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XXIX.—On the Nostochineæ

John Ralfs M.R.C.S. ^a

^a Penzance

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XXIX.—*On the Nostochineæ.* By JOHN RALFS, M.R.C.S.,
Penzance*.

[With two Plates.]

FROND gelatinous, containing simple, jointed, generally moniliform filaments. Some joints enlarged, all finally separating.

The *Nostochineæ* may be regarded as a tribe of freshwater and terrestrial Algæ, for only a very few of its species are either littoral or inhabitants of brackish waters. They are allied on the one hand to the *Oscillatoria* and on the other to the *Palmelleæ*; but I consider they have a closer affinity to the former than to the latter. Some species of *Nostoc*, to the naked eye, have considerable resemblance to fronds of *Rivularia*. Without the use of the microscope we are sometimes unable to distinguish *Trichormus* and *Sphærozyga* from *Oscillatoria*, and even with its assistance the young filament in *Spermosira* is liable to be regarded as an *Oscillatoria*. So closely too is this family allied to the *Palmelleæ*, that some distinguished naturalists have united them. *Hormospora* in the latter scarcely differs from it except by its uniform and more distant cells.

In the *Nostochineæ* the filaments are always imbedded in gelatine. In *Nostoc* and *Hormosiphon* this gelatine is very evident, and, especially in the young plant, is comparatively firm. It is, indeed, often fleshy or even cartilaginous, and externally is always condensed so as to form a distinct covering or epidermis (generally smooth and glossy) which limits the frond and gives it a definite form. In *Trichormus* and the remaining genera the plant forms a stratum of no determinate form or extent.

In all the genera the filaments are simple, jointed and usually moniliform, and finally break up into single joints. Their joints

* Read before the Botanical Society of Edinburgh, April, May, June and July 1849.

or cells are commonly more or less orbicular, but sometimes disciform or cylindrical, and in a few instances confluent. At first they are uniform; they divide in the same way as they do in other simple Algæ, and during division are geminate.

I believe that the filaments multiply in consequence of the division of the joints being here and there complete in the same way as in *Oscillatoria*; because we find that the filaments in an early state (as Mr. Hassall has correctly noticed) are but sparingly scattered through the mass, whereas in mature specimens they become very numerous. Mr. Hassall considers that this increase results from the separation or dislocation of the enlarged cells. I believe, on the contrary, that when the enlarged cells are fully formed the plant approaches maturity, and the filaments cease to multiply. The following facts will, I think, prove that the multiplication of the cells has no essential connection with the enlarged joints. In *Cylindrospermum* they terminate the filament, yet here the filaments are as numerous as in the other genera, nor do we find them of more unequal lengths, which would however necessarily be the case if the enlarged terminal joints separated to form new filaments; and further, the enlarged joints themselves are not developed until after the filaments have become numerous.

As I have stated above, the joints or cells are at first uniform in size and figure; but in the mature plant they are of three different kinds, all of which are generally, though not I believe invariably, present in the same filament. These are—

1st. *Ordinary joints or cells*.—Of these I shall only observe, that they divide by separating into two hemispheres, each gradually acquiring a new portion in the room of that from which it has separated, and that until this process is complete they appear geminate. As this geminate state is common to every species during growth, it cannot be employed as a specific character, and as the other cells do not divide, the elongation of the filament must be solely due to the ordinary ones. Their endochromes are slightly granular, which gives them a dotted appearance.

2nd. *Vesicular joints or cells**.—These make their appearance at an early period. They are generally orbicular, but sometimes elliptic, and are usually larger than the ordinary cells. They are evidently analogous to the vesicles present in *Rivularia* and in some of the *Oscillatoriæ*. They do not contain granular matter, but are filled with a bluish fluid, which eventually acquires a brown tint. When mature they are frequently furnished with diverging hairs or cilia. They seem to be connected with the adjacent

* By Mr. Thwaites they are named, from their usual position, "connecting cells;" they have also been called "Heterocysts."

cells by a minute orifice at each end, which *in situ* looks like a minute globule; by this peculiar appearance and by the absence of granular matter the vesicular cells may be easily recognized.

3rd. *Enlarged cells or sporangia*.—These are produced by enlargement of the ordinary cells, and are the last formed. They are filled with a dense granular matter which becomes homogeneous and opaque, and finally turns from green to brown like the sporangia in the *Conjugata* and *Desmidiæ*. When they are fully developed the filament has fulfilled its function, separates into single joints and disappears. The sporangia in *Nostoc* and *Trichormus* differ but little except in size from the ordinary joints, and are more or less orbicular. In *Sphærozyga* and *Cylindrospermum* they are either elliptic, oblong or cylindrical. Usually they are, even before the appearance of granular matter, easily distinguished from the vesicular cells by the absence of the remarkable puncta-like globules I have just noticed. The sporangia continue to enlarge after their separation from the filament.

That these enlarged cells are true sporangia I cannot doubt; but the nature of the vesicular cells is less certain. The coexistence of the vesicular cells and sporangia in the same filament may lead to a better understanding of their office in other tribes. As the former are evidently of the same nature as those present in *Rivularia* and in some of the *Oscillatorieæ*, we cannot pronounce that they are reproductive organs in the one family and not in the other.

On the present occasion I shall examine only those genera of the *Nostochineæ* in which the plant forms a stratum. As I have before remarked, they form more or less extended patches, either on the damp soil or on aquatic plants, or at the bottom of pools and ditches. Their colour is bluish green or verdigris, and the stratum is extended by the filaments radiating at its margin. Hence both in colour and habit, as well as in general appearance, they resemble species of *Oscillatoria*; the stratum, however, is usually more tender and gelatinous. The mass, which in an early state is somewhat translucent, at length commonly becomes opaque and presents a pulverulent appearance.

The facility with which the filaments break up, especially in warm weather, considerably increases the difficulty of studying these plants. When the plant is mature, the destruction of the filament so frequently takes place in a few hours, even though it be kept in water, that recent specimens forwarded to any distance seldom arrive in a condition fit for examination; I am therefore less able to profit by the examination of those sent me from other districts. Even when they are mounted in fluid, the labour is

often rendered useless by the separation of the filament into single cells. The destruction of the filament is attended by the escape of the colouring matter, which stains the water or whatever is in contact with the mass, and is usually the first sign of that destruction.

I find the best method of preserving specimens is to dry them as quickly as possible on talc or glass. Specimens preserved on paper can rarely be removed without injury. In examining specimens that have been dried, it is necessary to bear in mind, that although, when revived by adding a little water, they present characters apparently but little altered from their recent ones, yet their joints are then more distinct and orbicular from contraction at their junction; hence a cell quadrate in the recent plant will be orbicular in the revived one. I have elsewhere mentioned that from a similar cause the dried frond in *Closterium* appears more attenuated at the extremities than is natural, and I fear that from inattention to this fact descriptions taken from dried specimens are sometimes faulty.

