has a well-developed assimilating tissue system, together with abundant mucilage-containing cells. Now, under circumstances which favour assimilation, e.g. strong light, sufficient warmth, and a dry atmosphere, an active transpiration-current will be set up, water-vapour being given off in the air-spaces through the pointed inward-projecting cells. To make good this loss, water will pass to the receptacle through the rhizoids. A large part of the water is absorbed by the mucilage-cells, and if any of the antheridia are ripe, the walls of the antheridium itself, as well as those of the antherozoid mother-cells, being at this time largely mucilaginous, also take up water and become swollen. The antheridia being closely packed together considerable pressure is thus set up, resulting in the expulsion of the antherozoids.

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ALGOLOGICAL NOTES.—

IV. REMARKS ON THE PERIODICAL DEVELOPMENT OF THE ALGAE IN THE ARTIFICIAL WATERS AT KEW.—

Whilst working out the algal flora of the Royal Botanic Gardens at Kew for publication by the authorities, I have made several observations on the periodicity of the flora, which I wish to remark upon more fully here. The flora¹ was found to be built up of a hot-house element, consisting for the greater part of Cyanophyceae; of the Thames element, due to the universal use of river-water throughout the gardens; and, lastly of the open-air terrestrial element.

The blue-green Algae, which abound in every moist hot-house, have received much attention from continental algologists, with the result that they are fairly well known. How far some of the forms may be looked upon as truly exotic and as introduced together with the higher plants, cultivated in the houses, it is difficult to say². It should be observed that some of these blue-green forms (e.g. *Symphyosiphon*

¹ The constitution of the flora will be more fully discussed in the introduction to the algal flora of Kew Gardens. (See The Fauna and Flora of the Royal Botanic Gardens, Kew, which is to be published in the course of this year.)

² A large number of the blue-green Algae, which occur in the moist heat of greenhouses, have also been observed in hot springs of different parts of Europe, notably those of Carlsbad; this seems to show that they are now truly indigenous in Europe, but can only exist under the peculiar conditions (i.e. high temperature and moisture) found at these particular spots.

Hofmanni, Kütz., *Symploca thermalis*, Kütz., *Gloeocapsa caldariorum*, Rabh., &c.) may have been originally introduced into our parts with greenhouse plants; since reliable observations on the Algae occurring in any given district do not date back very far, whereas the cultivation of exotic plants in hot-houses is an old practice. Many of the blue-green Algae (e.g. *Scytonema cinereum*, Menegh., *Symphyosiphon Hofmanni*, Kütz., &c.) are so absolutely characteristic for every moist hot-house, that it seems plausible that in our parts they first originated here, and only later on escaped to other (more natural) localities. I have also observed these characteristic species in many of the hot-houses of the gardens at Glasnevin, near Dublin.

The hot-house flora is practically equally developed during the whole year, the conditions under which it exists remaining uniform. The flora outside, however, shows quite a different character in the winter and in the summer, and attains its maximum development in August and September; in the winter only the hardy genera of Algae (*Vaucheria*, *Oedogonium*, *Cladophora*, *Rhizoclonium*) are present, whilst the smaller forms (Protococcoideae, &c.) are absent. Desmids, not very common even in the summer¹, are quite absent, as also most of the other Conjugates, *Spirogyra crassa*, Kütz., being the only species that can be met with all the year round. This species usually has a very well-developed sheath, often as much as one-fifth of the diameter of the cell in thickness², and the hardness of the species is probably due to its presence. Desmidiaceae first appear in March, and species of *Scenedesmus* and *Pediastrum* at the beginning of April or a little before³. Even in the tanks in the warmer houses (e.g.

¹ Very few Desmids were also observed in the Plankton of the Thames; analysis of the river-water shows that a considerable percentage of calcium carbonate is present (cp. Algological Notes, III: Preliminary Report on the Phytoplankton of the Thames; Annals of Botany, vol. xvi, 1902, p. 581). I should like at this spot to mention that since the publication of my note I have received from Professor G. S. West a paper by his father and himself (A Contribution to the Fresh-water Algae of the North of Ireland, Trans. Royal Irish Acad., vol. xxxii, sect. B, pt. i, August, 1902) which contains an account of the Plankton Algae of Lough Neagh during the months May, 1900, and August, 1901. In the same paper reference is made to a publication of Borge's: 'Süsswasser-Plankton aus der Insel Mull,' in Algologiska Notiser, 4; Botaniska Notiser, 1897.

² A somewhat similar sheath is described for *Sp. lubrica* by Braun; cp. Verjüngung, 1851, p. 261.

