7.

THE FRESH-WATER CYANOPHYCEÆ OF ICELAND

BY

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INTRODUCTION.

ON THE KNOWLEDGE OF THE FRESH-WATER ALGÆ OF ICELAND.

In earlier papers on the Botany of Iceland a number of fresh-water algae are mentioned. These statements are of no great interest nowadays, more especially as, in most cases, it is impossible to identify the species mentioned with the species we have now to take into account. Lauder Lindsay (1861) has, however, undertaken, by means of the literature to collect all he could about the Icelandic flora up to 1860, and it is evident that he has given himself no little trouble, partly in finding all the extant literature, partly in unravelling the synonymics of the species.

On the basis of these studies he has compiled a list containing 89 species of algae, of which ca. 16 may be presumed to originate from fresh water. The 7 of these species are *Cyanophyceæ* and the rest *Chlorophyceæ*. Even the species mentioned by Lindsay are not all easy to identify with the now recognised species, and there is, of course, no guarantee whatever that the earlier authors have determined the algae correctly. Lindsay himself is well aware of this. A list of the *Cyanophyceæ* mentioned by Lindsay will be found at the end of this work.

Regarding the literature prior to 1860 I refer to Lindsay's work that, inter alia, contains a list of literature.

Lindsay, however, overlooked, in any case, two works on Icelandic flora. Firstly Liebman's treatise "De islandske varme Kilders Vegetation" ("The vegetation of the Icelandic hot springs") 1840, that demands a special remark as the algae therein mentioned are illustrated in Flora Danica. Japetus Steenstrup had in 1839—40 been on a journey to Iceland, whence he, amongst other things, brought home some algae samples from the hot springs. Liebman examined the specimens and described 3 new species, viz.: *Sphærozyga thermarum*, *S. Japeti* and *Scytonema Chthonoplastes*, besides mentioning *Oscillatoria elegans*, and finally a rusty red *Oscillatoria* which he considered to be a new species giving it, however, no name. Steenstrup's samples are still extant at the Botanical Museum, where I have had the opportunity of examining them anew. It was then shown that: —

Scytonema chthonoplastes Liebm. (Fl. dan. tab. 2398,2) = *Scytonema mirabile* (Dillw.) Bornet

Sphærozyga Japeti Liebm. (Fl. dan. tab. 2399,1) = *Hapalosiphon laminosus* (Cohn) Hansg.

Sphærozyga thermarum Liebm. (Fl. dan. tab. 2399,2) = *Hapalosiphon laminosus* (Cohn) Hansg.

Oscillatoria elegans (Fl. dan. tab. 2517,2) = *Symploca muscorum* (Ag.) Gom.

Oscillatoria sp. (*rufescens* Liebm. in schedula) = *Schizothrix calcicola* (Ag.) Gom.

Secondly Ehrenberg 1843, in which is recorded 50 species of Diatoms from Iceland.

Lauder Lindsay in a later work (1867) mentions a number of the algae, that were comprised in his first treatise on the vegetation of Iceland; he adds merely 9 species of Diatoms of which the majority are marine or fossils, some are, on the whole, doubtful species. M'Nab (1867) mentions 6 genera of Diatoms from the hot springs, without having determined the species.

Then a number of years passed without anybody, as far as I know, contributing anything to the knowledge of the fresh-water algal flora of Iceland. Not until 1893 when P. Hariot published his: "Contribution à l'étude des Algues d'eau douce d'Islande" in which 10 species of *Cyanophyceæ*, 24 species of *Chlorophyceæ* are mentioned. The same species are mentioned by É. Belloc (1894) with the addition of 34 species of *Desmidiaceæ* and 76 species of *Diatomaceæ*, besides some varieties. The two latter algal groups *Hariot* did not deal with at all.

The next work of importance is by F. Børgesen (1898) who treats of a collection of fresh-water algae, brought home by A. Feddersen. Børgesen mentions 58 species of *Desmidiaceæ*, 27 other *Chlorophyceæ* and one *Flagellate*, whereas *Diatomaceæ* and *Cyanophyceæ* are not taken into consideration. In 1900 Rosenvinge described a Floridea that grew in a cave on the Vestman Islands and over a well at Öndverðarnes under the name of *Rhodochorton islandicum*.

In 1902 G. S. West gave a list of the species he had found in a number of samples collected at the hot springs in Iceland by A. W. Hill. He mentions 5 species of *Chlorophyceæ* and 16 species of *Cyanophyceæ*. These are all mentioned in the present work. He introduces a new species *Aulosira thermalis* which I, however, must assume to be identical with *Hapalosiphon laminosus* (Cohn) Hansg. (See below under this species).

The first information regarding the phytoplankton of Iceland was given by Ostenfeld (1904). He examined a plankton sample from a small lake in South Iceland and found that it contained 6 *Chlorophyceæ*, 1 *Flagellate*, 2 *Peridineæ*, and 6 Diatoms. This was followed in 1906 by a treatise by Ostenfeld and Wesenberg-Lund, "A regular fortnightly Exploration of the Plankton of the two Icelandic lakes, Thingvallavatn and Mývatn." For a whole year the authors had plankton samples collected every fortnight in the two lakes, having at the same time the temperature of the water and atmosphere ascertained. With regard to Mývatn the result of the investigation was that practically no phytoplankton was found, excepting a few individuals of the genus *Anabæna* in one single sample, but neither plankton Diatoms nor *Chlorophyceæ* were present. (When I, in 1914, collected some plankton samples in Mývatn there was a vigorous "water bloom" of *Anabæna flos aquæ*. Of this see further under remarks regarding this species). In Thingvallavatn, on the other hand, a phytoplankton consisting of 8 species of *Chlorophyceæ*, 14 *Diatomaceæ*, 1 *Flagellate*, 1 *Peridineæ* was found, whereas *Cyanophyceæ* were entirely lacking in the plankton.

Among works treating of Icelandic fresh-water algae those of Helgi Jónsson (1911), dealing with *Rhodochorton islandicum*, and E. Østrup, who gives a list comprising 468 species of Icelandic fresh-water Diatoms, many of which had not hitherto been described, must be recorded. Furthermore scattered remarks on fresh-water algae occur in treatises by Ostenfeld (1899), Helgi Jónsson (1895 I and II, 1898, 1900, 1905, 1913) and Thoroddsen (1910).

ON THE COLLECTIONS OF CYANOPHYCEÆ MADE IN ICELAND.

The material of the present work is collected by a number of different travellers. An essential portion of the specimens examined were gathered by Helgi Jónsson (abbrev. H. J.) during his various explorations in the years 1894—1915 in diverse parts of the island. A not unimportant number of specimens were collected by Ólafur Davidsson (O. D.), and the material collected at the various hot springs by Japetus Steenstrup in 1839—40 is momentous. More occasional are the algae collections of C. H. Ostenfeld (C. H. O.), O. Paulsen (O. P.), Th. Thoroddsen (Th. Th.), Hjalmar Jensen (Hj. J.), Johs. Gandrup (J. G.) and Mogens Lund (M. L.). (A note of exclamation following the name of the collector denotes that I have seen and examined the specimen). In June—August 1914 I myself travelled in Iceland to collect fresh-water algae. I landed at Seyðisfjörður 21 June and from there undertook a tour up the Fljótsdalur, primarily via Egilstaðir, Vallanes and Hallormstaður along the south east coast of the Lagarfljót to Valþjófstaðir and from there I returned via the north west coast to Seyðisfjörður. From there I sailed to Akureyri, whence I journeyed via Háls and Ljósavatn to Skútustaðir at Mývatn. A few days stop at Geiteyjarströnd permitted a trip to Námuskarð, then via Grímstaðir (Slútnes), Halldórsstaðir and Þverá I passed Uxahver and reached Húsavík. Here I had a stay of a few days to await a ship to continue my journey, but a strong northerly wind followed by rain and dense fog upset my calculations and these days were practically lost. Then I sailed to Reykjavík, but on the way the ship dropped into numerous harbours, and at some of these the stay was so protracted that I could land and undertake collections, for instance at Siglufjörður, Ísafjörður, Stykkishólmur. From Isafjörður I wandered over the hills to Flateyri where again I encountered the ship.

Taking Reykjavík as a starting point I made two trips viz: —

1) over the pass Svínaskarð to Mödruvellir, further over Geitaberg and Grund up through Reykjadalur to Reykholt, from here to Norðtunga with a trip to Helgavatn through the Norðtunga forest and finally to Borg and Borgarnes, whence I returned by steamer to Reykjavík;
2) via Mosfellsheiði to Þingvellir, further on to Laugarvatn, past Apavatn to Kotströnd and Reykir, finally via Kolviðarhóll back to Reykjavík.

On the return journey I stayed for some hours at Vestmannaeyjar.

The whole of the present work has been carried out on the basis of preserved material and therefore I have had the opportunity of studying the best preservation methods for blue-green algae.

All the usual methods have certain bad points so that the ideal must be said to be work on living material, in fact quite to avoid preservation. 1) The dried material offers the advantage that the algae retain the colour quite well and in many cases it is possible to soak them out (in ammonia or lactic acid) so much that the natural forms can distinctly be observed; but the softer forms, for instance species of *Anabœna* never, however, assume the original forms even with the most careful soaking out. 2) When preserved in alcohol the forms and cell contents as a rule are very perfect, their colours, however, are entirely lost. 3) Formalin often preserves the forms well, but frequently strange granulations come into existence in the cells and sometimes *Cyanophyceœ* become almost irrecognisable in this fluid.

Therefore I shall recommend other investigators, wishing to collect *Cyanophyceœ* in localities where an examination of the living plants cannot be practiced, to divide each sample into 2 parts, dry the one and place the other in alcohol; it will then be possible both to examine the colour of the plant as well as the form and content of its cells and trichomes.

THE SYSTEMATIC CHARACTERISTICS WITHIN THE CYANOPHYCEÆ.

The determination of *Cyanophyceœ* frequently causes considerable difficulty, especially when dealing with undeveloped specimens, and in not a few cases a determination has to be given up. The difficulties are most frequent within the *Coccogoneœ,* but this is especially due to the fact that this group is greatly in need of a revision. In the course of time a considerable number of species have been recorded, among which many will certainly prove to be identical, and a comparative summary of the species lacks almost entirely. An attempt at comparison was first made by Hansgirg (1892) later by Lemmermann (1910). W. B. Crow (1922) has written about the principles regarding a natural system within the *Coccogoneœ,* but I shall not go into this treatise here. Even within the *Hormogoneœ,* in spite of the excellent existing revisions of this group (Bornet et Flahault, Gomont) a determination is often difficult.