Until the publication of Professor Kützing's 'Phycologia Generalis,' the described species belonging to this group were few in number, and usually retained in a single genus either as *Anabaina*, Bory, or *Sphærozyga*, Ag. Professor Kützing has now determined upwards of thirty species, which he has distributed in four genera*.

Attempts to ascertain the earlier synonyms in tribes which require the aid of the microscope to detect the generic and specific differences are necessarily attended with much difficulty. Not only are our present instruments far superior to those used a few years ago, but when natural history began to take its proper rank in science, the higher tribes sufficiently taxed the time and skill of collectors and writers; it is therefore not surprising that the more minute Cryptogamia should have been comparatively neglected. The descriptions were chiefly taken from characters obvious to the naked eye, and besides were often so brief and at the same time so vague, that they were equally applicable to members of very different genera; hence authors, unable to determine with certainty the species of their predecessors, were frequently compelled either to depend on chance in

* I take this opportunity of directing attention to his 'Tabulæ Phycologiæ,' now publishing in numbers in a cheap form, and containing magnified figures of every species known to him. To those who wish to identify our British freshwater Algæ it is indispensable. Of British species of *Oscillatoria* we have no figures of the slightest value, for unfortunately Mr. Hassall, many of whose figures in other genera are very useful, has, in every figure which he has given of that genus, omitted to give the ends of the filaments, though they are often essential to the determination of the species.

the employment of old names, or, renouncing the task as hopeless, to invent new ones. In the present group all these difficulties have been experienced, and unless authentic specimens, in a fit state for examination, exist in the collections of Linnæus and other early botanists, it must in some instances be impossible to affix their names with any certainty. I cannot flatter myself that my nomenclature will be free from error; but I venture to hope that by pointing out the essential peculiarities of these plants, and by more detailed descriptions of the species, I shall facilitate the labour of those who can find opportunity for inspecting the herbaria of original authorities.

Should I succeed in my endeavours to elucidate the British species, the success will be due in a great measure to the kind assistance of my fellow-students. Mr. Thwaites, who in Harvey's 'Phycologia Britannica' was the first to recognize three kinds of cells, has supplied descriptions of some species which I have not met with. Other friends, especially Professor Allman, Mr. Andrews, Mr. Jenner, Mr. Moore, the Rev. T. Salwey, and Mr. W. Thompson, have aided me by specimens accompanied with remarks; whilst Mr. Borrer has enabled me, by means of his rich botanical library, to clear up points on which I must otherwise have remained in doubt*.

* The following synoptical table will, it is hoped, convey a clear idea of the characters distinguishing respectively the various genera proposed to be described. The genus *Nostoc* is not included in the present paper on account of the necessity which exists of a further examination and study of its several species, some of which have been stated by Professor Kützing and M. Fries to be merely a condition of species of *Collema*.

Synoptical Table of Genera.

I. Filaments not included in a membranous sheath.

- a. Frond definite.
 - 1. *Monormia*, Berkeley.
- b. Frond indefinite.
 - 2. *Trichormus*, Allman. *Vesicular cells* interstitial and terminal. *Sporangia* formed first from the cells at the greatest distance from the vesicular cells.
 - 3. *Spherozyga*, Ag. *Vesicular cells* interstitial. *Sporangia* formed first from the cells nearest the vesicular cells.
 - 4. *Cylindrospermum*, Kützing. *Vesicular cells* terminal. *Sporangia* as in *Spherozyga*.
 - 5. *Dolichospermum*, n. gen. *Vesicular cells* interstitial. *Sporangia* without any definite arrangement, and of unequal length.

II. Filaments included in a membranous sheath.

- 6. *Aphanizomenon*, Morren. *Vesicular cells* none? *Sporangia* usually single and of unequal length.
- 7. *Spermosira*, Kütz. *Vesicular cells* interstitial, single or sometimes two together. *Sporangia* as in *Trichormus*.

MONORMIA*, Berkeley.

Frond definite, gelatinous, elongated, linear, spirally curled and convoluted, inclosing a single continuous moniliform filament.

Monormia is very closely allied to *Trichormus*, Allman, differing principally, if not solely, in its definite linear frond, which incloses a single moniliform filament to be traced throughout all the peculiar convolutions of the frond. The *vesicular cells* are interstitial and occur singly. The *sporangia* are numerous, and are first formed from the cells at the greatest distance from the vesicular cells.

Without due attention *Monormia* might easily be mistaken for a species of *Nostoc*, but the mass formed by its convoluted frond is not inclosed by a common membranous pellicle as in that genus.

Monormia intricata, Berk. Gleanings of British Algæ, p. 46. t. 18 (1832); Harvey, Man. of Brit. Algæ, p. 185; Phycologia Britannica, t. 256; Hassall, Brit. Fresh. Algæ, p. 286. t. 75. fig. 11. *Nostoc intricatum*, Meneghini, Mon. Nostoch. Ital. p. 122 (1842). *Anabaena intricata*, Kützinger, Phycologia Germanica, p. 171 (1845); Species Algarum, p. 288; Tabulæ Phycologicæ, p. 50. t. 94. fig. 1.

In ditches of the marsh to the south of Frindsbury Canal, near Gravesend, *Rev. M. J. Berkeley*; in brackish ditches at Shirehampton, near Bristol, *G. H. K. T.*; near Warcham, *Rev. W. Smith*. Germany, *Kützinger*.

This species occurs in slightly brackish ditches as floating gelatinous masses, each about as large as a walnut, and usually of a reddish brown colour. When a small portion of the plant is examined with a lens of moderate power, it is seen to consist of an elongated continuous moniliform filament included in a definite linear gelatinous sheath, which is very much curled and convoluted, and the apposed surfaces of which are more or less coherent. The vesicular cells are somewhat oblong, and rather larger than the nearly spherical ordinary cells. The sporangia are numerous, twice the diameter of the ordinary cells, and perfectly spherical.

When the sporangia are mature the definite outline of the linear frond is almost lost, and then there is little to distinguish the plant from *Trichormus* but the peculiar convolutions of the moniliform filament. The original colour of the gelatinous frond has also then disappeared, and the plant has assumed a pale greenish tint.

In drying, the plant stains paper of a deep blue or purplish colour.

PLATE VIII. fig. 1.

* By Mr. G. H. K. Thwaites.

TRICHORMUS, *Allman*.

Filaments simple, moniliform, distinctly jointed, aggregated into an indeterminate gelatinous stratum; sporangia separated from the vesicular cells by the ordinary joints, which they more or less resemble in form.

(*Anabaina*, Bory, Brébisson, Kützinger, Montagne and others.)

In *Trichormus* the stratum is indeterminate and very gelatinous; at first it is nearly colourless and transparent, and the filaments are only sparingly scattered through the matrix; but the filaments rapidly increase in number, and the mass, gradually becoming more opaque, acquires at length a deep bluish green colour, which is occasionally mottled with brown, especially beneath.