³ Most of these unicellular or few-celled forms probably only occur when the conditions of temperatures, and especially of illumination, begin to be favourable (cp. Zacharias, Über die Ursache der Verschiedenheit des Winterplanktons in

Water-lily House, *Victoria Regia* House) this periodicity is observable. Desmids and other Conjugates are very rare before April, although some of the unicellular Protococcoideae are here to be found all the year round.

Much has already been written about the periodicity in the development of certain Plankton organisms, but little attention in this respect has been paid to those inhabiting the deeper strata of the water. In all the artificial waters at Kew a regular sequence of forms was observed; it was most pronounced in the aquatics' tank near the Jodrell Laboratory, in which, by the removal every now and then of the mass of Algae that collects there, room is constantly being furnished for the development of other forms. Table I (see next page) illustrates this periodicity in the algal flora very well.

A careful perusal of this Table will show that the flora in any one month differs more or less considerably in character from that of the preceding or succeeding month. Undoubtedly the removal of the large masses of Algae, which collect in the space of every fortnight during the summer, considerably furthers this periodical development. Thus a little time after the tank had been thoroughly cleaned out, I met with the curious red oospores of *Sphaeroplea annulina*, a species which had been found in abundance in this tank in a former year, but had since not been observed. These oospores had probably been liberated during the cleaning-out of the tank, and in a few weeks gave rise to a large number of vegetative filaments of the *Sphaeroplea*.

However, even in the lake, where no such artificial agency comes into consideration, the periodicity of the flora is well marked, as will be seen by Table II (see next page).

Enteromorpha intestinalis, *Tetraspora gelatinosa*, and *Oscillaria nigra*, all very abundant in the summer months, especially the first and last species, are entirely absent in the early part of the year; they thus give the algal flora of the summer an entirely different stamp to that of the winter. In addition to this we may note the development of the Desmidiaceae, which is, however, relatively poor in the calcareous waters of Kew, as already mentioned.

Oscillaria nigra also played an important part in the water-lily pond. In the earlier part of the year a *Cladophora* was the most abundant form here, and no trace of the *Oscillaria*

grossen u. kleinen Seen, Zoolog. Anzeiger, Bd. xxii, Nos. 577 and 578, 1899, p. 19, &c.).

I. Table illustrating the periodical development of Algae in the tank near the Fodrell Laboratory¹.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
<i>Characium Sieboldi</i> , Braun	—	—	—	—	—	—	—	+	+
<i>Chlamydomonas pulvisculus</i> , Ehrb.	—	—	—	+	+	+	+	+	+
<i>Chaetophora endiviaefolia</i> , Ag.	—	+	+	—	—	—	—	—	—
<i>Draparnaldia plumosa</i> (Vauch.), Ag.	—	—	—	—	+	+	+	+	—
<i>Mesocarpus pleurocarpus</i> , De Bary	—	—	+	+	—	—	—	—	—
<i>Spirogyra crassa</i> , Kütz.	+	+	+	+	+	+	+	+	+
„ <i>condensata</i> , Kütz.	—	—	—	—	—	+	+	—	—
„ <i>longata</i> , Kütz.	—	—	—	—	—	+	+	+	—
<i>Closterium acerosum</i> (Schrank), Ehrb.	—	—	—	—	+	+	+	+	+
<i>Sphaeroplea annulina</i> , Ag.	—	—	—	—	+	+	—	—	—
<i>Cladophora fracta</i> , Kütz.	—	—	—	—	—	+	+	+	+
<i>Ulothrix radicans</i> , Kütz.	—	—	—	—	+	—	—	—	—
<i>Sciadium arbuscula</i> , Braun	—	—	—	—	—	—	—	—	+
<i>Tetraspora lubrica</i> , Ag.	—	—	—	—	—	—	+	+	—