The older systematists exclusively employed such characters that simply could be observed either by macroscopic or microscopic examination. In short, it was the whole plant's macroscopic appearance, colour, shape, consistence etc. further the dimensions and ramification of the threads and trichomes, the appearance of the sheaths, and finally if heterocysts or spores should be present, their dimensions and general appearance.

This method of describing the species attains its highest perfection in Bornet and Flahault's "Revision des Nostochacées hétérocystées", and for these, the most perfectly developed of the *Cyanophyceæ*, these features will also, in the main, be sufficient to characterize the species in question in such a manner that they can be determined with a certain amount of security.

Gomont, on the contrary, evidently felt this method of characterization to be insufficient as to species belonging to the *Oscillarieæ* and therefore attempted to find new distinguishing characters. He introduced two new methods whereby to distinguish the species, viz. by taking special note of 1) the apex of the trichome, with regard to its shape, especially as to whether it had a calyptra or not; 2) the reaction of chlor-zinc-iodine on the sheaths. The importance of the former character was, to begin with, disputed in various quarters, but now certainly all will agree that the distinguishing characters derived from the appearance of the apex has proved an added security in the characterization of the species.

Among the *Oscillarieæ* Gomont (1888, p. 220 ff.) found that the micro-chemical relations of the sheaths differed in the various species, not only within the great generic groups, but also within the individual genera. Therefore in his "Monographie des Oscillariées" he uses the reaction of chlor-zinc-iodine on the sheaths as a distinctive character of the species. Within this group a cutinization of the sheaths seldom occurs, therefore he, in the main, only needs to consider 2 cases: — 1) whether the sheath becomes blue when treated with chlor-zinc-iodine or 2) whether it remains unstained.

Also this distinguishing character appears to be an acquisition to systematism, but a theoretical basis for its application is still lacking, and this can hardly be obtained except by means of pure cultures. A guarantee is still wanting as to whether or not the reaction of chlor-zinc-iodine on the sheaths can vary during the development of the individual plant. I have reason to presume that this is the case with *Hapalosiphon laminosus*, where the gelatinous sheaths that envelop f. *anabænoides* do not colour with chlor-zinc-iodine whilst the sheats in f. *typica* are rather blueish if so treated, and there is certainly no reason to suppose that this case is unique. Nevertheless I opine, that the introduction of the chlor-zinc-iodine test is a great improvement which will certainly be of great import in the revision of the *Coccogoneæ*, that certainly is to be expected.

Later Günther Schmid (1917, p. 342) has partly tested the accuracy of the characters formerly employed and has partly attempted to work out a new one. Within the individual species Günther Schmid proves the thickness of the trichomes to be very constant, likewise he cites various observations from pure cultures by Schindler and Pringsheim tending in the same direction. The result of my observations is that in individual growths the thickness is often but slightly varying, but if the same species is obtained from different localities rather important deviations may occur in this respect (cf. Gomont, Monogr. I, p. 287). Crow also (1922, p. 86) adheres to the same opinion with regard to the size of the cells of the *Chroococcaceæ*. However, there can certainly be no question of various species on this ground, it is rather a case of the individual growths being a "Clon" caused by the vegetative reproduction of a single mother individual.

I am therefore of the opinion that the thickness of the trichomes is not of so great an importance as a systematic character as Schmid appears to consider.

It was evident to the old systematists that the characters based on the colour might frequently be doubtful, but nevertheless such characters were usually applied.

According to our present knowledge there seems to be a number of different external conditions that can change the colour of the blue-green algae viz. light and nutrition. Nadson (1908) demonstrated how direct exposure to the sun could bleach *Phormidium laminosum* so that it assumed a yellowish colour.

In a series of treatises Gaidukov (1902, 1903 I-II, 1904, 1906) demonstrated that the action of different coloured monochromatic lights was able to cause certain blue-green algae *(Oscillatoria sancta, O. caldariorum, Phormidium tenue)* to change their colours, so that they approached the complementary colour to the monochromatic light used. Similar results were noted by Dangeard (1911) in respect to *Lyngbya versicolor* and Boresch (1919) respecting *Phormidium foveolarum.* But Boresch (1919) as well as Harder (1922) have by means of culture experiments with a large number of species found that only a low percentage of the species in question show "chromatic adaptation" in different coloured lights. Thus Harder (l. c.) found that among 50 species 2 only had the stated capacity. Boresch (1919, p. 36) found that the colour variations were due to differences of Phycocyanin, whilst Chlorophyll and Carotin were not affected by the monochromatic lights.

Boresch (1910), Magnus and Schindler (1912) and Schindler (1913) demonstrated that in Agar-cultures the colours of the blue-green algae varied when the nitrogen was exhausted, this phenomenon Boresch named "Stickstoffchlorose". Quite a number of varying tints might appear under the chlorose. These observations are also confirmed by Maertens (1914) and E. G. Pringsheim (1912, 1913).

Boresch (1920, 1921) has further proved that absence of iron in the cultures produce similar chlorotic conditions as lack of nitrogen. Violet, brown or yellow tones and the transitions between them occur. With regard to the iron chlorose, Boresch further proved that the Chlorophyll and the Phycocyanin gradually disappears from the cells so that finally only the Carotin remains.

The question as to whether such colourations of the *Cyanophyceæ* caused by external conditions are to be met with in nature to such an extent that the use of colour as a distinctive feature in the *Cyanophyceæ* is thereby precluded, is of great interest. Günther Schmid (1917) has already attempted to solve this question, but he arrives at a negative conclusion, in that he seems to consider the conditions governing the deviating colourations in the cultures to be of such a description that they hardly can be found to any appreciable extent in nature. I am of the opinion that further investigations must be awaited, and that for the present an attempt should be made to ascertain, more accurately than hitherto, the colours in the various species of the *Cyanophyceæ* under varying conditions in order thereby to obtain a more reliable basis for the solution of this question. For the determination and ascertainment of the colours Günther Schmid (l. c.) recommends Klincksieck et Valette: Code des couleurs, Paris 1908, as a serviceable aid. The references (Codex number) given in the systematic part of this work refer to the book in question. I must add, that I, in contrast to Schmid, have used the colours in a dry condition as all my colour determinations have been made on dried material.

I have carried out a number of colour determinations by means of microscopic examination of individual cells using an Abbes camera lucida when comparing. I have exclusively used transmitted light but it certainly would have been better at the same time to have determined the colour in reflected light, that, for instance, might be produced by a paraboloid condensor.

Schmid (1917) introduces a new distinguishing character for the various species, viz. whether their trichomes in movement turn to the left or to the right. According to Schmid this is supposed to be absolutely constant in each species. But it can only be used when living material is to hand, hence in the determination of collections originating from expeditions and the like it is absolutely inapplicable. Therefore its practical importance appears to me to be rather limited.

REMARKS ON THE INDIVIDUAL SPECIES MENTIONED BELOW.

In the following systematic list regarding species of *Cyanophyceæ* found in Iceland are included: — 1) all species personally observed in samples from Iceland; 2) the species that in the more recent literature are mentioned as belonging to the island.

The description as well as the illustrations and exsiccata which may have been used to the determinations are cited under each species. Thereupon follows a statement of the localities in Iceland from where I know the species. I use the following abbreviations: E. Icel. (East Iceland); N. Icel. (North Iceland); N.W. Icel. (North West Iceland); W. Icel. (West Iceland); S. Icel. (South Iceland). These abbreviations do not correspond to those used by Helgi Jónsson (1912, p. 5) in respect to marine algae; therefore I shall quite briefly mention what is meant by the expressions which I have mainly added because the same place-names often occur in different parts of the island and not because a special phyto-geographical difference between these districts can be expected with regard to the fresh-water algae.

When referring to East Iceland, I mean the country from Hornafjörður to Langanes; North Iceland extends from this point to Húnaflói; N.W. Iceland is the great North-West peninsula; West Iceland the country from the interior of Breiðifjörður to almost the interior of Hvalfjörður; South Iceland the whole of the rest. In fact, it is chiefly but the populated districts along the coast and the great valleys stretching inland that are as yet investigated. In the whole of the vast desert and also to a great extent in the southern regions so inaccessible, practically no algae have been collected.

For every species the area is furthermore given i. e. its distribution over the world as far as it is known at the present moment. These statements are based: — 1) on the information obtained from De-Toni: Sylloge Algarum; 2) on the algological literature at my disposal from the time after the finishing of this work (1907). On perusal of this extensive literature I have at the same time noted what the authors have remarked in respect to the habitat of the individual species. I have endeavoured to fuse all these items with the information contained in De-Toni (A. Forti) and in the monographies, and it is included among the remarks on the individual species.

I. COCCOGONEÆ.

1. CHROOCOCCACEÆ.

I. Gloeothece Näg.

Gloeothece confluens Näg.
Nägeli, Gatt. einz. Alg. p. 58, tab. I, G. fig. 1. Lemmermann 1910 p. 48.

S. Icel. Hafnarfjörður Stp.!
Area: Eur., Afr., N. Am., Iceland (West).

In the above-mentioned sample from Hafnarfjörður a Gloeothece was found the cells of which measured 6.6—10.1 μ in length and 1.9—2.2 μ in thickness. Their dimensions thus lie between what is stated as to *Gl. linearis* and *Gl. confluens.* I have decided to refer the form to *G. confluens* because this is the older name; but practically it is undoubtedly impossible to distinguish between the two species, which also seems to have been Lemmermann's opinion (l. c.).

The sheath did not colour with Chlor-zinc-iodine. Unfortunately I have had no exsiccata of this species at my disposal.

De-Toni mentions (Sylloge Alg. V p. 61) that it is said to have been found in Iceland by G. S. West, but I have not been able to discover De-Toni's source.

Gloeothece rupestris (Lyngb.) Bornet.
Wittr. et Nordst. Alg. exsicc. Nr. 399.
Palmella rupestris Lyngbye: Hydrophytologia p. 207, tab. 69 D.
Gloeocapsa tepidariorum A. Br. in Rab. Alg. Nr. 221.
Gloeothece tepidariorum Lagerheim 1883 p. 45, tab. I, fig. 12.

E. Icel. Vallanes, among mosses, marshy place $^{26}/_{6}$ 1914. Fljótsdalur, dripping rock $^{30}/_{6}$ 1914. Seyðisfjörður, among mosses in marsh (at 300 m) $^{23}/_{6}$ 1914.
Area: Ubiquist, Spitzbergen, Færöes.

This species grows on rocks, walls, among mosses, on earth and in similar places; it seems to require considerable moisture in order to thrive. Presumably it may be considered as a true aërophilous alga. On growing in very dry places its sheath becomes more or less brownish, but this stage can hardly be considered as actual spores (see below).