The filaments are mostly short, distinctly moniliform, and frequently as much curved as those of a *Nostoc*. The cells are all more or less orbicular, and the sporangia differ less from the ordinary cells than they do in the following genera. Viewed under the microscope the filaments scarcely differ from those of a *Nostoc*. In both genera they are usually curled, their cells are orbicular, the vesicular ones are interstitial and terminal, and the sporangia are often not apparent, or are known only by their denser endochromes.

In some of the aquatic species the stratum separates into large floating gelatinous masses, and then can only be distinguished from *Nostoc* by the gelatinous portions having no definite form or size, and by the absence of an epidermis.

Professor Kützinger refers *Monormia intricata*, Berk., to this genus. I have never gathered that plant, and I was unable to determine the genus from recent specimens sent me by Mr. Thwaites from Bristol; but, judging from Mr. Berkeley's figures and description, I should suppose that the more definite frond and the elongated, solitary and peculiarly convoluted filament are sufficient to sustain the genus.

As Professor Harvey has reminded us in his 'Phycologia Britannica' that Bory's name *Anabaina* has been appropriated to a genus of flowering plants, and it becomes necessary to choose another, I have adopted Professor Allman's name *Trichormus* as next in priority.

Trichormus differs from *Dolichospermum* in its sporangia, which are more or less orbicular, and from *Sphærozyga* and *Cylindrospermum* by the different arrangement of the sporangia and vesicular cells.

1. *T. Flos-aquæ* (Lyngbye). Filaments flexuose or curved, moniliform; cells orbicular, vesicular ones larger, terminal and interstitial. *Nostoc Flos-aquæ*, Lyngbye, Tentamen Hydrophytologiæ Danicæ,

p. 201. t. 68. fig. D (1819). *Anabaina membranina*, Bory, Arthr. fig. 7 d (according to Kützinger); Mougeot et Nestler, Stirpes Cryptogamiæ Vogeso-Rhenanæ, no. 896. *Anabæna Flos-aquæ*, Trevir. in Linn. 1843, t. 3. fig. 5-7; Kützinger, Phycologia Generalis, p. 209; Phycologia Germanica, p. 171; Species Algarum, p. 289. *Sphærozyga membranina*, Eadlicher, Mantissa Bot. Alterum Sup. tertium, p. 12 (1843). *Trichormus incurvus*, Allman, Annals of Nat. Hist. vol. xi. p. 163. t. 5 (1843); Hassall, Brit. Freshwater Algæ, p. 285. t. 75. fig. 1.

Stagnant pools and other still waters. Portmore Lough, Antrim, Mr. W. Thompson; Ayrshire, Rev. D. Landsborough; Dolgelley, J. R.; Oswestry, Shropshire, Rev. T. Salwey; Grand Canal Dock, Dublin, Professor Allman.

Finland, *Lyngbye*; France, *Bory*; Germany, *Kützinger*.

Trichormus Flos-aquæ rises to the surface of the water in gelatinous masses of considerable size, and is generally of a rich bluish green colour. Filaments curved and beautifully moniliform. Cells spherical; vesicular ones resembling the ordinary ones, but larger and without granular matter. Sporangia I have not detected, but since cells, not different in form from ordinary ones, are often filled with granular matter, there is probably no very obvious difference between the latter and the sporangia.

PLATE VIII. fig. 2.

2. *T. spiralis* (Thompson). Filaments coiled or spiral; ordinary cells subquadrate or orbicular; vesicular cells and sporangia orbicular. *Anabaina spiralis*, Thompson in Annals and Mag. of Nat. Hist. vol. v. p. 81 (1846). *Spirillum Thompsoni*, Hassall, Brit. Freshwater Algæ, p. 278. t. 75. fig. 7 (1845).

Ballydrain Lake, near Belfast, Mr. Thompson; Petersfield, Mr. Jenner.

I regret that the specimens Mr. Thompson has sent me are too imperfect to serve for the identification of the species. I am by no means certain that Mr. Jenner's plant is identical with the Irish one, and I have referred it to this species in deference to the opinions of Mr. Thwaites and Mr. Jenner, rather than from my own conviction.

The filament in Mr. Jenner's specimen is somewhat coarse, and coiled rather than loosely spiral. The ordinary joints are more or less quadrate, the vesicular cells orbicular, and the sporangia similar to the ordinary cells, but larger and more orbicular. Mr. Thompson's figure represents his *T. spiralis* with perfectly orbicular ordinary cells, and a slender filament which, except in being spiral, scarcely differs from *Trichormus Flos-aquæ*.

PLATE VIII. fig. 3. a, Mr. Jenner's specimen; b, fragment of Irish specimen with sporangium between ordinary cells; c, mature sporangium.

Monormia.

Trichormus.

Sphaeroszga.

Cylindrospermum.

3. *T. Thwaitesii* (Harv.). Filaments moniliform, slightly flexuose; ordinary cells globular or nearly so; vesicular cells larger, globular when interstitial, ovate when terminal, ciliated; sporangia oval, catenate. *Sphærozyga Thwaitesii*, Harvey, Phycologia Britannica, t. 113 B (1847).

Salt-marshes, Dolgelley, North Wales, and Hayle, near Penzance, J. R.; Shirehampton, near Bristol, Mr. Thwaites; Portbury, Somersetshire, Mr. Broome; near Hastings, Mr. Jenner.

Trichormus Thwaitesii forms thin, gelatinous, dark green patches either on the damp soil covered at spring-tides or at the bottom of brackish ditches or pools. Filaments moniliform, elongated, pale bluish green. Ordinary joints nearly orbicular, except when dividing. Vesicular cells interstitial and terminal, ciliated, twice as large as the ordinary ones, ovate when terminal, otherwise spherical. Sporangia oval or nearly globular, larger than the ordinary cells, beginning near the centre of the filament and forming chain-like groups of six or more together.

Mr. Thwaites's specimens vary in some respects from those I have gathered. I find the stratum very thin and tender, and the sporangia rarely produced; but Mr. Thwaites informs me, that at Bristol, on the contrary, it forms, after a time, large, floating, gelatinous masses, and then abounds with sporangia.

Trichormus Thwaitesii is more likely to be confounded with immature specimens of *Sphærozyga Carmichaelii* than with either of the preceding species of this genus, especially as they often grow intermixed. In the present plant however the filament is longer, the ordinary cells are more globular, and the terminal cell either resembles the others or is ovate and vesicular. Its ciliated and globular vesicular cells distinguish it from *T. oscillarioides* and *T. recta*.

A specimen of *Anabaina variabilis* sent me by Professor Kützinger is apparently identical with the present species; but, as the former is described as lacustrine, with attenuated ends, I have thought it advisable not to unite them*.

PLATE VIII. fig. 4. *a*, immature filament; *b*, mature filament.

4. *T. oscillarioides* (Bory). Filaments elongated, flexuose; ordinary joints subquadrate, distinct; vesicular cells barrel-shaped or elliptic, naked; sporangia oval, catenate. *Anabæna oscillarioides*, Bory, Dict. Class. d'Hist. Nat. *Sphærozyga oscillarioides*, Kütz. Species Algarum, p. 291 (1849); Tabulæ Phycologicæ, t. 96. fig. 5. *Trichormus affinis*, Ralfs in lit.

