thus emptied and its contents transferred entirely into the protuberance, which, as it gradually increased, assumed the form of a sac. At this moment the division of the contents into zoospores became evident, and we distinguished on its surface a very thin membrane, which was speedily ruptured, and through the aperture of which the zoospores issued one after the other. Generally the membrane was speedily dissolved, but sometimes it remained intact for a long time after.

The zoospores are elongated, narrowed at the anterior part, and furnished at this end with two cilia directed forward. By means of iodine, we could easily recognize in the middle of each zoospore a nucleolate formation, the nature of which we are unable to explain. The zoospores moved in the water for a certain length of time, and then became motionless. We are still unable to explain their ulterior development; and all our knowledge only establishes that the motionless zoospores augment in size without any change of form, and finally attain to two or three times their primitive diameter.

The most delicate and at the same time most important point of these researches was to establish incontestably that the zoosporal cellules were really the gonimic cellules, and not some other organism which had been accidentally developed in our apparatus. We believe that the following facts demonstrate this fully:—

1. We obtained the zoospores by means of gonidia sown on the surface of bits of bark previously boiled in water, and consequently cleaved from living organisms. Direct observation has demonstrated, moreover, that our seed-beds did not contain any other green organism besides the gonidia which we had deposited in them, and that they were only polluted by some filaments of a *Hyphomycetes* which had probably been transported on the bark or existed in the water in which the lichen had been macerated.

2. The changes which we have described were observed not only in a very great number of free gonimic cellules, but also in gonidia still attached to the medullary filaments. From these latter we have repeatedly observed the zoospores to

escape; and under the action of iodine the membrane of these cells was coloured violet, whilst the extremity of the filament to which they were attached was of a pale yellow.

3. We have equally obtained zoospores from gonidia united into a considerable mass. Some, indeed, of these cellules were already empty, the zoospores having escaped, whilst, on the other hand, others had undergone no change.

4. Lastly, we have found, on the bark of a birch tree in the garden of the University [of St. Petersburg], green patches exclusively formed of free gonidia, completely destitute of thallus. These cellules also produced zoospores perfectly identical with those of the gonidia which we had sown.

The formation of zoospores by sowings requires always many weeks, as the following experiments demonstrate:—

First experiment.—Vertical sections of a thallus of *Physcia* were placed, March 13, on fir-bark. The issue of zoospores was first observed April 19.

Second experiment.—On March 21 a bit of lime-bark with a lichen growing on it was fixed on the exterior of a large glass vessel filled with water, which was made to fall on it drop by drop by means of a cotton wick curved siphon-like. On April 1 the filaments of the lichens were disintegrated. On April 3 we transferred the gonidia, as well as the mucous mass of decomposed filaments, to two bits of bark. On April 20 the zoospores appeared.

Third experiment.—The lichen was immersed until the complete disintegration of the filaments, and on April 3 the gonidia were placed on gravel, on the earth, and on bits of rotten wood. Those on the two former became decomposed by too much moisture; but those on the latter succeeded well, and on May 15 the zoospores were observed.

The gonidia which did not produce zoospores separated into a great number of motionless spherical cellules, amongst which we distinguished two forms—one presenting a protuberance at the commencement of the division, the others preserving to the end their regular spherical form.

We also submitted these two lichens to similar experiments, except that, instead of vertical sections of the thallus or of gonidia already isolated, we used the soredia from the surface of the thallus, and sowed them either on bark or bits of decayed wood. Their gonidia presented precisely similar results to those of the *Physcia*, both in their form and their ulterior development.

These observations authorize us to propound the following propositions:—

1. Not only Algæ and Fungi, but Lichens also, are provided with zoospores.

2. Zoospores have been discovered in three very different genera of Lichens, viz. *Physcia*, *Cladonia*, and *Evernia*; and as these genera were selected undesignedly, it is probable that zoospores exist in all other lichens furnished with chlorophyll.

3. We have demonstrated the identity of free gonidia with the unicellular Alga *Cystococcus* of Nägeli; consequently this is not a distinct genus, but only a phase of development of a lichen.

4. The culture of the freed gonidia of *Physcia*, *Cladonia*, and *Evernia* led us to expect that other lichens would afford forms corresponding with rudimentary Algæ. Our researches prove this to be well founded. Vertical sections of the thalli of *Peltigera* and of *Collema*, cultivated on moist earth, showed the filaments in disintegration, the augmentation in size of the gonidia, and their transformation into glomerules composed of spherical cellules. The gonimic cellules of *Peltigera* and *Collema* continued to live when separated from the thallus: those of *Peltigera* were identical with an Alga called *Poly-coccus*; those of *Collema* produced organisms similar to *Nostoc*. Consequently these three genera of Algæ, hitherto regarded as different and distinct, are in reality only the gonidia of lichens in a state of development when separated from the thalli which produced them.

XVII.—On the Ehretiaceæ.

By JOHN MIERS, F.R.S., F.L.S., &c.

EHRETIA.

This genus, as arranged by DeCandolle, is very heterogeneous, and requires redistribution, as it contains several distinct groups easily recognized by good characters, especially by those founded on their carpical structure. After the examination of all the plants within my reach, referred to *Ehretia*, from the New World, I propose to retain in the genus only those species which are proximate to *E. tinifolia*, Linn. Many of those belonging to the Old World will probably be found, upon critical examination, to be foreign to the genus. I have not had leisure to analyse them; but among those which I have examined, some distinct forms have been noticed. A few from Australia and Asia have a fruit containing four nucules, each 2-celled and 2-seeded, with a particular organization; others, again, have a bifid style, each obcuneiform branch bearing two distinct sessile stigmata; but the placentation of the ovary is that of *Ehretia* and *Rhabdia*.

The greater number of the Neogean species of *Ehretia* enu-