Bornet was the first to realize that *Palmella rupestris* Lyngbye was a *Gloeothece* (Wittr. et Nordst. no. 399), though the description and figure in "Hydrophytologia danica" does not resemble the form in question in any appreciable degree. The most conspicuous error is that every cell is drawn round. Probably Bornet, however, has had at his disposal an original specimen whereby he has noted that *P. rupestris* actually has elongated cells and therefore must be referred to the genus Gloeothece.

Lagerheim (1883 p. 45) dared not subscribe to Bornet's assumption and refused to identify *Glococapsa tepidariorum* A. Br. (Rab. Alg. no. 221) with *Palmella rupestris* Lyngbye.

In Herb. Lyngbye we have a specimen with the following inscription in Lyngbye's hand: "*Palmella rupestris* d. 4. July 1816 in rupibus udis earumdemque fissuris ad Næss Norvegiæ, sat frequens. Cum delineatione." If we compare this with the text in "Hydrophytologia", we shall see that it is evidently just this specimen on which the description was based, and the "delineatio" in question not to be found in the herbarium is certainly the figure shown on tab. 69 D in the book.

In the above-mentioned sample a blue-green alga with elongated cells and gelatinous sheaths occurs. The latter are, however, not identical in all the cells; sometimes they are almost non-stratified and somewhat confluent, at times very distinct and with pronounced stratification. In the latter case the sheaths may be almost hyaline, but are most frequently brown and granulated. In the first case they are most frequently somewhat yellowish. Between the various forms, however, almost continuous transitions exist, and I therefore feel convinced that they all belong to the same species. It is just these various forms Lyngbye has figured in tab. 69 D. Fig. 2 chiefly represents a mass of cells with confluent sheaths, whereas figs. 3 and 4 show cell-families with distinct and brownish sheaths.

Besides I have examined no. 221 in Rab. Alg. which is the original specimen of *Glococapsa tepidariorum* A. Br. Here we have a form with elongated cells, distinct, stratified and entirely hyaline sheaths identical with those which also were found, although in lesser numbers, in the specimen in Herb. Lyngbye.

No. 399 in Wittr. et Nordst. is, in a way, a transition between the two above-mentioned exsiccata in that we here have — besides cell-families with hyaline, stratified sheath — some with stratified brownish sheaths.

Furthermore I have tested the reaction of chlor-zinc-iodine on the three afore-mentioned exsiccata. In all three cases I arrived at the conclusion that the absolute hyaline sheaths slowly were stained faintly bluish, whereas the brown sheaths gave a rapid and deep blue reaction.

Therefore it is undoubtedly the same species we have to do with in these three exsiccata, and consequently this species should be named *Gloeothece rupestris* Lyngb. Bornet, whilst *Glococapsa tepidariorum* must be set up as a synonym. Neither is there any reason to retain the latter form as a variety as there is no difference in the dimensions of the cells or families in the three exsiccata in question.

In this species cells with brown sheaths have been considered as spores (Lagerheim l. c., Hansgirg Prodromus p. 136). It is probable that the brown sheaths may serve as protection for the cells, but it seems doubtful to me whether such protected cells can be regarded as spores. That depends upon whether cell-division can be effected in this form or whether the brown sheaths must first split and peel off before a reproduction can take place.

II. Chroococcus Näg.

Chroococcus turgidus (Kütz.) Näg.

Lemmermann 1910 p. 53. Kütz. Tab. Phyc. 1, tab. 6. Wittr. et Nordst. Alg. exsicc. no. 100, 250, 472, 699, 799. Phycotheca polonica no. 1.

Chroococcus turgidus var. *chalybeus* Hauck et Richter Phycotheca univers. no. 145.

Chroococcus chalybeus Rab. Alg. Eur. no. 1144.

E. Icel. Rocky wall over which water was trickling Fljótsdalur $^{30}/_{6}$ 1914. — N. Icel. Pond near Grimstaðir at Mývatn $^{20}/_{7}$ 1914. Brennisteinstjörn near Geiteyjarströnd (Mývatn) temp. 18°. In plankton. — N. W. Icel. Arnarfjörður Belloc (1894), Hariot (1893 p. 314).

Area: Ubiquist, Færöes, Novaya Zemlya, Lappland, Spitzbergen, Greenland, Alaska.

According to literature this species is one of the most pronounced ubiquists of the blue-green algae also in respect to its being able to grow under highly varying conditions. Thus it occurs in bogs as well as in lakes, in benthos as well as in plankton and as semi-aërophilous alga on damp rock-walls. Bohlin (1901 p. 10) characterizes it as a "sphagnophilous", and Reiter (1919 p. 183, 190) as well as Steinecke (1916 p. 24) incline towards the same opinion, whereas others, for instance, Kufferath (1914 p. 262) considers it to be actually calciphilous (cf. Steiner 1911 p. 5). The conflicting views are perhaps due to the fact that we have not to do with a single species, but with several resembling each other closely.

On examining a series of exsiccata and determining the colour of the cell contents, the stratification of the sheath and its reaction to chlor-zinc-iodine, I have been able to distinguish a special form which I suppose to be identical with *Chroococcus turgidus* var. *violaceus* W. West (1892). I describe this form as a new species under the name *C. Westii*. Microscopic examinations showed the genuine *C. turgidus* exsiccata to be of a colour which mainly corresponds to Codex no. 356; in a few cases, however, the colour was obviously bleached in the course of time. In one case only it was possible to get a somewhat reliable macroscopic determination of the colour, viz. Hauck et Richter Phycotheca univers. no. 145, in which a sufficiently "pure" sample was found i. e. not containing other algae or impurity. The colour of the plant-mass almost corresponded to Codex no. 326. In all the cases the sheath proved to be absolutely hyaline and indistinctly or not at all stratified. When treated with chlor-zinc-iodine it swelled more or less or dissolved entirely, at times it assumed a very faint bluish tone.

According to Virieux (1910 p. 335) the sheath should consist of pectin substances. My investigations seem to prove that it at times may contain faint indications of a cellulose-like substance.

Chroococcus Westii Boye P. n. sp.

Chroococcus turgidus var. *violaceus* W. West (1892 p. 741)?.

— — - — Schorler (1914 p. 16)?.

Chroococcus turgidus var. *dimidiatus* Hauck et Richter Phycotheca univ. no 482.

Pleurococcus turgidus Rab. Alg. no. 104.

Chroococcus cellulis sphæricis vel e pressione mutua plus minusve angulosis, singulis vel binis, ternis vel quaternis in familias consociatis, sine tegumento 13—27 μ crassis, cum tegum. 18—32 μ crassis; tegumento itaque crasso, distincte lamelloso, chlorozincico jodurato lutescente vel fuscescente; contentu cellularum violaceo.

S. Icel. Hafnarfjörður (Steenstrup)! — N. Icel. Skútustaðir (Mývatn) in a small pond temp. 19° 17/7 1914.

Area: — Engl., Germ.

This species was formerly classed together with *Chroococcus turgidus* (Kütz.) Näg. from which, however, it is easily distinguished by 1) its colour which is a pronounced blue violet (Codex nr. 459 or 486), 2) its strongly stratified sheath, 3) and by the fact that its sheaths, when treated with chlor-zinc-iodine, assume a yellowish or brown colour, the stratification becoming at the same time still more distinct.

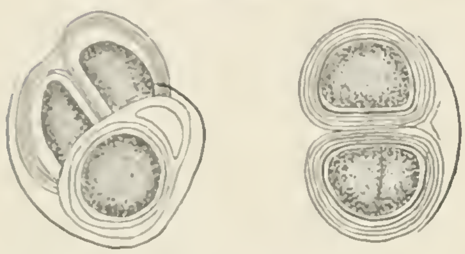

Fig 1. Chroococcus Westii n. sp. (×600).

In his diagnosis of *C. turgidus* v. *violaceus* West does not mention anything at all about the stratification of the sheath, but this does not necessarily imply the absence of same, as the diagnosis of *C. turgidus* admits of stratification of the sheath. The two first mentioned synonyms are, in fact, to a great extent doubtful.

Wille (1914 p. 8) described a new var. *subviolaceus* which, according to his opinion, is distinguished from var. violaceus West by smaller cells and by living epiphytic on other algae. The illustration (l. c. tab. I, fig. 1), however, shows that var. *subviolaceus* Wille hardly can be included in the new species *C. Westii* nob. as the sheath apparently lacks stratification entirely.

Hauck et Richter Phycotheca universalis nr. 482 refer to Rab. Alg. nr. 2033. I have examined this sample, but it is evidently a quite different plant, the cells having apparently no sheath at all.

Chroococcus helveticus Näg.

West 1902 p. 245.

»Hveravellir, on rocks and stones among Calothrix parietina var. thermalis, temp. 24° C.

Area: Eur., Afr., Tromsø, Novaya Zemlya.

Chroococcus macrococcus (Kütz.) Rab.

Kutz. Tab. phyc. I tab. 2. De-Toni Sylloge Alg. V p. 8. Rab. Algen nr. 921

E. Icel. Among mosses in inundated area at Lagarfljót, temp. 16° 25/6 14. — N.W. Icel. Arnarfjörður Hariot (1893 p. 314), Belloc (1894 p. 6).

Area: — Eur., Am., Austr., Færoes, Greenland, Antarctic.

This species is evidently a form intermediate between the aërophilous and the hydrophilous algae, in that it is often found among mosses and on earth or damp rocks, but not in dry places however. Thus Coupin (1915 p. 52) also refers it to the terrestrial species.

E. Acton (1914 p. 444) has examined its cytology as well as the structure of its cell-wall. She states that it consists of alternating layers of pectose and chitin, whereas cellulose is lacking. On the Icelandic specimens the darker layers coloured brownish with chlor-zinc-iodine, whilst in Rab. Algen, Nr. 921 the reaction was much fainter.

III. Aphanocapsa Näg.

Aphanocapsa Elachista W. et G. S. West var. **irregularis** Boye P. n. var.

Strato irregulari, non libere natanti; cellulis magis confertis. Diam. cell. 1—2 μ.

E. Icel. Stagnant water in a branch to Grimsá, Vallanes, among Myriophyllum temp. 14° 26/6 1914. — N. Icel. Pond near Grímstaðir (Mývatn) 20/7 14.

This new variety which is closely related to *A. E.* var. *conferta* W. et G. S. West (1912 p. 432, pl. 19 fig. 1) is distinguished especially from the latter by its larger and more irregular colonies which are not free-floating.

IV. Gloeocapsa Kütz.

Gloeocapsa atrata (Turp.) Kütz.