Brackish ditches. Shirehampton, near Bristol, Mr. Thwaites.

* "*Anabaina variabilis*, lacustris, mollis, viridi-æruginea; trichomatibus attenuatis, ærugineo-viridibus, laxè implicatis; articulis ellipticis, majoribus, granulosis."—Kützinger, Phyc. Gener. p. 210.

Stratum bluish green; filaments elongated, flexuose, moniliform, often attenuated at the ends. Ordinary joints quadrate, with rounded angles, frequently longer than broad, terminal ones conical. Vesicular cells oblong, usually flattened at the ends so as to appear barrel-shaped, broader than the ordinary joints, and, according to Mr. Thwaites, always naked. Sporangia elliptic, catenate, and somewhat larger than the ordinary cells.

Trichormus oscillarioides differs from *T. Thwaitesii* by its more quadrate ordinary cells and by its smooth and elliptic vesicular cells. It may be known from *T. recta* by its elongated filaments and by its more quadrate ordinary cells.

PLATE VIII. fig. 5.

5. *T. rectus** (Thw. MS.). Filaments bright green, straight, short, slightly tapering towards the extremities; ordinary cells subspherical, rather shorter than wide; vesicular cells oblong, smooth, scarcely wider than the ordinary cells, and never terminating the filament; sporangia spherical or oblong, numerous.

Pools. Hanham, near Bristol, August 1847, G. H. K. Thwaites.

This little species differs from every other we have seen in its short, straight filaments, which are of a beautiful green colour. The vesicular cells, of which there are seldom more than one or two in each filament, are of a reddish colour, and about half as long again as wide. The ordinary cells are nearly spherical, somewhat compressed, so as to be rather wider than long. The sporangia vary in shape from spherical to oblong.

PLATE VIII. fig. 6.

SPHÆROZYGA, Ag.

Filaments simple, generally moniliform, aggregated into a gelatinous stratum; sporangia interstitial, in groups of two or more connected by a vesicular cell.

(*Sphærozyga*, Agardh, Endlicher, Kützinger, Montagne. *Anabaina*, Bory, Brébisson.)

Sphærozyga agrees with *Trichormus*, *Dolichospermum*, *Cylindrospermum*, *Aphanizomenon* and *Spermosira* in its mode of growth as well as in the colour and general appearance of its stratum, and differs from those genera solely in the microscopic characters of its filaments.

The filaments are somewhat elongated. The joints, though seldom so orbicular as in *Trichormus*, are usually very distinct. The sporangia are generally elongated and cylindrical; they occur in little groups of two or four, with a vesicular cell interposed at the centre. Sometimes a vesicular cell has a sporangium

* For the description of this species I am indebted to Mr. Thwaites.

on one side and apparently an ordinary cell on the other, but this occurs only when the sporangia begin to be developed, and the individual on one side is more forward than that on the other. In such a case close examination will detect a slight preliminary elongation of the incipient sporangium. The sporangia indeed are always developed, first on one side of the vesicular cell and then on the other, and whatever number may occur together they follow the same rule, and are produced alternately adjacent to those previously formed, and as they are thus produced in succession they all vary in size (except in the mature plant), the inner ones in each group being the largest.

Sphærozyga differs from *Trichormus* and *Dolichospermum* by producing its sporangia adjacent to the vesicular cells; its filaments also are straighter, and its sporangia more elongated than in the former genus. The interstitial position of the sporangia and vesicular cells distinguishes it from *Cylindrospermum*, and the ordinary cells are not disciform as in *Spermosira*.

* *Filaments moniliform; sporangia elongated, not turgid.*

1. *S. Carmichaelii* (Harvey). Filaments moniliform, with tapering extremities; ordinary joints distinct, subquadrate; sporangia oblong; vesicular cells spherical. *Belonia torulosa*, Carmichael, Alg. Appin ined.; Harvey in Hooker's Brit. Flora, vol. ii. p. 379 (1833); Manual of Brit. Algæ, p. 167. *Sphærozyga compacta*, Kützinger, Phycologia Generalis, p. 211 (1843); Phycologia Germanica, p. 172. *Anabaena marina*, De Brébisson in Ann. Sc. Nat. !; Kützinger, Species Algarum, p. 287; Tabulæ Phycologicæ, t. 92. fig. 111. *Sphærozyga Carmichaelii*, Harvey, Phycologia Britannica, t. 113 A (1847); Kützinger, Species Algarum, p. 294; Tabulæ Phycol. t. 99. fig. 4.

β. *tenuissima* (—). Filaments very slender.

On the damp soil in salt-marshes flooded at spring tides, more rarely in brackish ditches or upon decaying marine algæ. Appin, *Capt. Carmichael*. Anglesea; Barmouth; Penman Pool near Dolgelley; Braunton near Barnstaple; Penzance, *J. R.* Shirehampton near Bristol, *Mr. Thwaites*.

β. Shirehampton, *Mr. Thwaites*.

France, *Brébisson*; Germany, *Kützinger*.

Stratum tender, very thin, of a dark or bluish green colour when recent, but opaque and glaucous when dry. Filaments short, straight, slender, moniliform, with attenuated ends. Ordinary joints distinct, the terminal ones longer than broad and triangular or conical, the others nearly equal in length and breadth, at first quadrate, finally rounded at their angles, and when dried orbicular. Whilst dividing they are geminate and longer than broad. Vesicular cells orbicular or oval and generally ciliated.

Sporangia oblong, three times longer than broad, much broader than the ordinary cells, one or two on each side of the vesicular cell, the outer ones generally smallest.

The best distinctive mark of this species is the subacute extremities, combined with the short filament and littoral habitat. There are rarely more than one or two groups of enlarged cells; when only one is present it is situated near the centre of the filament. I believe that the attenuated extremities are constant, at least in the young plant, unless the filament has been broken.

The var. β . differs in having much slenderer filaments: I am not sufficiently acquainted with it to determine whether it be, as Mr. Thwaites supposes, a distinct species.

PLATE VIII. fig. 7. *a*, *b*, ordinary form; *c*, var. β .

2. *S. Jacobi* (Ag.). Filaments elongated, their ends usually attenuated; ordinary cells subspherical; vesicular cells spherical; sporangia oblong or cylindrical. *Sphærozyga Jacobi*, Agardh, Icones Algarum Europæarum!; Berkeley in Eng. Bot. t. 2826. fig. 2.

Upper Mill, Dolgelley; near Swansea, *J. R.* Durham Down near Bristol, *Mr. Thwaites*!

Carlsbad, *Agardh*! Madeira, *Rev. T. Salwey*.

Sphærozyga Jacobi occurs in thick bluish green gelatinous masses, from which the filaments issue in long rays. The filaments are moniliform, elongated, and generally taper at their ends. Ordinary joints at first somewhat quadrate but finally orbicular, the terminal one longer than broad and usually conical. Vesicular cells spherical, larger than the ordinary joints, but not so broad as the sporangia. Sporangia oblong or cylindrical, one or two on each side of the vesicular cell.

