agrees in its trapezoid segments, and in the number and disposition of its spines, but differs in possessing the central frontal projections, which are absent in the species alluded to, and which circumstance, I think, should place it out of the genus Xanthidium. The form now under consideration also differs from that alluded to in having its margins straight, not concave; in its spines being minute, not elongate; in the segments, in side view, which is less compressed, being sub-orbicular, not elliptic; in the ends being truncate, not rounded; and in the extremities in the end view being blunt, not rounded. Notwithstanding, therefore, considerable similarity in the general outline between the present species and Arthrodesmus octocornis, var. β, I cannot suppose they can be identical. The latter I have not myself met with in this country, but var. α is not uncommon. However, I prefer to follow Brébisson, and to place both those forms in the genus Arthrodesmus, though, perhaps, Jenner's suggestion to form a new genus for them, including, of course, Arthrodesmus bifidus (Bréb.), would, after all, be the better course. Certain it is that the plant now described is an unquestionable Xanthidium.

I imagine the initials on the slide above alluded to must be those of the late Professor William Smith; it is, however, in any case by no means an inappropriate, though but a small and very inadequate, mark of respect to dedicate this species, which I believe to be very distinct, to his memory.


Fasciculus 1.

It needs no remarks of mine to point out the extreme ambiguity which exists in regard to the arrangement of both the species and genera of the unicellular algae and their kindred organisms. Perplexing to the last degree to the older student, to the novice they are bewildering, and highly unsatisfactory to all who, allured by their simplicity of structure, have been desirous of studying Nature on her protophytic threshold.

However, within the last few years an opinion, based on
some valuable observations,* has sprung up—that many organisms of the class alluded to are but a condition of the growth of the gonidia of lichens.

To add new facts to those already published, tending in the same direction, will be the endeavour of the following contributions, and which, it is confidently hoped, will throw additional light on this confessedly difficult subject.

And it may be well at the commencement to remark that the gonidia of lichens have extraordinary powers of dissemination, far beyond what is generally recognised. From a series of observations, extending now over many years, in which they were never absent, I found that they may be collected in comparatively great numbers from snow and rain, particularly the former, and especially in windy weather. The quantity of gonidia, frequently with attached fragments of lichens, entangled and brought down by the snow, generally considerably exceeds that of any other organic molecules.

Experiments upon this point may be easily made by placing a clean sheet of glass in the open air during a fall of snow. When a sufficient quantity has fallen, it should be melted, and the snow-water allowed to run into a tube; the supernatant fluid being poured off after the foreign matter has subsided, I have noticed sometimes that the discoloration of the water is in a great measure dependent on the gonidia of lichens. These I have kept in the water for some months, and have seen them passing through the same varieties of segmentation to be described below as occurring in the gonidia of lichens and in "Chlorococcus." Hence it will be seen that every surface upon which snow or rain can fall must have a number of these gonidia deposited upon it during the year. In the course of the following communication it will be seen that these organisms have the property of increasing to an unlimited extent by subdivision, and thus will be explained how enormous surfaces are covered by the so-called "Chlorococcus."

Now, although the gonidia of the various lichens are wafted by air-currents hither and thither, doubtless to very distant points of the globe, yet we may for the same reason expect the unicellular alge and their allies, if really derived from them, would, in any given district, vary according to the species of lichens prevalent in that district; and this I have found, so far as my observations have extended, to be the case; for although the gonidia of many lichens are scarcely to be distinguished from each other, yet there are,

in many, constant minute differences, visible to a practised eye, while in some there are essential variations during their growth, which will be noticed hereafter.

After these remarks I will pass to the consideration of that unicellular plant, commonly called "Chlorococcus," which covers with a green coating, walls, trees, palings and indeed any exposed body rough enough to give attachment to it.

It is, in its mature, quiescent state, a round, globular cell (fig. 1, a, a), consisting of a cell-wall, with green cell-contents, having a nucleus in its centre. It is shown highly magnified at fig. 3. These cells may remain in a dormant condition for a considerable time during cold weather, but upon the return of warmth and moisture they begin to increase in numbers, by a process of subdivision which varies in the different cells.

Sometimes the mass of contents divides into from two to eight or more portions, which soon assume a round form, and burst the parent cell-wall open; or the septa radiate from the centre; these secondary cells soon begin to divide by binary and quaternary division, and this process may go on for a very long period, even for years, without much variation. The size of these divisions varies according to the rapidity with which the process of segmentation exceeds that of individual cell-growth (Pl. X, figs. 1, 2). Ultimately, however, they all assume the form and size of the parent round, nucleated cell.

Now, the gonidia of many of the lichens are precisely similar, both in the mature, quiet state, as also in the active process of multiplication, and are of the same size. This is well seen in making a section of the thallus of any ordinary lichen about to undergo what is called "soridiferous degeneration—for instance, of Parmelia parietina. The gonidia, increasing beneath the cortical layer by subdivision, at first elevate in parts the layer above it, till at length they burst through, and then at first appear of a green colour, continuing the process of subdivision in a manner indistinguishable in every respect from the "Chlorococcus" before described. For this reason it has been suspected by some recent investigators that the latter is possibly derived from the gonidium of the lichens.

The additional facts I shall bring forward will, I conceive, set the question affirmatively at rest.