II. Table illustrating the periodical development of Algae in the Lake at Kew¹.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
<i>Vaucheria geminata</i> (Vauch.), D.C., var. <i>b. racemosa</i> , Walz	—	—	—	+	—	—	—	—	—
<i>Mesocarpus pleurocarpus</i> , De Bary	—	—	—	+	+	+	+	+	+
<i>Sirogonium sticticum</i> , Kütz.	+	+	+	+	—	—	—	—	—
<i>Spirogyra porticalis</i> , Cleve, var. <i>a. quinina</i> , Corda	—	—	—	—	—	+	+	+	—
<i>Gonatozygon Brebissonii</i> , De Bary	—	—	—	—	—	—	+	—	—
<i>Closterium Jenneri</i> , Ralfs.	—	—	—	—	—	+	+	+	—
„ <i>Dianae</i> , Ehrb.	—	—	—	—	+	+	+	+	+
<i>Euastrum venustum</i> , Bréb.	—	—	—	—	+	+	+	+	+
<i>Cosmarium crenatum</i> , Ralfs.	—	—	—	+	+	+	+	+	+
„ <i>quinarium</i> , Lund.	—	—	—	—	—	—	+	+	—
„ <i>isthmochondrium</i> , Nords	—	—	—	—	+	+	+	+	—
<i>Staurastrum striolatum</i> , Pritch.	—	—	—	—	—	—	—	+	+
„ <i>polymorphum</i> , Bréb.	—	—	—	—	—	—	+	+	+
<i>Cladophora crispata</i>	—	—	+	+	+	+	+	+	+
<i>Aphanochaete repens</i> , Braun	+	+	+	+	+	+	+	+	+
<i>Enteromorpha intestinalis</i> , Link.	—	—	—	—	—	+	+	+	+
<i>Eudorina elegans</i> , Ehrb.	—	—	—	+	+	+	+	+	+
<i>Pandorina morum</i> , Ehrb.	—	—	—	+	+	+	+	+	+
<i>Gonium pectorale</i> , Müll.	—	—	—	+	+	+	+	+	+
<i>Pediastrum Boryanum</i> , Turp.	—	—	—	+	+	+	+	+	+
„ <i>pertusum</i> , Kütz.	—	—	—	+	+	+	+	+	+
<i>Tetraspora gelatinosa</i> , Desv.	—	—	—	—	+	+	+	—	—
<i>Coelastrum microporum</i> (Naeg.), Braun	—	—	—	—	—	+	+	+	+
<i>Tetrapedia setigera</i> , Archer	—	—	—	—	—	—	—	—	+
<i>Oscillaria nigra</i> , Vauch.	—	—	—	—	—	+	+	+	+

¹ + indicates the presence; — the absence of any form.

was to be found. During the summer months the latter genus, however, attained an enormous development, the whole bottom of the pond being covered with a thin blue-green film from which dense, almost black masses of various shapes stood up vertically in the water.

In the introductory remarks to the many algal lists that have been published I have as yet found little discussion on the periodicity of Algae. Hilse¹ in 1863 remarks of the Algae in the numerous small pools in the granite quarries of the Galgenberg near Strehlen: 'Sehr bequem ist auch hier der Wechsel der einzelnen Arten zu beobachten. So findet man in den Jahreszeiten Frühling, Sommer und Herbst in ein und derselben Wassersammlung sehr oft auch verschiedene Algen, ja manche dieser Species hat kaum eine Dauer von einigen Wochen (!)' Bohlin² quite recently, in a very comprehensive account of the algal flora of the Azores, remarks: 'Il est sûr qu'une certaine quantité de ces plantes sont, plus qu'on ne le pense en général, liées à certaines saisons.' This remark applies to a tropical flora, but might equally well be applied to the development of an algal flora in our parts. The few remarks made by Schimper³ on the periodicity of the water-plants all refer to the Phanerogams or to the Plankton. The writer is at present occupied with the collection of data concerning the periodical development of Algae in different parts of the South of England, and hopes at a future date to enter much more fully into this interesting subject.

F. E. FRITSCH.

JODRELL LABORATORY, KEW,
October 30, 1902.

NOTE ON ABNORMAL PLURALITY OF SPORANGIA IN LYCOPODIUM RIGIDUM, Gmel.—Though few, if any, morphological generalizations are without any exceptions, one which has hitherto stood, I believe, without any recorded instances to the contrary is that in the Lycopodinae (excl. Psilotacea) the sporophyll

¹ Hilse, Neue Beiträge zur Algen- u. Diatomeen-Kunde Schlesiens, insbesondere Strehlens, Abhandl. d. Schles. Ges. f. vaterl. Cultur, naturw.-medizin. Abtheilung, 1863, Heft II, p. 57.

² Bohlin, Étude sur la flore algologique d'eau douce des Açores. Bihang till K. Svenska Vet.-Akad. Handlingar, Bd. 27, Afd. III, No. 4, 1901, p. 5.

³ Schimper, Pflanzengeographie, p. 857.

Fritsch, Felix Eugene. 1903. "Algological Notes IV. Remarks on the periodical development of the algae in the artificial waters at Kew." *Annals of botany* 17, 274–278. <https://doi.org/10.1093/oxfordjournals.aob.a088915>.

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