Kützing Phyc. germ. p. 151. Tab. phycol. I, tab. 21, fig. 4. Nägeli Gatt. einzell. Algen tab. I, fig. F. 1. Rabenhorst Algen Nr. 173.

S. Icel. Hafnarfjörður Stp.!
Area: Eur., As., N. Am., Alaska.

Occurs on rocks. The sheath colours violet with chlor-zinc-iodine. This reaction agrees with the Icelandic sample as well as with Rab. Algen Nr. 173. On the other hand, Rab. Alg. Nr. 1914 is, as already mentioned by Brand (1900 p. 312, (note)), a different form, according to Brand a *Gloeothece rupestris*. In this exsiccatum the sheaths do not colour with chlor-zinc-iodine.

Gloeocapsa rupestris Kütz.

Kützing Tab. phyc. tab. 22, fig. 2. Lemmermann 1910 p. 64. Rabenhorst Alg. Nr. 2030.

E. Icel. On dripping rocks Fljótsdalur 30/6 14. Ekkjufell 2/7 1914.
Area: Eur., Afr., Am., Lappland, Spitzbergen, Greenland.

Chlor-zinc-iodine colours the sheath deep dark brown, almost black. It is a pronounced aërophilous, petrophilous species.

Gloeocapsa Magma (Bréb.) Kütz. var. **Itzigsohnii** (Born.) Hansg.
Hansgirg Prodromus II p. 147. Zopf, Spaltpflanzen tab. VII, figs. 6–9.

E. Icel. Damp rocky-wall, Vestdalur near Seyðisfjörður 4/7 14.
Area: Eur., Am.

According to my microscopic examinations I determined the colour of the sheaths to correspond almost to Codex nr. 63. Chlor-zinc-iodine coloured in some cases the outermost layers of the sheaths faintly violet; in other cases no colouring seemed to take place.

Gloeocapsa alpina (Näg.) Brand emend.
Brand, Bot. Centralbl. Vol. 83, 1900 p. 224. Lemmermann 1910 p. 67.

E. Icel. On more or less damp rocky walls, Fljótsdalur 30/6 1914. Ekkjufell 2/7 1914.
Area: Eur., As., Afr., Am., Lappland, Alaska, Greenland, Spitzbergen, Antarctic.

A genuine aërophilous petrophilous alga which often together with other Cyanophyceae forms a deep black coating on rocky walls in places over which water is running during torrents of rain or during the thaw. Lagerheim has found it on snow in mountain regions.

V. Aphanothece Näg.

Aphanothece microscopica Näg.
Nägeli, Gattungen einz. Alg. p. 59, tab. I, fig. H. Lemmermann 1910 p. 70.

E. Icel. Bog at an elevation of 300 m, on moss. Seyðisfjörður 23/6 1914. Former branch of Grimsá, among Myriophyllum. Vallanes, temp. 14° 26/6 1914. — N. Icel. Pool of water east of Skútustaðir, temp. 21° 17/7 1914. — S. Icel. Plancton from a small lake west of Reykjavik 9/6 1896 (C. H. O.)! Mud from dried-up lake bottom in a "Flói" Grímstaðir 30/7 1905 (H. J.)!
Area: Eur., As., Afr., Am., Austr., Færöes, Greenland, Novaya-Zemlya, Lappland, Alaska.

This species is frequently found in plankton, but it is hardly any genuine plankton organism. Its best habitats are rather in stagnant water among mosses, Myriophyllum and the like. Has been found in very cold as well as in the warmest climates and also in Alpine lakes at extremely high elevations (Rübel 1911 p. 531; at 2306 m). Its power of adaptation seems thus to be very great if it actually is the same species which has been found in the various parts of the world.
In some of the above-mentioned samples I have examined the influence of chlor-zinc-iodine on its mucilaginous coating, and repeated examinations have shown that this does not colour.

Aphanothece stagnina (Spreng.) A. Br.
Lemmermann 1910 p. 71.
A. Mooreana (Harv.) Lagerh. Wittr. et Nordst. Alg. exsicc. nr. 695.
A. prasina A. Br. in Rab. Alg. Eur. nr. 1572.
Coccochloris stagnina Sprengel, Linn. Syst. vegetab. IV, 1 p. 372. (1827).

E. Icel. Green lumps among washed up Myriophyllum, pond in bog near Grímsá, temp. 16° 26/6 1914. — N.W. Icel. Isafjörður, Arnarfjörður, Hariot (1893 p. 315), Belloc (1894 p. 6).

Area: Eur., As., Am., Hawaii, Antarctic, Lappland, Færöes, Alaska, Greenland.

The specimens found at Grímsá were fairly large, up to 3 cm in diameter.

In close proximity to Sprengel's species *Coccochloris stagnina*, Al. Braun (1863) placed two new species *Aphanothece prasina* and *A. coerulescens*. A. Braun himself presumed it not improbable that both should be considered as varieties of *A. stagnina* (Spr.) A. Br. Richter (1886) examined these species and found that *A. prasina* and *coerulescens* could not be kept apart and subsequent authors agreed with him on this point; so that it may be considered given that *A. coerulescens* = *A. prasina*. I myself have examined the sample of *A. coerulescens* (Rab. Alg. Nr. 3) cited by A. Br. and can confirm Richter's conclusions in so far as it is impossible to distinguish *A. coerulescens* as a separate species or variety.

A. prasina A. Br. is retained in the more recent algological literature and considered occasionally as an independent species and at other times as a variety of *A. stagnina*. Al. Braun writes in Rab. Alg. Nr. 1572 the following: "Von beiden (viz. *A. prasina* and *A. coerulescens*) durch hellergrüne Farbe, bestimmtere Abrundung der Massen und in der Gallerte zerstreute Kalkkrystalle abweichend ist die ächte *Coccochloris stagnina* Sprengel." At the same time he refers to Kützing Alg. aquae dulcis dec. III nr. 29 as the type specimen. — Thus Al. Braun has 3 distinguishing characters between the two species, viz. 1) the colour of the colony, 2) its form, 3) whether it contains crystals of calcium carbonate or not.

Rabenhorst (Fl. eur. Alg. II p. 66, 1865) mentions nothing about crystals, but adds a new distinguishing character between the two species, viz. difference in size between the cells, i. e. presupposing those in *A. stagnina* to be smaller than those in *A. prasina*. Richter (1886), however, on the basis of exsiccata investigations, arrived at the conclusion that no difference in size between these two species could be demonstrated; he therefore distinguishes them by the three other characters, viz. 1) presence or absence of crystals of calcium carbonate, 2) colour, 3) greater or lesser regularity and solidity of the colony. The latter feature (solidity) is, however, a new character advanced by Richter, and in certain authors this becomes later the principal distinguishing character. Richter founds his statement on a "Herbarnotiz" by A. Braun which is unknown to me. But there is an obvious discrepancy between Richter's words regarding *A. prasina* in his treatise in Hedwigia (1886 p. 254) in which he says: "Gallertklumpen . . . aus mehreren Stücken bestehend und leicht zerfallend", and the inscription on the label belonging to the very sample which he deals with in the treatise (Phycotheca univers. Nr. 91). It reads: „Kugeln von festerer Consistenz und rundlich-eckigem Umfang". The specimens in the sample verify the last statement.

Lemmermann (1910 p. 71) is in accordance with Richter's statement on the label of the sample when he, with regard to *A. stagnina*, writes: "Lager mehr oder weniger kugelig, leicht in Stücken zerfallend", and with regard to *A. prasina*: "Lager . . . nicht so leicht in Stücke zerfallend". Finally did Tilden (1910 p. 30, 32) readmit the difference in size between the cells as a principal distinguishing character which agrees with the two exsiccata, she cites, viz. Phyc. Bor. Am. Nr. 251 and 1302. On the other hand, she does not mention anything about crystals.

As we have seen, the various authors do not at all agree (not even with themselves!) as to the manner in which the two species (or varieties) may be separated.

In order to investigate the characters more closely I have examined all the exsiccata of the two species which I have been able to get hold of, and the results of this investigation is recorded in the present table. In the first column measurements of a number of cells from each sample are to be found. The numbers indicate the thickness of the cells, their length, on the other hand, I have not measured as it is very variable. In the second column the external form of the colony is described; its solidity could not be determined on the basis of exsiccata. The third column records the results regarding the determinations of the colour of the colonies by means of Klinksieck et Valette: Code des colours. In the fourth column is stated whether crystals (+) or not (÷) are to be found in the colony. In the fifth column Lemmermann's determinations of the various samples are recorded, and in the sixth column Tilden's. Finally in the seventh column the sample's own designation of the species. Almost all the exsiccata show about the same cell-diameter except Phycotheca Bor.-Am. Nr. 1302 which has especially small cells, and Hauck et Richter Phycotheca universalis nr. 193 which also has rather small cells. In specimens from Iceland I found that the size of the cells in the individual thallus may vary just as much as between all of the examined exsiccata, viz. from 3,3—6,2 μ. There is no noticeable difference in the size of the cells between the two exsiccata which A. Braun originally employed for the establishment of the differences between *A. prasina* and *A. stagnina*, viz. Rab. Alg. nr. 1572 and Kütz. Dec. nr. 29. I therefore opine, like Richter, that this circumstance may be disregarded as a distinguishing character.

If we now consider the other characters, we will find that in some cases they unite in such a manner in the individual specimen that it might be determined either to *A. stagnina* or var. *prasina*, e. g. according to Lemmermann 1910. In other cases the characters are mingled, so that the individual has one character which agrees with *A. stagnina* and another agreeing with *A. prasina*. This fact seems in itself to indicate that we have in reality to do with only one systematic unit and not two as generally supposed since the time of A. Braun.

We will now consider the individual characters one by one. With regard to colour some variation is apparent in that some individuals are brownish, others more pure green, and others again having a bluish tint. The majority of the specimens have a colour which almost corresponds to Codex nr. 326 or 330—33. A few are more brownish like nr. 308 or 304, whereas Wittr. et Nordst. nr. 1596 a approaches nr. 352 which has a bluish tint. The specimens collected by me in Iceland have exactly the same colour.