Agardh's figure represents his *Sphærozyga Jacobi* as having the ordinary joints closely united, in fact separated merely by transverse dissepiments, and consequently so unlike the present plant, that I should scarcely have suspected their identity if Mr. Borrer had not afforded me an opportunity of examining an authentic Carlsbad specimen which he received from Agardh himself.

Sphærozyga Jacobi in some respects agrees with *S. Carmichaelii*; but the filaments are stouter and more elongated, the ordinary cells are more orbicular, its habitat is also different, and the dried plant wants the opaque verdigris appearance so usual in the latter. The orbicular ordinary and vesicular cells distinguish it from *S. elastica* and *S. leptosperma*.

PLATE VIII. fig. 8. *a*, immature filament; *b*, mature state.

3. *S. elastica* (Ag.). Filaments moniliform, dissepiments conspicuous; ordinary cells quadrate; vesicular ones elliptic; sporangia

cylindrical, truncate. *Sphærozyga elastica*, Agardh, Icones Algarum Europæarum. *Cylindrospermum elongatum*, Kützinger, Species Algarum, p. 294 (1849); Tabulæ Phycologicæ, t. 99. fig. 111.

Cromlyn Bog near Swansea, *J. R.*

Sweden, *Agardh*; Germany, *Braun*.

Stratum deep bluish green, tender. Filaments elongated, constricted at the dissepiments. Ordinary cells about equal in length and breadth; but when dividing they lengthen, and though quadrate in the recent plant they acquire slightly rounded angles when dry. Vesicular cells at first barrel-shaped, finally elliptic. Sporangia cylindrical, four to eight times longer than broad, their ends at first truncate, but rounded after separation.

The moniliform filaments and shorter joints distinguish this species from *Sphærozyga leptosperma*, and its elliptic vesicular cells from *S. Jacobi* and *S. Carmichaelii*.

PLATE VIII. fig. 9. *a*, immature filament; *b*, mature state.

** *Filaments moniliform; sporangia turgid, much broader than the ordinary cells.*

4. *S. Broomeii* (Thwaites). Filaments moniliform, elongated; ordinary joints suborbicular; vesicular cells barrel-shaped or elliptic; sporangia elliptic, catenate. *Sphærozyga Broomeii*, Thwaites.

Brackish ditch at Shirehampton, near Bristol, *Mr. Broome*.

Stratum bluish or yellowish green. Filaments elongated, obtuse; ordinary cells at first nearly quadrate, but finally orbicular. Vesicular cells smooth, at first barrel-shaped, then elliptic, broader than the ordinary joints, but not so broad as the sporangia, which are elliptic and numerous.

The gelatinous matrix is firmer than in many species of this genus, and under the lens can be detected without difficulty.

The numerous sporangia in each series distinguish *Sphærozyga Broomeii* from every other species I am acquainted with.

PLATE VIII. fig. 10. *a*, immature filament; *b*, mature state.

5. *S. Berkeleyana* (Thwaites). Ordinary joints spherical or slightly compressed; vesicular cells spheroidal, compressed, as broad as the large turgid-elliptic sporangia. *Sphærozyga Berkeleyana*, Thwaites.

Brackish ditch at Shirehampton, near Bristol, *Mr. Thwaites*.

Filaments elongated; ordinary joints nearly globular, sometimes compressed and slightly broader than long, terminal ones longer and somewhat tapering. The vesicular cells are globular in dried specimens (but Mr. Thwaites informs me that in the recent state they are compressed); they are nearly as broad as the sporangia, which are large, broadly elliptic, and sometimes almost globular.

The turgid sporangia and large, compressed vesicular cells characterise the species.

PLATE VIII. fig. 11. *a*, immature state; *b*, mature state.

6. *S. Mooreana* (—). Ordinary joints subspherical; vesicular cells barrel-shaped, much narrower than the large broadly-elliptic sporangia.

Ireland, Mr. Moore, to whom I am indebted for specimens.

Ordinary cells minute, somewhat orbicular. Sporangia very turgid, often nearly orbicular, much larger than either the vesicular or the ordinary cells. Vesicular cells minute, smooth and barrel-shaped.

I regret that I have only seen imperfect and dried filaments of this species intermixed with *Nostoc variegatum*, Moore; in a recent state therefore the form of the ordinary cells may not agree with the above description, still the large turgid sporangia must distinguish it from every species but *Sphærozyga Berkeleyana*, and from that it differs in its vesicular cells, which are comparatively much smaller and also longer than broad.

PLATE VIII. fig. 12. Mature filament.

*** *Dissepiments obscure, cells longer than broad.*

7. *S. leptosperma* (Kützinger). Filaments elongated, not constricted at the dissepiments; ordinary joints longer than broad, confluent; vesicular cells elliptic; sporangia linear. *Cylindrospermum leptospermum*, Kützinger, Bot. Zeit. 1847, p. 198; Species Algarum, p. 294; Tabulæ Phycologicæ, t. 99. fig. 11.

Ditches and pools. Near Carnarvon and near Barmouth, J. R. France, Lenormand.

Sphærozyga leptosperma occurs in large, shapeless, gelatinous masses in still waters. Its colour varies from deep green to pale yellowish green, but when the filaments are comparatively few it is nearly colourless. The ordinary joints are longer than broad, separated only by transverse dissepiments, which are not contracted, and indeed are often so obscure, that, in the recent state, they can hardly be detected, whilst the filaments, in all respects but their enlarged cells, appear not unlike those of an *Oscillatoria*. Vesicular cells at first barrel-shaped, finally elliptic, and as broad as the sporangia, the early state of which they somewhat resemble, but they may be recognized by the absence of granular contents and by their globules. Sporangia cylindrical, four to six times longer than broad, truncate, slightly broader than the ordinary cells.

The confluent ordinary cells with their obscure dissepiments distinguish *Sphærozyga leptosperma* from every other British species.

PLATE VIII. fig. 13. Mature filament.

DOLICHOSPERMUM, *Thwaites MS.*

Filaments simple, generally moniliform, aggregated into a gelatinous stratum; sporangia interstitial, elongated, separated from the vesicular cells by the ordinary joints.

Dolichospermum differs from *Sphærozyga* only in the different arrangement of its cells. In the latter genus the vesicular cells connect the sporangia, whereas in the former they are situated amongst the ordinary cells.

The sporangia are much elongated and mostly cylindrical. They are developed from the ordinary cells, which are more or less remote from the vesicular ones. Mr. Thwaites finds that their extremities are invariably truncated, and the endochrome escapes in an undivided mass, a circumstance he has not noticed in the other genera belonging to the *Nostochineæ*.

This genus is distinguished from *Cylindrospermum* by the interstitial position of the sporangia and vesicular cells, and from *Trichormus* and *Spermosira* by its elongated sporangia.