It will, therefore, be necessary to watch the true gonidium a stage further, while still resting on the thallus through which it has burst. After the process of segmentation has been repeated an uncertain number of times, and the divisions
have again become full-sized and globular, it begins to make
the first step towards the formation of the felted fibres of its
parent, and it will be observed that a small, colourless, tubular
projection appears at one spot on the surface of the cell-wall
(fig. 2 a), which, increasing in length becomes a tubular
fibre, which, whilst adhering closely to the exterior of the
cell, and articulated and branching (fig. 2, b, b, b), at last
completely encloses it by its ramifications, which vary in
colour. In the case of Parmelia parietina they are yellow,
and the round mass, opaque by transmitted light, and rough
on its outside in consequence of the branches of the fibres
not closely adhering by their ends, is denominated a
"soridium." This gives the powdery appearance to the
surface of the lichen upon which it rests, and has a consider-
able influence on the general colour of the plant, which thus
depends on the amount and colour of these enclosing fibres.
The soridium may remain in this stage for an indefinite period
—for months, and, I suspect, even for years—in which event
the case produced by the branching, adhering fibres becomes
thickened and denser, as shown at fig. 9. This is generally
more apparent during the colder months, and is probably a
means of protection.

When segmentation commences within this soridium, it often
results in a very large number of subdivisions, as at fig. 10, a,
and the fibres, passing inwards between the segments, separate
them, while the whole ball enlarges, so as to produce the first
commencement of a thallus. This point is of importance, as
will be remarked upon when we come to speak of the corres-
ponding stage in the "soridium" of Cladonia. But segmenta-
tion of the enclosed gonidium may proceed simultaneously
with the fibre-growth, in which case the soridia assume the
appearance shown at figs. 4 and 5. Frequently the subdivisions
become oval and small, undergoing binary segmentation.
Fig. 6 represents an instance of this, in which the parent
cell-wall is still seen partly dissolved. Fig. 8, a, also shows
this form. In others they are globular from the commence-
ment, and simply increase in size, as at figs. 4, 5, 10, b, b, till
they are as large as the parent cell.

The contents of one of these broken soridia is shown at
fig. 8, with fibres branching among the segments.

Precisely the same changes take place in the so-called
"Chlorococcus." As I said before, the multiplication by
division may proceed during an indefinite period; however,
circumstances favouring the tendency to form the fibre com-
ences, and a "soridium" is the result. To describe these
changes would be but to repeat the above remarks on the
process in the undoubted gonidium of the lichen. If a portion of the bark of a tree on which the *Chlorococcus* is growing be placed under glass, so as to keep it in a moderately moist atmosphere, the phenomenon may be observed in all its changes. It may also be traced perfectly in nature, and may be recognised by lighter-coloured patches, appearing where "Chlorococcus" has been growing. That the change of colour is caused by the growth of the fibres may readily be seen on microscopical examination; and this point is instructive, because it will be found that the colour varies notably according to the lichen prevalent in its neighbourhood. Where the yellow Parmelia is found, the "Chlorococcus" will assume a yellow tinge in its soridial stage. Viewed by transmitted light, they are also opaque balls, with irregular outline (fig. 7).

But it must be clearly understood that every Chlorococcus does not follow exactly this course, for I shall show marked exceptions; but it obtains with the generality; and it is a remarkable fact, that when "Chlorococcus" does vary, it is in the neighbourhood of those lichens whose gonidia also vary, and in precisely the same manner.

That this "Chlorococcus" stage does continue for a long period without showing any disposition to form soridia, constantly multiplying till large surfaces are covered, and to some depth, may be plainly observed; and this, taken with what I have remarked before, will explain its almost universal presence. This condition seems to be favoured by cool, moist weather. The soridia also remain dormant for a very long time, and do not develop into thalli unless in a favorable situation; in some cases, I think, for years. It will be easily perceived that the soridium contains all the elements of a thallus in miniature; in fact, a thallus does frequently arise from one alone, yet, generally, the fibres of neighbouring soridia interlace, and thus a thallus is matured more rapidly. This is one of the causes of the variation of appearance so common in many species of lichens, and is more readily seen towards the centre of the parent thallus. When the gonidia remain attached to the parent thallus the circumstances are, of course, generally very favorable, and then they develop into secondary thalli, attached more or less to the older one, which, in many instances, decays beneath them. This process being continued year after year, gives an apparent thickness and spongy appearance to the lichen, and is the principal cause of the various modifications in the external aspect of the lichens which caused them formerly to be misclassified.
Summary.—I think, then, from the above remarks, that there can be no doubt but that what has been called "Chlorococcus" is nothing more than the gonidia of some lichens, which, having been conveyed by the movements of the atmosphere, had been deposited on a favorable surface, where they soon begin to increase by various modes of segmentation, which continue for an unlimited period. But under suitable conditions, chiefly drought and warmth, the gonidium throws out from its external envelope a small fibre, which, adhering and branching, ultimately encases it and forms a "soridium." At this stage gonidium may continue also for an indefinite period in a dormant condition, but, circumstances favoring, segmentation of the gonidium goes on within the soridium, while the branches of the fibre penetrate within the divisions, till at last a young thallus is formed. But a check may occur during any of these stages, and yet vitality be prolonged for a period of months and even years.

Of this, I believe, any one may satisfy himself if he will be careful to watch an old wall or tree, and check his observation by the microscope from time to time. In every particular, the whole of these stages are passed through by those gonidia whose pedigree is known, which, having burst through the cortical layers of the lichen-thallus, still remain attached to its surface.

There are two other points which, although they require more observations to give any certain value to them, it will be as well to mention here:

The first is the occurrence among the fibres of dilatations which contain a number of small, actively moving bodies, of a reddish-brown colour (as at fig. 11, a, a). They apparently have a motion different from the ordinary molecular movement.

The other is, that there are to be found among the crushed soridia some small, moving, green cells, like minute zoospores, but I cannot satisfy myself as to their origin.

On Cyclotella.
By G. A. Walker-Arnott, LL.D.

My object is not to give here a monograph of the genus Cyclotella, but to endeavour to clear up the synonyms of our British species, which to me appear to be in a little confusion.