	Diam. of cells	Form of colony	Colour (Codex-Nr.)	Crystals present	Lemmermann	Tilden	Determination in exsiccata	
Kütz. Alg. III nr. 29	4.4—5.5	roundish	(326) 333	+	stagn.		stagn.	
Wittr. et Nordst. Alg. exsicc. nr. 695	4.6—6.2	somewhat lobed	332 326	÷	pras.		Moo-reana	
— — — nr. 794	4.8—6.4	lobed	(308 326	+	stagn.		stagn.	
— — — nr. 1595 a	4.8—6.2	irreg. form	(309)? 331	+?			stagn.	
— — — nr. 1596 a	4.6—5.5	roundish	(326) 352	÷			stagn.	
— — — nr. 1596 b	4.4—5.5	somewhat lobed	308 326	÷			stagn.	
— — — nr. 1597 a	4.6—6.1	somewhat lobed	333 326	+			stagn.	
— — — nr. 1597 b	4.8—5.7	somewhat lobed	(312) 326	+			stagn.	
Phycotheca Bor.-Am nr. 251	4.0—5.5	somewhat lobed	304	÷		pras.	pras.	
— — nr. 1302	3.3—4.4	lobed	(308)? 326	÷		stagn.	stagn.	
Hauck et Richter Phyc. univers. nr. 91	4.6—6.2	roundish	330 280 258	÷	pras.		pras.	
— — — — nr. 193	4.2—4.4	lobed	308	a few	stagn.		stagn.	
Rab. Alg. Eur. nr. 1572.....	4.4—6.2		326	+!			pras.	Spec. orig.!!
— Alg. Sachsens nr. 3 ...	4.8 – 5.5	somewhat lobed	331 (on glass) 309 (on paper)	÷			stagn.	Aphanothece coerulescens. A. Br.
Specimens from Iceland ...	3.3—6.2	roundish	351	÷				

The difference in colour is, however, not so wide as might be imagined according to the Codex-numbers stated. There is, for instance, in fact but a slight difference between nr. 308 and 326, and in the various specimens from the same sample several colour-tones are represented, e. g. in Phycotheca univers. nr. 91 we find the following: 330, 258, 280 of which nr. 330 probably represents the colour of specimens in a young stage, the more brownish, i. e. 280 and 258, the older stages where the colour is more or less faded.

Consequently the exsiccata cannot be divided into two types with different colour-tones. If anything, an even gradation of colour-tones from the brown (258) to the bluish (351) is found. Between the two previously mentioned exsiccata Kütz. Dec. nr. 29 and Rab. Alg. 1572 there is but a very slight difference in colour.

These remarks on the colours naturally apply but to dried material, and there is of course a slight possibility that the examination of living plants might give a different result. However, it is not probable as a difference in the living state presumably also would have given a difference in colour in the dried state even if the difference would not have been the same.

As to the presence or absence of crystals it has to be remarked that this condition on the whole must be considered as a poor systematic character as it varies to a great extent according to the age of the plant and furthermore is absolutely dependent upon the chemical nature of the water in which the alga grows. The importance of this character is in the present case further impaired by the fact that I in A. Braun's original specimens of *A. prasina* (Rab. Alg. 1572) found numerous small crystals which under evolution of air were dissolvable in acetic acid.

We have still the last distinguishing character between the two species, viz. the form of the colony, left. Already from the time when A. Braun's original description appeared confusion has prevailed as to the actual meaning of the expressions, and later authors have added to this confusion. I therefore consider it as granted that *A. prasina* and *A. stagnina* cannot be kept apart on the basis of the form of the colony. Hence it appears to me that none of the hitherto mentioned distinguishing characters between the two species are of such a nature that they carry conviction as to the necessity of keeping the species apart, and I have consequently set down *A. prasina* A. Br. as a simple synonym of *A. stagnina* (Spr.) A. Br. It is possible that *A. prasina* represents the young, vigorous, beautifully green coloured and not yet calci-encrusted specimens, whereas *A. stagnina* represents the somewhat older, more brownish coloured and often highly calci-encrusted specimens.

VI. Coelosphærium Näg.

Coelosphærium Kützingianum Näg.

Nägeli 1849 p. 54, tab. I, C. Lemmermann 1910 p. 81, 82 fig. 2.

E. Icel. Stagnant water in a branch of Grimsá, among Myriophyllum. Temp. 14° $^{26}/_{6}$ 1914. — N. Icel. Small pond, on decaying parts of plants, Grímstaðir Mývatn $^{20}/_{7}$ 1914. — S. Icel. Grímstaðir, mud from dried-up lake bottom in a Flói $^{30}/_{7}$ 1905 (H. J.)!

Area: ?

It is difficult to state the distribution of this species as it has been constantly confused with *C. Nægelianum* Ung. (*Gomphosphæria Nægeliana* Lemm.). This is, for instance, the case with De-Toni (1907, p. 100). Nevertheless the two species are easily distinguishable in that *C. Kützingianum* is not provided with pseudovacuoles, whereas such are developed in *C. Nægelianum* Ung. (Bachmann 1907 p. 63). This species is a pronounced plankton form, whereas the former thrives best in mud on the bottom among other algæ or aquatic plants. I do not believe that any specimen of *C. Kützingianum* exists in any of the more prominent collections of exsiccata.

The form found in the three above-mentioned samples had very small cells, ca. 2 μ or slightly larger. It consequently approaches *C. minutissimum* Lemm. (1910 p. 81). The colonies, too, were slightly smaller than in the typical *C. Kützingianum* viz. ca. 26—28 μ.

VII. **Merismopedia** Meyen.

Merismopedia glauca (Ehr.) Näg.

Nägeli, Gatt. einzell. Algen p. 55, tab. I D., fig. 1. Lemmermann 1910 p. 85.

N. W. Icel. Botn in Geirþjófsfjörður, dried-up lake $^{26}/_{7}$ 1915 (H. J.)! Same place, lake. $^{26}/_{7}$ 1915 (H. J.)! Arnarfjördur, Hariot (1893 p. 314), Belloc (1894 p. 6). — S. Icel. Grímstaðir, mud from "Flói" (2 samples) $^{30-31}/_{7}$ 1905 (H. J.)! Ibid. mud from dried-up bottom of a lake in a "Flói" $^{30}/_{7}$ 1905 (H. J.)!

Area: Ubiquist. Lappland, Færöes, Novaya Semlya, Greenland.

Not infrequently found in plankton, being, however, undoubtedly a true bottom-form thriving best in mud on the bottom of lakes and in streams with quiet water. It is capable of withstanding considerable salinity of the water and exhibits on the whole great power of adaptation. According to Kolkwitz and Marsson (1908 p. 515) it should be oligosaprobe.

At all the above-mentioned Icelandic localities where I have had opportunity to observe it, it occurred in mud in more or less dried-up lakes.

Merismopedia tenuissima Lemm.

Lemmermann 1910 p. 85, p. 82 fig. 8.

S. Icel. Grímstaðir. Mud from dried-up lake bottom in a "Flói" $^{30}/_{7}$ 1905 (H. J.)!

Area: Eur., As., Afr., Am., Antarctic, Færöes, Greenland.

Occurs in the same places as the preceding species.

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2. CHAMÆSIPHONACEÆ.

I. **Clastidium** Kirchner.

Clastidium setigerum Kirchn.

Lemmermann 1910 p. 97, p. 91 fig. 2. Hansgirg, Prodromus II p. 125, fig. 38.

S. Icel. Holmsá, temp. 14° $^{14}/_{8}$ 1914, on Cladophora and Oedogonium.

Area: Germany, Bohemia, Courland, Lappland.

In the above-mentioned sample I have only observed a few specimens of this small rare species; but their appearance corresponded exactly to the figures and descriptions quoted above.

The species has hitherto been found like the species of *Chamæsiphon* epiphytic on various algæ especially on the genus *Cladophora*.

II. Chamæsiphon A. Br. et Grun.

Chamæsiphon cylindricus Boye P. n. sp. Fig. 2.

Ch. gonidangiis stricte cylindricis, 2—2.5 μ crassis, 11—13.2 μ longis, rectis, basi non angustatis (fig. 2, a—d), vel brevissime stipitatis (fig. 2, e), vulgo inarticulatis, interdum superne duobus gonidiis; vaginis achrois apice tenuibus, basi incrassatis; contentu cellularum granulato. Epiphytica in Cladophora sp.

N. Icel. On a lake-margin above Húsavik $^{26}/_{7}$ 1914.

This species is most closely related to *C. africanus* and *C. minimus* Schmidle (1902 p. 62, tab. II, fig. 3). In dimensions it forms an intermediate between the two species. From *C. africanus* it is chiefly distinguished by the sheath not being thickened at the apex; furthermore it is very rarely provided with any distinct stalk, this being at any rate never so distinctly developed and so thin as in *C. africanus*.

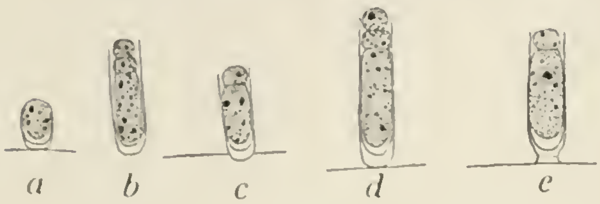

Fig. 2. *Chamæsiphon cylindricus* n. sp. (×1200).

Chamæsiphon incrustans Grun.

De-Toni, Sylloge Alg. vol. V p. 136.

N. Icel. Slútnes off Grímstaðir (Mývatn); on leaves of moss $^{20}/_{7}$ 1914, temp. $17^{1}/_{2}$ °. — S. Icel. Holmsá, temp. 14 ° on Cladophora. $^{14}/_{8}$ 1914.

Area:— Eur., As., Afr., Am., Austr., Færöes, Spitzbergen.

This species seems to be distributed all over the world and is found on a number of various species of Algae, on Cyanophyceæ as well as Chlorophyceæ, especially, however, on species of Cladophora. It has been met with in stagnant as well as running water and seems even able to thrive in brackish water. (Fritsch et Stephens 1921 p. 61).

Chamæsiphon curvatus Nordst.

Nordst. 1878 p. 4, tab. I, fig. 1—2.

W. Icel. Geitabergsvatn, on moss near the margin, temp. 12 ° $^{7}/_{8}$ 1914.

Area: Eur., As., Austr., Novaya Semlya.

The form in question agrees in all respects with Nordstedt's species, but it lacks the mucilaginous coating which the figures (l. c.) seem to indicate.

II. HORMOGONEÆ.

1. OSCILLATORIACEÆ.

I. LYNGBYEÆ GOMONT.

I. **Oscillatoria** Vaucher.

Oscillatoria proboscidea Gom. var. **Westii** De-Toni.
De-Toni Sylloge Alg. vol. V p. 152.
O. proboscidea var. West 1902 p. 245, figs. 28—30.

N. Icel. Akureyri, in hot springs, temp. 35 °—40 ° 11/7 1914 (3 samples); ibid., in hot spring 29/6 1903 (O. P.)! — W. Icel. Hveravellir, in hot springs, temp. 24 °—38 ° C. (West 1902 p. 245). Stóra Kroppar, stream below laug, temp. 15 ° 8/8 1914 (typica?). Reykholt, outlet from Skrifla, temp. 25 ° 9/8 1914. — S. Icel. In stream from Great Geysir, mean temp. about 40 ° C. (West l. c.). Reykjafos; in hot stream, temp. 35° 18/8 1914; ibid., in hot spring, temp. 32 ° 18/8 1914. Laugarvatn, outlet from laug, temp. 36° 16/8 1914. Reykjavík, Laugarne, temp. 35° 3/8 1914; ibid, temp. 40 ° 2/10 1896 (H. J.)!