1. *D. inaequale* (—). Filaments moniliform; ordinary cells at first quadrate, finally orbicular; vesicular cells large, spherical; sporangia linear, catenate.

Boggy pools. Dolmelynlyn near Dolgelley, *J. R.*

This plant forms extensive strata, composed of thick gelatinous masses of a deep green colour. Filaments elongated, consisting of from 100 to 200 cells, and, being stouter than in most species belonging to this family, visible to the naked eye. Ordinary cells distinct, quadrate in immature specimens, but at length nearly spherical, appearing punctate on account of the scattered granular matter which they contain. Vesicular cells spherical, broader than the ordinary joints and occurring at short intervals. Sporangia three or four times longer than broad, with truncate ends, in chains of from two to five members.

Dolichospermum inaequale may be known from the following species by its spherical vesicular cells and catenate sporangia.

PLATE IX. fig. 1.

2. *D. Ralfsii* (Kützinger). Filaments moniliform; ordinary joints spherical; vesicular cells elliptic; sporangia elliptic or cylindrical, one or two in each series. *Cylindrospermum Ralfsii*, Kützinger, Bot. Zeitg. (1847), p. 197; Species Algarum, p. 293; Tabulæ Phycologicæ, t. 98. fig. 7.

Bog and rivulet at Llyn Gwernan near Dolgelley, *J. R.*

Dolichospermum Ralfsii occurs in extensive strata of a velvety rich dark green colour, sometimes verging towards æruginous green. A portion placed in water threw out, in the course of one

night, rays an inch or more in length. Filaments elongated, comparatively stout, visible to the naked eye, under the lens full green when grouped, but bluish green when scattered. Ordinary joints orbicular. Vesicular cells elliptic, broader than the ordinary ones. Sporangia near the middle of each series of ordinary joints, most frequently solitary, rarely more than two together, at first oval, afterwards oblong, finally cylindrical, and about six times longer than broad. In their early state they resemble the vesicular cells in form; but the presence of granular matter and the absence of junction-globules reveal their true character: the longer ones are frequently contracted at the middle, a circumstance I have occasionally noticed in those species which have elongated sporangia.

Dolichospermum Ralfsii is distinguished from *D. inæquale* by its elliptic vesicular cells (which are comparatively less broad), by its more orbicular ordinary joints and by having fewer sporangia.

PLATE IX. fig. 2.

3. *D. Thompsoni* (—). Filaments spirally curved; ordinary and vesicular cells spherical; sporangia oblong, curved, usually solitary. *Anabaina Flos-aquæ*, Harvey, Manual of Brit. Algæ, p. 186 (1841); Hassall, British Freshwater Algæ, p. 282. t. 75. fig. 2.

“Floating like powdered verdigris on one of the small Lochs Maben, Dumfries-shire,” *Mr. W. Thompson*.

A specimen of this plant, given me by Mr. Thompson, forms on paper a thin stain of a bluish green colour. Filaments moniliform and loosely spiral. Ordinary and vesicular cells orbicular, and so much alike in form and size that in the dried state I am unable, with absolute certainty, to distinguish the latter from ordinary cells which have lost their granular matter. Mr. Thwaites however informs me, that by a careful adjustment of the lens, he has detected the puncta in the vesicular cell, in which also he finds the membrane firmer than in the others. Sporangia solitary (rarely two together) in each series, two or three times longer than broad, curved, so as to appear somewhat reniform, and more rounded at their ends than is usual in this genus.

This species is easily distinguished from the others by its curved filament and reniform sporangia. Its moniliform, spiral filament agrees better with *Trichormus* than with *Dolichospermum*, but in its elongated sporangia it differs from every species of the former.

PLATE IX. fig. 3.

4. *D. Smithii** (Thwaites MS.). Filaments straight, each included in

* For the description of this and the following species I am indebted to Mr. Thwaites.

a definite gelatinous sheath; ordinary cells subspherical, compressed, about as long as wide; vesicular cells subspherical, somewhat barrel-shaped, half as wide again as the ordinary cells, puncta very distinct; sporangia cylindrical, very unequal in length, and with the ends rounded and somewhat truncated.

Occurring amongst other algæ from a freshwater boggy pool at Wareham, Dorsetshire, *Rev. W. Smith*.

D. Smithii is immediately distinguishable from its congeners on account of its possessing a definite gelatinous sheath to each of its filaments, which are of smaller diameter than those of any other species of *Dolichospermum* we are now describing. The ordinary cells are subspherical, somewhat compressed, and of less diameter than the vesicular cells, which are barrel-shaped and with very distinct puncta. The numerous sporangia, which are of about twice the diameter of the ordinary cells, are elongated and cylindrical, very variable in length and in the number which occur together, and their ends are slightly truncate.

PLATE IX. fig. 4.

5. *D. Thwaitesii* (—). Filaments straight or nearly so; ordinary cells quadrate; vesicular cells oblong, subquadrate, puncta very distinct; sporangia numerous, cylindrical, with truncated ends, very variable in length. *Sphærozyga Ralfsii*, Thwaites in lit. (1849).

In a freshwater pool, Dendham Down near Bristol; also in a brackish ditch near Shirehampton, *G. H. K. Thwaites*.

D. Thwaitesii is nearly allied to the foregoing species, but its filaments are not included in a definite gelatinous sheath. Its filaments are also stouter than those of *D. Smithii*, and there is a difference in the form of its ordinary as well as of its vesicular cells. The vesicular cells of *D. Thwaitesii* are quadrangular, and hardly exceed in diameter the ordinary cells. The cylindrical truncated sporangia are numerous, occurring many in a chain, and very variable in their length; they are of about twice the diameter of the ordinary cells.

PLATE IX. fig. 5.

CYLINDROSPERMUM, *Kützinger*.

Filaments simple, jointed, nidulating in a gelatinous stratum; vesicular cells terminal; sporangia oblong or elliptic, interposed between the vesicular and ordinary cells.

(*Anabaina*, Bory and others.)

In *Cylindrospermum* the stratum is similar to that described under the preceding genera; but as the filaments radiate less than is usually the case in *Sphærozyga*, I was, in one instance of admixture, enabled to separate the *Sphærozyga* from the *Cylin-*

drospermum, by availing myself of the greater radiating capacity of the former.

The filaments, as in the other genera, have at first all their joints uniform, but the terminal joint at each end soon enlarges into a vesicular cell, which is either orbicular, elliptic or ovate, and is generally furnished with fine scattered hairs or fibres: the penultimate joints then elongate and become cylindrical, afterwards they increase considerably in breadth, and when mature are always elliptic or elliptic-oblong. Sometimes two or even three sporangia are formed between the vesicular and the ordinary cells. The additional sporangia however are not uniformly present even in filaments from the same stratum, and are sometimes double at one extremity and not at the other; in fact, few mature specimens can be examined without observing examples of these variations. Hence, although the doubling of the sporangia occurs more abundantly in some specimens or species than in others, I cannot rely upon it as a specific distinction.