This variety is only known from Iceland where it, to begin with, was found by West in samples from Hveravellir and Geysir. Later I have myself found it at the majority of the hot springs I have visited (frequently in temp. of 32 °—40 ° C.). At Stóra Kroppar only I found in a sample from the stream below a "laug" some few trichomes of same, but one might well imagine that these originated from the hot spring. The variety I chiefly distinguished from the species by the greater thickness of the trichomes. On the dried material faint constrictions can be seen between the cells, but it is not by any means certain that these could be seen on living specimens. It is not quite improbable that var. *Westii* in reality may possess so many distinctive features that it could be placed as an individual species. This, however, I could not do as I lacked the necessary material for comparison.

O. proboscidea does not belong to the common species, but its habitats are to be found all over the world especially in Eur., Afr., As., Antarctic, Alaska. Therefore it is probable that it will prove to be an Ubiquist. It has not been found in hot springs at other places than Iceland.

Oscillatoria sancta Kütz.
Gomont, Monogr. II p. 209, pl. VI fig. 12.

E. Icel. Vallanes 22/5 1893 (H. J.)! — N. Icel. Skútustaðir, pool in which a spring flows out, temp. 7 ° 17/7 1914. Mývatn near Geiteyjarströnd, washed ashore 17/7 1914; ibid., squeezed out of Sphagnum on the shore 17/7 1914.

Area: All continents, Antarctic, Fr. Josephs Land, Greenland.

Has been found under highly varying external conditions: in water (stagnant and running), on earth and rocks. In Iceland I have only found it in the neighbourhood of Mývatn in a cold spring and on the lake-margin.

Oscillatoria limosa Ag.
Gomont, Monogr. II p. 210, pl. VI, fig. 13.

N. Icel. Skútustaðir, small pool in which a spring flows out, temp. 7° 17/7 1914. — W. Icel. Hveravellir, temp. 49° C. (West 1902 p. 245). — S. Icel. Þingvellir. In Nicolasargjá on rocks, temp. 3½° 15/8 1914. Apavatn, stream with faint current, temp. 4° 16/8 1914. Laugarvatn, spring at the edge of the shore, temp. 12° 16/8 1914. (Notice, the temp. of the lake at hardly 1 m. distance 18°.)

Area: Ubiquist. Spitzbergen, Lappland, Færöes, Greenland.

This widely ranging and common species is chiefly found in fresh water, whether stagnant or running. Frequently it has, however, been met with on moist earth and in brackish water. West (l. c.) opines having found this species in a hot spring (49°), but this is unique. Tilden only (1910 p. 66) mentions that it is found in Iowa "in a sulphur spring". What is meant by a sulphur spring I cannot conceive, and no temperature is given. In Kolkwitz and Marsson the species is placed as β-mesosaprobe.

All the localities in Iceland, where I myself have found it, are identical in that they all occur at the outlet of cold springs where consequently the temperature is low.

Oscillatoria curviceps Ag.
Gomont, Monogr. II p. 213, pl. VI, fig. 14.

E. Icel. Vallanes 23/5 1894 (H. J.)! — S. Icel. Eyðistjörn near Reykjavik 9/6 1896 (C. H. O.)!

Area: Eur., Am., Antarctic, Færöes, Greenland.

Seems to thrive best in quiet water, hence often in ditches and thickets of reed along lake-margins.

Oscillatoria anguina Bory.
Gomont, Monogr. II p. 214, pl. VI, fig. 16.

N. W. Icel. Botn in Geirþjófsfjörður, lake, temp. 10° 26/7 1915 (H. J.)!

Area: Eur., Afr., Am.

This easily recognizable species has not been found very often and always under highly varying external conditions. It is mentioned as terrestrial (Esmarch 1914 p. 265), is found in hot springs and in stagnant as well as running water. In the Icelandic sample, consisting of mud from the bottom of a small lake, it occurs but sparingly.

Oscillatoria irrigua Kütz.
Gomont, Monogr. II p. 218, pl. VI, figs. 22—23.

S. Icel. Streamlet near Apavatn, current not strong, temp. 4° 16/8 1914.

Area: Eur., As., Afr., Austr., Antarctic, Spitzbergen.

Strange to say this species has not yet been found in America. It occurs in stagnant as well as in running water and on moist rocks too.

In the Icelandic sample it grows together with *Oscillatoria limosa* among *Ulothrix* and *Zygnema*.

Oscillatoria tenuis Ag.
Gomont, Monogr. II p. 220, pl. VII, figs. 2—3.

N. Icel. Stóra Gjá on mud 19/7 1914.
Area: Ubiquist. Fr. Josephs Land, Lappland, Beeren Eiland, Greenland, Færöes.

O. tenuis has a world-wide distribution and occurs under the most varying external conditions. Besides appearing in stagnant as well as running fresh water it has also been found in brackish water and hot springs (40° C. Borge 1906 p. 10). It often grows on moist earth, e. g. at the Icelandic locality this being a lava creek at the bottom of which a hot spring flows out.

According to Maertens (1914) it should need a great quantity of nitrogen, and Kolkwitz et Marsson (1908 p. 511) class it as α-mesosaprobe.

Oscillatoria amphibia Ag.?
Gomont, Monogr. II p. 221, pl. VII, figs. 4—5.

N. W. Icel. Botn in Geirþjófsfjörður, lake at 200 m., temp. 8° 26/7 1915. (H. J.)!
Area: Ubiquist, Spitzbergen, Beeren Eiland, Greenland.

The determination of this species cannot be said to be absolutely certain as I have not observed any curved apex; on the other hand the dimensions are in accordance.

O. amphibia does not belie its name, being found in fresh, brackish (e. g. Schultz 1914 p. 23, West 1909 p. 243) as well as in thermal-water (e. g. Fritsch 1914 p. 52, Borge 1906 p. 10) and showing thereby great powers of adaptation to the physical and chemical qualities of the water. It has, in fact, also been found in the coldest as well as the warmest regions of the earth.

Oscillatoria brevis Kütz.
Gomont, Monogr. II p. 229, pl. VII, figs. 14—15.

S. Icel. Laugarne, Reykjavik, 40° C. 2/10 1897 (H. J.)!
Area: All continents, Antarctic, Greenland.

The specimen in question was first determined by J. Schmidt and I have later revised the determination.

O. brevis possesses great power of adaptation. It is found in fresh as well as salt water (var. *neapolitana*); furthermore it appears as aërophilous alga on damp walls (Kaiser 1914 p. 146). Bohlin (1901 p. 73) and Puymaly (1921 p. 190) have previously found it in hot springs. By culture experiments Maertens (1914) arrived at the conclusion that it needed considerable quantities of nitrogen in order to thrive well. This is in accordance with Kolkwitz and Marsson (1908 p. 511) who place it in their ecological system as α-mesosaprobe.

Oscillatoria formosa Bory.
Gomont, Monogr. II p. 230, pl. VII, fig. 16.

S. Icel. Reykjavík, Laug. Temp. 35 ^{0} $^{3}/_{8}$ 1914.
Area: All continents, Antarctic, Spitzbergen.

An evidently cosmopolitan species which also is found under highly varying conditions. It occurs in fresh as well as brackish water and has several times been found in hot springs at a temperature up to 54 ^{0} C. (Borge 1906 p. 11). It seems also capable of growing more or less aërophilous in that it is found on earth (Esmarch 1914 p. 265, Moore and Karrer 1919 p. 304). It probably thrives best in and on mud. Pieper (1915 has examined its movements in connection with the light and finds that it shows positive phototaxis in weak light, negative in strong light. In a certain medium light the threads turn at right angles to the beams of light. In this Pieper sees an adaptation by means of which the algae always can obtain the most favourable illumination.

According to Kolkwitz et Marsson (1908 p. 511) it is α-mesosaprobe.

Oscillatoria numidica Gom.
Gomont, Monogr. II p. 231. Günther Schmid 1914 p. 129, fig. 4.

S. Icel. In stream from Great Geysir, mean temp. about 40 ^{0} C. (West 1902 p. 245).
Area: Eur., Am., Afr.

This species has only been found five times in all. It was described by Gomont on basis of material from the hot springs at Hammam-Salahin in North Africa. Later it was found by Tilden (1910 p. 81) in a hot-house in Minneapolis, and Günther Schmid (1914 p. 129, 1917 p. 352) found it in similar circumstances in the Botanical Garden of Jena. Finally it has been found once more in Minneapolis, but this time in a small pool with cold water. Judging by the findings in hand it is to be presumed that it is a species which requires a rather high temperature in order to thrive well, but anything definite can of course not be stated.

Oscillatoria terebriformis Ag.
Gomont, Monogr. II p. 234, pl. VII, fig. 24.

S. Icel. Reykjavík; Laugarne $^{13}/_{6}$ 1895 (C. H. O. !
Area: Eur., As., Afr., Antarctic.

Coupin (1915 p. 56 considers this species to be a genuine thermal alga. To be true, it has been found several times in thermae, but just as frequently it has been found in countries where no thermae exist at all, e. g., Denmark, Sweden, Luxemburg, and even on Ross Island (W. and G. S. West 1911 p. 265) in a pond where the temperature never exceeded 60 ^{0} F. Therefore I cannot agree with Coupin, but must refer it to the facultative thermal algae.

Oscillatoria beggiatoiformis (Grun.) Gom.
Gomont, Monogr. II p. 235, pl. VII, fig. 25.

E. Icel. Norðfjörður, June 1894 (H. J.)! Hallormstaðir; spring, temp. $3^1/_2{}^0$ $^{28}/_6$ 1914. — S. Icel. Nicolasargjá at Pingvellir; on rocks, temp. $3^1/_2{}^0$ $^{15}/_8$ 1914.
Area: Hungary.

This species has only been found twice, viz. in the typical form by Kalchbrenner near Zsivadreda in "aquas acidulas" and by Gutwinski (1909 p. 541) "in uvidis muscosis in silva", but the latter adds "specimina recta". The same applies in part to the above-mentioned Icelandic specimens. As to dimensions, apex and granules on each side of the transverse walls of the filaments everything is in accordance with Gomonts diagnosis; but the trichomes are often straight or more or less irregularly curved. However, rather regularly spirally coiled trichomes are also frequently found.