There can be no difficulty in recognizing this genus under the microscope. The filaments, especially when only one extremity is visible, are remarkable for their animal-like appearance. The chain of ordinary cells resembles a slender-jointed body; the enlarged elliptic sporangium, at least twice as broad as the remainder of the filament, represents the thorax, and the head is mimicked by the vesicular cell, which, in colour, shape and general aspect, differs from the other cells, whilst the presence of fine hairs renders the imitation more perfect.

It will thus be seen that the terminal cells are invariably vesicular, the penultimate ones always become sporangia, and the central ones remain unaltered.

When the filaments break up, the sporangia separate from the ordinary cells, but remain for some time crowned by the vesicular ones. The filament in *Sphærozyga* frequently breaks at the vesicular cells, after which the portion retaining one attached to its sporangium, appears, at first sight, to belong to this genus. In the recent state however the slightest attention will show its true character, for the vesicular cell of the broken *Sphærozyga* retains the punctum or globule at each end, which is not the case in *Cylindrospermum*, as it is only present where another cell has been conjoined.

1. *C. catenatum* (—). Filaments moniliform; ordinary joints orbicular; vesicular cells oval; sporangia oval, catenate.

This species was probably gathered in South Wales, but I omitted to note the habitat when the specimens were preserved.

Stratum bluish green; filaments very fine, elongated, straight or slightly flexuose, generally parallel. Ordinary cells orbicular,

numerous, very minute. Vesicular cells oval. Sporangia (two to eight in each chain) at first similar to the ordinary cells, but usually less orbicular; finally they become more or less oval, the shorter ones approaching to orbicular, and the longer ones to oblong; they are frequently but little broader than the vesicular cell; in fact their size never differs so much as in many species.

Cylindrospermum catenatum differs from every other species in its numerous sporangia.

Cylindrospermum contains many other species, several of them by no means uncommon in this country; but their descriptions must be deferred to some future period, as my friend Mr. Thwaites, who had paid great attention to them, was prevented by his appointment at Ceylon from fulfilling his kind promise to describe them for this paper.

PLATE VIII. fig. 14. *a*, immature filament; *b*, mature state.

APHANIZOMENON, Morren.

Filaments simple, flaccid, obsoletely jointed, "cohering laterally into flat lamellæ," aggregated into a mucous stratum; vesicular cells none; sporangia linear, interstitial.

(*Aphanizomenon*, Morren. *Limnochlide*, Kütz.)

Aphanizomenon forms a thin, tender, mucous stratum of a bluish colour. The filaments are extremely slender, flaccid, and very obscurely jointed. No vesicular cells have been detected. The sporangia are much elongated, either scattered or, more usually, solitary near the centre of the filament.

I have examined an authentic specimen of *Limnochlide Flos-aquæ*, and as there seems to be no essential difference between *Aphanizomenon* and *Limnochlide* I have united them, retaining the former appellation on account of its priority. The filaments in both genera are described as cohering in flat lamellæ, but that character is sometimes so little obvious in dried specimens, that I am not inclined to place much dependence upon it as a generic distinction, especially as I could not detect it in recent specimens of a plant, presently to be described, which I think should by no means be placed in a different genus.

Authors differ widely respecting the proper situation of this genus. In Harvey's 'Manual of British Algæ' it is placed at the end of the *Conserveæ*, Montagne appends it to the *Oscillatorieæ*, Endlicher omits it altogether, and Kützting instituted for it a distinct family, which he placed between *Leptotricheæ* and *Nostochineæ*. Mr. Hassall, I believe, first placed it in this family, and I fully concur with his observation that "the true position of the genus is undoubtedly amongst the *Nostochineæ*, connecting them with the *Oscillatorieæ*."

Aphanizomenon agrees in its filament with *Oscillatoria*, but is sufficiently separated by its conspicuous sporangia, which are similar to those of *Dolichospermum*. It differs from all the other genera in the *Nostochineæ* by the absence of vesicular cells and by its obsoletely articulated filament.

1. *A. Flos-aquæ* (Linn.). Filaments cohering laterally in flat lamellæ which separate at their extremities into fasciculi; sporangia cylindrical with an inconspicuous covering. *Byssus farinacea virescens, aquæ inspersa*, Linnæus, Flora Lapponica, no. 532 (1737), ed. 2nd, p. 388 (Smith, 1792); Flora Suecica, ed. 1st, no. 1128. *Byssus Flos-aquæ*, Linn. Species Plantarum, no. 1168 (1753), ed. 2nd, p. 1637. *Conferva Flos-aquæ*, Roth, Catalecta Botanica, fasc. 3. p. 192 (1806). *Oscillatoria Flos-aquæ*, Agardh, Synopsis Algarum Scandinaviæ, p. 107 (1817); Syst. Algarum, p. 59. *Nostoc Flos-aquæ*, Jürgens, Algæ aquaticæ. *Limnanthe Linnæi*, Kützing in Linnæa, vol. xvii. p. 86. *Limnochlide Flos-aquæ*, Kützing, Phycologia Generalis, p. 203 (1843); Phycologia Germanica, p. 168; Species Algarum, p. 286; Tabulæ Phycologicæ, t. 91. fig. 2a. *Aphanizomenon incurvum*, Allman in lit. cum specimine.

Probably not uncommon. Grand Canal Docks, Dublin, Professor Allman.

Sweden, Linnæus; Germany, Kützing.

I am indebted to Professor Allman for a beautiful and characteristic specimen of this species. In its dried state the stratum appears to be composed of minute flocculi, and, with the exception of colour, might not unaptly be compared to scattered snow-flakes. The colour is opaque, æruginous green, which however becomes more or less altered after being dried a second time. The microscope shows that the flocculi consist of parallel filaments united together laterally, and forming a flat layer which appears plumose from the filaments converging at the ends into little conical or subulate tufts or pencils. The filaments are straight, obtuse, not attenuated; the joints are rather longer than broad, faintly visible, and especially difficult of detection in consequence of their granular contents. Kützing describes the sporangia as elliptic. In the Dublin specimen they are few in number and immature; but in specimens given me by Professor Kützing they are linear, much elongated, often ten or twelve times longer than broad, and resemble those of the next species except in having a far less conspicuous hyaline covering. The best distinctive mark between these species is the lateral coherence of the filaments in *A. Flos-aquæ*.

In the dried state, the only condition in which I have seen it, the *Aphanizomenon Flos-aquæ* is easily recognized by its flocculent appearance, even to the naked eye. I believe that not only was it one of the earliest-known plants in this group, but that it

is the true *Flos-aquæ* of almost every algologist prior to Lyngbye, whose error has misled many succeeding writers and confounded plants of widely different aspect. The descriptions of Linnæus, Roth and Agardh, although more or less deficient, agree far better with this species than with any others which have been confused with it. Lyngbye, indeed, suspected that his *Nostoc Flos-aquæ* was distinct from the plant of the two latter writers*, an opinion confirmed by Agardh so far as regards himself. Mr. Borrer has sent me a specimen of *Byssus Flos-aquæ* distributed by Mohr, who, there is every reason to suppose, was fully acquainted with the plant then known by that name: the specimen, which is a very good one, scarcely differs even in colour from those recently gathered by Professors Kützinger and Allman.