II. **Spirulina** Turpin.

Spirulina subsalsa Örst.
Gomont, Monogr. II p. 253, pl. VII, fig. 32.

S. W. Icel. Knararnes $^2/_8$ 1905 (H. J.)!
Area: Cosmopolitan; Greenland.

This widely distributed species is strictly speaking a marine form, and in the above-mentioned Icelandic locality it was, in fact, also found in company with other marine or brackish-water species, viz. *Lyngbya stagnina* Kütz., *Nodularia Harveyana* and *Lyngbya lutea.*

Spirulina labyrinthiformis (Men.) Gom.
Gomont, Monogr. II p. 255.

N. W. Icel. Mýri in Dýrafjörður. Moist places near the shore $^{30}/_5$ 1895 (C. H. O.)!
Area: Eur., Afr., S. Am.

The form in hand is a *Spirulina* with a close spiral ca. 2 μ in diameter. However, it is not quite excluded that we here have to do with a thin form of *S. subsalsa.* The species is stated to have been found partly in brackish water, partly in hot springs.

III. **Phormidium** Kützing.

Phormidium fragile (Menegh.) Gom.
Gomont, Monogr. II p. 163, pl. IV, figs. 13—15.

W. Icel. Reykholt, Snorralaug $^{13}/_9$ 1897 (H. J.)!
Area: Eur., Afr., Am., Austr., Antarctic.

In the above-mentioned sample the trichomes were 1.2 μ in diameter, the cells almost quadrate and the apical cell acute-conical corresponding to that in Gomont pl. IV, fig. 15.

The species has previously been found in hot springs, e. g., in Bohemia (Hansgirg), in Italy (Meneghini) as well as in California (Borge

1909 p. 19) and in Argentine (Borge 1906, p. 9). Besides it has often been found in brackish water and also in fresh water.

Whether *P. Henningsii* Lemm. (1910 p. 124) actually can be distinguished from *P. fragile* Gom. is highly questionable. The sole distinguishing character, which I can find in the description, is the appearance of the sheaths which in the former are considered to be firm, in the latter diffluent. But such a character can hardly be utilized here as a basis of distinction as numerous species now have firm, now diffluent sheaths.

Phormidium luridum (Kütz.) Gom.
Gomont, Monogr. II p. 165, pl. IV, figs. 17, 18.

W. Icel. Hveravellir, temp. 38° C. (West 1902 p. 244).
Area: Eur., As., Am., Austr.

This species, which is only mentioned from about half a dozen localities, I have not been able to find in Iceland. The main distinctive character, by means of which it can be distinguished from the other thin species of *Phormidium*, is evidently the colour of the thallus. The localities, on which it occurs, are rather varied, so that it is difficult to form any opinion on the basis of the statements in the literature as to which conditions are most favourable for its growth. Perhaps it will appear that this species has a wider distribution in hot springs as we now know. Later it has been found in a hot spring on the Feejee Islands, temp. 59° C. (West in Gibbs 1909 p. 202.)

Phormidium laminosum (Ag.) Gom.
Gomont, Monogr. II p. 167, pl. IV, figs. 21, 22. Ostenfeld 1899 p. 238.

N. Icel. Outlet from Uxahver, temp. 35° and 42° 22/7 1914. — W. Icel. Outlet from "Skrifla" at Reykholt, temp. 25° 9/8 1914. Hveravellir, temp. 24° C. (West 1902 p. 245). — S. Icel. Reykjavík, Laugarnar, 40° C. 2/10 1897 (H. J.)! Ibid., 5/6 1896 (C. H. O.)!
Area: All continents, Antarctic, Spitzbergen, Alaska.

To distinguish *P. laminosum* from *P. tenue* is often attended with considerable difficulties partly because they are both possessed of extremely thin trichomes, partly because the distinguishing characters cannot always be seen with sufficient distinctness. Therefore it has been necessary to leave a number of specimens undetermined, although great pains have been bestowed on the determination.

From Iceland the species is only known from the hot springs, and on that kind of locality it has a world-wide distribution, and Elenkin (1914) mentions it together with *Hapalosiphon laminosus* as cosmopolite among the thermophilous algae. Furthermore it is also supposed to occur in cold fresh water, on moist rocks or between mosses. Finally Miss Bristol (1920 p. 59) has found it in a sample from cultivated soil in England.

In Iceland I have found it at temperatures lying between 25° and 42°. On the basis of literature it is difficult to draw any conclusions, as to the maximum of temperature at which it is able to thrive, owing to the fact that often but the temperature of the spring is stated without further statement as to whether the alga also actually grew in water of this temperature. However, in Tilden (1910 p. 97) we have a definite statement that it grew at 51 ^{0}—56 ^{0} C.

Phormidium tenue (Menegh.) Gom.
Gomont, Monogr. II p. 169, pl. IV, figs. 23—25.

N. Icel. Reykhús, S. of Akureyri, hot spring 48^0—50^0 $^{11}/_7$ 1914 (2 samples). Akureyri, hot spring $^{29}/_6$ 1903 (O. P.)! — N.W. Icel. Reykholar, margin of hot spring, 20^0 in the algal layer. $^8/_7$ 1919 (H. J.)! — W. Icel. Hveravellir, in spray of small geysir, temp. 85^0 C. (West 1902 p. 245). Stóra Kroppar, laug, temp. 26^0 $^8/_8$ 1914. — S. Icel. Reykir, at margin of hot spring. The temp. of the spring 100—102^0. Stp.!
Area: All continents, Antarctic, Fr. Joseph's Land, Spitzbergen, Alaska.

In none of the above-mentioned samples have I found a bent apex corresponding to the one in Gomont's fig. 25. Neither have I succeeded in discovering such an apex in the exsiccata cited by Gomont, Rab. Algen nr. 268 and 1730. *P. tenue* is distinguished from *P. laminosum* chiefly by the constrictions between the cells and the absence of granules at the transverse walls. In Iceland it has only been found at the hot springs, and with certainty in water of a temp. at 26 ^{0}—50 ^{0}. West's statement that it occurs in a small geysir at a temp. of 85 ^{0} C. must be received with every possible reservation in that the author had not collected the algae himself; they probably grew at the margin of the spring where the temp. was considerably lower.

For the rest the species has been found under highly varying conditions, viz. in thermae, fresh water, brackish water, on earth; Miss Bristol (1919) even found it in an old soil-sample from 1868. This sample contained comparatively much water, and she therefore considers the species incapable of withstanding any longer period of drought. Later the same author (Bristol 1920) has found that it is a very common occurrence in cultivated soil in England.

Phormidium subuliforme Gom.
Gomont, Monogr. II p. 169, pl. IV, fig. 26.

W. Icel. Hveravellir, temp. 55^0 C. (West 1902 p. 245).
Area: St. Paul (the Pacific), Algiers, N. Am. (Nebraska).

I have had no opportunity of observing this rare species. It has only been found four times in all.

Phormidium angustissimum W. et G. S. West.
Journ. of Bot. 1897 p. 298.

G. S. West (1902 p. 245) mentions that he has found this species in Iceland, viz. on the following localities:

"Hveravellir, in hot spring, temp. 55 ^{0} C. Also in spray of a small geysir, temp. of spray 85 ^{0} C. In the stream from the Great Geysir, mean temp. about 40 ^{0} C."

West makes the suggestion that this species is identical with *P. Treleasei* Gom. Regarding this suggestion I cannot express any opinion as I have had no opportunity of examining West's material. In West's description information concerning the relation of the sheaths to chlor-zinc-iodine is lacking.

P. angustissimum has, as far as I know, only been found by G. S. West and on various localities: England, Africa, Antarctic regions.

Phormidium Treleasei Gom.
Gomont 1899 p. 37. Tilden 1910 p. 96.

N. Icel. Hrísey, 40° C. 3/7 1898 (H. J.)! Uxahver, on silicious sinter at the hot spring, temp. 80°; but the water does not reach the algæ 22/7 1914? — W. Icel. Kleppjárnsreykir, hver, 8/8 1914 (2 samples). — S. Icel. Reykjafos, in hot stream, temp. 35° 18/8 1914?
Area: Arkansas (Gomont l. c.), Canada (Tilden l. c.).

The finest development of this alga was seen in the samples from Kleppjárnsreykir where it grew at a great boiling spring which had deposited a metre-high mass of silicious sinter, on the top of which the water now was spouting. Then it ran down over certain parts of the silicious sinter, whereas other parts of this remained dry. On the bottom of the outlets *P. Treleasei* formed inch-thick crusts being orange-brown on the surface, blue-green deeper down. The temp. of the water 35° C. But higher up on the dry parts of the sinter which, however, might be reached by the spray when the spring was on the boil, the alga was growing in the most peculiar manner. Here it formed thick, cartilaginous, stratified crusts. The uppermost layer was brown; beneath this appeared a rich blue-green layer which was followed by red and brown layers that became more and more greyish inwards presumably because they gradually contained more and more silica. All the layers were quite thin, and I could count in all about 40.

The various colours of the surface layers might perhaps be accounted for on the basis of what we know of colour changes owing to the action of the light in other species. (Se introduction p. 257). The uppermost layer, which has been exposed to the direct rays of the sun, may possibly have been discoloured, hence the yellowish-brown colour. The second layer had presumably the natural colour of the alga in that the intensity of the light here was so diminished that the colour did not change. The green layer, however, acted as a light-filter to the following layer which was thus illuminated with green light. Therefore it assumed the complementary colour and became red. The explanation is, however, somewhat problematic, in that no indication whatever exists of this species belonging to those who have "complementary chromatic adaptation".

Gomont has, as far as I understand his description, had this species in a similar form. In these samples the sheaths, which were highly diffluent, coloured intensely with chlor-zinc-iodine.

In the other above-mentioned samples the alga rather resembled *P. laminosum* in its mode of growth in that it formed thin, membranous layers on the silicious sinter without any stratification and the reaction of chlor-zinc-iodine was not so pronounced. However, I believe that the mode of growth is to a great extent dependent upon the external conditions and presumably other species of *Phormidium* may also occur in a manner corresponding to that of *P. Treleasei* at Kleppjárnsreykir. Tilden (1897 p. 194) describes similar formations in *P. laminosum*. Nevertheless, I do not consider it to be quite excluded that it, in reality, was *P. Treleasei* that was present. Judging by Tilden's figure (pl. VIII, fig. 8) the cells were much too long for *P. laminosum*, but of suitable length for P. Treleasei. To keep these two species apart is, for the rest, extremely difficult. *P. Treleasei* is only known from hot springs.

Fig. 3. *Phormidium ramosum* n. sp. Thallus (natural size).

Phormidium ramosum Boye P. n. sp.