I cannot obtain the slightest clue to the *Flos-aquæ* of our earlier British writers. They give no habitats, and although the specific definition of Hudson, Lightfoot and Withering agrees with this species ("filamentis plumosis natantibus"), yet, as it is a mere copy from Linnæus, no dependence can be placed upon it. The two former authors give no original remarks, and Withering's own observations agree but indifferently with his specific quotation; for his description, "jointed filaments straight or curled like a cork-screw," is more applicable to a *Trichormus*.

PLATE IX. fig. 6. *a*, portion of foreign specimen magnified; *b*, Dublin sp. ditto; *c*, filaments highly magnified.

2. *A. cyaneum* (—). Filaments free, aggregated into a thin mucous stratum; sporangia linear, eight to twelve times longer than broad, furnished with a conspicuous hyaline covering. *Limnochlide Flos-aquæ*, *β. hercynica*, Kützinger, Species Algarum, p. 286 (1849); Tabulæ Phycologicæ, t. 91. f. 11?

On aquatic plants in boggy pools at Llyn Gwernan and Dolmelynlyn near Dolgelley, *J. R.*

Germany, *Kützinger*.

Stratum minute, thin, tender, of an opaque light blue colour. Filaments very slender, straight, nearly colourless, having a slightly dotted appearance from the scattered granular endochrome, not constricted at the dissepiments, which are very indistinct, and only to be detected by careful examination in a favourable light; ends obtuse, not attenuated. Joints or ordinary cells nearly equal in length and breadth. Sporangia elongated, cylindrical, generally solitary near the centre of each filament, but sometimes scattered, each inclosed in a broad, hyaline covering.

* "An sit *Conferva Flos-aquæ*, Roth, *Oscillatoria Flos-aquæ*, Ag., justo ambigitur; illæ enim filis rectis et parallelis gaudere describuntur, hæc vero filis curvatis, implexis instructa est."—Lyngbye, Tentamen Hydrophytologiæ Danicæ, p. 202.

Aphanizomenon cyaneum differs from *A. Flos-aquæ* by its stratum not appearing flocculose, by its paler inconspicuous filaments, which do not cohere in laminæ, and would often escape detection under the microscope but for the presence of the sporangium, which has a far broader hyaline covering in this than in the latter species.

PLATE IX. fig. 7. Filament highly magnified.

3. *A. incurvum* (Morren). "Filaments articulated, cohering together in flat laminæ, lacinated at the apex; articulations two to eight times longer than broad." *Trichodesmium Flos-aquæ*, Ehrenb. in Poggend. Annal. 1830, p. 168 (according to Kützing). *Aphanizomenon incurvum*, Morren in Memoir (1837); Thompson in Annals of Nat. Hist. vol. v. p. 82; Harvey, Manual of Brit. Algæ, p. 145; Hassall, Brit. Freshwater Algæ, p. 280. t. 76. fig. 6. *Lamnochlide Flos-aquæ* γ . *Harveyana*, Kützing, Species Algarum, p. 286 (1849); Tabulæ Phycologicæ, t. 91. fig. 2.

Ballydrain Lake, Mr. W. Thompson; Lough Neagh, Mr. D. Moore. Belgium, Morren; Germany, Kützing.

I regret that I am unable to afford any satisfactory information respecting this plant, for although Mr. Thompson has supplied me with specimens, they are unfortunately preserved upon paper, and could not be removed in a condition fit for examination. Respecting the Ballydrain species, one would suppose there could be no reasonable doubt as Dr. Morren has determined it. Still it is very possible that his *Aphanizomenon incurvum* has been rightly supposed by Kützing to be merely the *Flos-aquæ*, for nothing in the descriptions renders the opinion improbable. The Dublin plant at least is decidedly the *A. Flos-aquæ*. Mr. Thompson's *A. incurvum* however differs materially from all my specimens of the *A. Flos-aquæ* both in colour and in the form of the particles, which are circular and dot-like, very unlike the larger and lobed flakes of the other. Mr. Hassall's figure represents the filaments as tapering—a character, indeed, amply sufficient to distinguish the *A. incurvum* from the preceding species; but unfortunately, if the filaments really possess this character, neither Dr. Morren nor Mr. Hassall have noticed it in their descriptions, and so the matter is still in doubt.

Since the above was written, I have received from Mr. Moore some specimens better suited for examination. Although not from the same station as Mr. Thompson's plant, they exactly agree with it in appearance; the specks are unlike any other species that I have seen, and in form as well as in size and scattered habit resemble the small dots made by house-flies. Under the microscope the filaments appear parallel; they do not closely cohere as in *A. Flos-aquæ*, but are rather held together by the

mucous matrix, and are neither fasciculated nor laciniated at their ends; they are so very slender that the triplet is not sufficiently powerful to afford a proper examination. I was unable to perceive either dissepiments or sporangia. In no respect, except in their parallel arrangement, did the filaments correspond with Morren's description.

PLATE IX. fig. 8. *a*, portion of stratum from Lough Neagh; *b*, filament.

XXX.—On *Trichites*, a fossil genus of Bivalve Mollusks.

By JOHN LYCETT, Esq.*

[With a Plate.]

THIS generic form is distributed over an extensive area both in this country and upon the continent; it occurs in more than one of the oolitic formations; the Cotteswold Hills more especially produce it abundantly; nevertheless it is almost entirely absent from the cabinets of English collectors; and if we examine that section of modern literature which professes to illustrate fossil conchology, our search will scarcely be more successful or satisfactory. In both cases the defect may be accounted for by a difficulty almost insurmountable experienced in obtaining illustrative specimens in a condition perfect, or even approaching to perfect; fragments indeed are easily detached, but these alone do not convey any precise or adequate idea of the generic characters.

The shells are large, the very Titans of their period, sometimes extending to upwards of a yard across, of a thickness far surpassing that of bivalves generally, but of a structure peculiarly fragile (prismatic crystalline), consisting of fibres closely arranged, placed perpendicularly to the surface and breaking readily in the direction of the fibres with any slight concussion; this is a serious obstacle to their separation, to which may be added, that the upper ragstone bed of the Inferior Oolite in which they most commonly occur is very hard and intractable in the nature of its fracture. In almost every open quarry of this rock, and more especially in the stratum called Trigonia grit, these thick fibrous masses may be noticed; more rarely also in the middle portion of the same formation and in the shelly beds of the Great Oolite. They have usually been referred to a gigantic species of *Pinna*, probably from a similarity of structure. The Cotteswolds have produced two species, which are distinct from another recorded from the Jura which will subsequently be noticed. Dr. Plott, the historian of Oxfordshire, appears to have been the first person who applied the term *Trichites* to these shells. Woodward,

* Read to the Cotteswold Naturalists' Club, Jan. 22, 1850.