Ph. thallis ramosis penicillatis, fluctuantibus, laete æruginosis, filis 0.1—1 mm. crassis; vaginis plerumque in mucum amorphum diffluentibus, chlorozincico jodurato non coerulescentibus; trichomatibus apicibus rectis, parallelis vel varie intricatis, rectis vel curvatis, 1.3—1.9 μ crassis, cylindricis, ad genicula non constrictis, dissepimentis sæpe inconspicuis, articulis diametro trichomatis 2—3-plo longioribus, protoplasmate homogeneo vel granulis paucis instructo; cellula apicali rotundata, membranam superne incrassatam præbente.

S. Icel. Laugarvatn, in outlet from a Laug, temp. 36° 16/8 1914. Reykjavík, Laugarne, temp. 35° 3/8 1914?

The colour of the dried thallus almost corresponded to Codex nr. 328. In the sample from Reykjavík a large number of *Oscillatoria proboscidea* var. *Westii* occur besides the species in question, and this is perhaps the reason why it has not on this locality assumed the branched floccose form. In the sample from Laugarvatn its habit reminds extremely of *P. Retzii* Gom. f. *fasciculata* Gom. 1893 p. LXXXVI, pl. IV, fig. 1—2); but the trichomes are far thinner than in this species, so there can hardly be any question of any close relationship. On the other hand, the trichomes agree to some extent with those in *P. orientale* West (1902 p. 248); however, such differences exist that I cannot think of identifying the two species. Something similar applies to *P. truncatum* Lemm. (1909 p. 189).

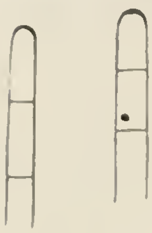

Fig. 4. *Phormidium ramosum* n. sp. Apices of 2 trichomes. (×1800).

Phormidium Corium (Ag.) Gom.
Gomont, Monogr. II p. 172, pl. V, fig. 1—2.

N. Icel. Hrafnagil, hot springs 25/5 1890 (Hj. J.)! — W. Icel. Sturlureykir; siliceous sinter at hot spring 9/8 1914. — S. Icel. Geysir, Blesi; margin of the hot basin (Stp.)! "Laugarvas". Near the margin of northern spring, temp. = 100° C. Stp.)! Reykjavík, Laugarne (Stp.)! Hurðarbak, 12/9 1897 (H. J.)!

Area: Eur., Afr., Am., Austr., Lappland, Alaska, Greenland.

Strangely enough this species is found in Iceland almost exclusively at the hot springs, hardly in the hot water, but rather on the margin of the spring. Otherwise the species is found on stones in streams, on moist trunks and thatched roofs. Therefore it is not quite correct when Coupin (1915 p. 57) refers it to the species which are found exclusively in rapidly running water. However, there is a possibility that the species might be divided in various species.

The Icelandic specimens correspond rather closely to Gomont's description and figures. The apical cell, however, is as a rule longer than that figured by Gomont. Almost identical apical cells are, nevertheless, found in a sample in Herb. Lyngbye, determined by Gomont. Therefore, I have not hesitated in referring the specimens in question to *Phormidium Corium* in spite of the slight deviation.

Phormidium subcapitatum Boye P. n. sp.

Ph. strato membranaceo, atro-æruginco, trichomatibus flexuoso-curvatis, sæpe parallelis, læte æruginеis, 1.8—2.2 μ crassis ad genicula leviter constrictis, apice rectis, interdum attenuatis, subcapitatis; articulis diametro æqualibus vel ad 3-plo longioribus, interdum granulis sparsis farctis; cellula apicali calyptram rotundatam vel depresso conicam præbente; vaginis mucosis, chlorozincico jodurato non coerulescentibus.

W. Icel. Geitaberg. In soil in a potato field just in front of the house 7/8 1914.

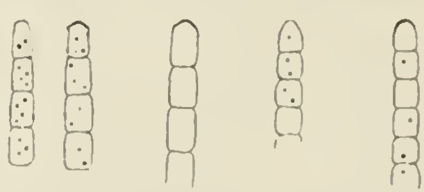

Fig. 5. *Phormidium subcapitatum* n sp. Different forms of apices. (×1200).

This species is one of the thinnest in which a calyptra is found. In order to see it the finest optical facilities are needed. The species, to which it is most closely related, is apparently *P. africanum* Lemmermann (1911 p. 89). This species, however, has slightly thinner trichomes and its vaginæ colour with chlor-zinc-iodine; and, when it furthermore is taken into consideration that P. africanum was found in a hot spring in Central-Africa, I think it justifiable to set up *P. subcapitatum* as a new species.

Phormidium ambiguum Gom.

Gomont, Monogr. II p. 178, pl. V, fig. 10. Wittr. et Nordst. Alg. exsicc. nr. 1172.

N. Icel. Reykhús south of Akureyri; in outlet from hot spring, temp. 40° 11/7 1914. Námuskarð, hot spring, temp. 45° 18/7 1914.

Area: Eur., As., Afr., Am., Spitzbergen.

The specimens from Reykhús had trichomes 8—9 μ in diameter, i. e. approaching var. *major* Lemm. (1910 p. 127). It proved very difficult to obtain a distinct colouration in blue of the sheath with chlor-zinc-iodine; but finally I succeeded. The cited sample (W. et Nrd., nr. 1172) behaved identically. In the sample from Námuskarð, on the other hand, the trichomes had the typical diameter, viz. about 6 μ.

P. ambiguum has previously been found in hot springs, e. g. by Ström (1921 p. 18) in a sample from Spitzbergen. Moreover the species has been found in fresh water, brackish water and in a soil-sample (Esmarch 1914 p. 265).

Phormidium subfuscum Kütz.

Gomont, Monogr. II p. 182, pl. V, figs. 17—20.

Vestmannaeyjar, Heimaey. On a rock beneath a fowling-cliff. 21/8 1914.

Area: Eur., As., Afr., Am., Lappland.

This species apparently deviates considerably in its distribution from *P. autumnale*, to which it otherwise is closely related in as much as it has neither been found in any antarctic nor in any true arctic area, but only at the boundary of this. On Vestmannaeyjar it grew in company with *P. autumnale*, but is otherwise supposed to need less organic matter in the substratum than the latter (Kolkwitz und Marsson 1908 p. 512: β-mesosaprob). It has generally been met with in water, running as well as stagnant, so that its occurrence on a fowling cliff is a remarkable fact.

Phormidium autumnale (Ag.) Johs. Schmidt emend.

P. autumnale Gomont, Monogr. II p. 187, pl. V, figs. 23—24. *P. uncinatum* Gomont, Monogr. II p. 184, pl. V, figs. 21—22. Johs. Schmidt 1899 p. 348. Ostenfeld 1899 p. 238.

E. Icel. Norðfjörður June 1894 (H. J.)! (var. uncinatum). Vattarnes 14/7 1898 (H. J.)! — N. Icel. Úlfsbær, soil at dunghill 15/7 1914. Geitey in Mývatn, soil beneath Archangelica highly manured by excrements of birds 19/7 1914 (2 samples). — W. Icel. Mödruvellir in Kjós, on soil in front of the house 6/8 1914. Grund in Skorradal, among stones in a wall 8/8 1914. — S. Icel. Kárastaðir, on soil among stones in a wall 15/8 1914. Laugarvatn, on soil abounding in refuse in front of the house 16/8 1914. Þingvellir, on soil on a path near the vicarage. 15/8 1914. Reykjavik. Laugarne (C. H. O.)! 5/6 1896 and 13/6 1895; ibid. (C. H. O.)! 5/6 1896 (var. *uncinatum*); ibid. (H. J.)! 21/3 1897 (var. *uncinatum*). At Laugarne, open place in grass moor 3/8 1914. — Vestmannaeyjar, Heimaey, fowling cliff 21/8 1914 (3 samples). ? Þorishólmi 23/6 1897 (H. J.)!

Area: Ubiquist, Lappland, Spitzbergen, Færöes, Greenland, Arctic N. Am.

According to Gomont *P. uncinatum* (Ag.) Gom. is a species growing especially in water, stagnant as well as running, whereas *P. autumnale* chiefly is found on soil and most frequently in the vicinity of human dwellings. Johs. Schmidt (l. c.) maintains that no valid morphological distinguishing characters between the two species exist, and also that they cannot be separated with regard to habitat. He therefore unites them under *P. autumnale*. Neither has G. Schmid (1917 p. 354), according to my opinion, succeeded in discovering any valid distinguishing characters between the two species. I therefore follow J. Schmidt, but I have, however, in the above mentioned list of localities recorded where I found pronounced *uncinatum*-forms. All my own collections originate from earth, and among those pronounced *P. uncinatum* was only present in one sample, but besides I have found this form rather pronounced in three samples collected by Helgi Jónsson and C. H. Ostenfeld. Whether these samples originate from water cannot be seen from the labels, except in the case of the sample from Laugarne at Reykjavík collected by H. Jónsson $^{21}/_{8}$ 1897. On this is written: "The heat at the surface + 21 ° C., at the bottom + 17 ° C." I draw the conclusion that this sample was collected in the stream near the hot springs. The two samples collected by Ostenfeld are presumably the same which he refers to (1899 p. 238) where he states that *P. uncinatum* was found at 30 °—33 °, *P. autumnale* at 21 ° C. Judging by the text of the paper the algæ were collected on the warm earth surrounding the springs. Should this be correct, it would mean that we also here have a conception which is at direct variance with that of Gomont in that *P. uncinatum* in this case appeared on earth.

All the remaining samples originate, as already mentioned, from earth, viz. from the immediate vicinity of houses, from fowling cliffs and from a small island in Mývatn frequented by numerous natatorial birds depositing their excrements there. This verifies the general supposition that *P. autumnale* is a species which to a great extent requires an abundance of nitrogenous nutrition in its substratum. Kolkwitz and Marsson (1908 p. 511) consider it also as α-mesosaprob, and the same applies to the uncinatum form.

IV. **Lyngbya** C. Agardh.

Lyngbya æstuarii (Mertens) Liebm.
Gomont, Monogr. II p. 127, pl. III, figs. 1—2.

N. W. Icel. Dyrafjörður. Moist places near the shore $^{30}/_{5}$ 1895 (C. H. O.)! — S. Icel. Knararnes $^{2}/_{8}$ 1905 (H. J.)!
Area: All continents, Antarctic.

This species is commonly met with in salt or brackish water, but at times it is found, however, in pure fresh water, e. g. in Switzerland (Kurz 1913 p. 363) or in thermæ, thereby showing great powers of adaptation under varying conditions. Gomont (l. c.) has already drawn attention to this fact.

The two Icelandic localities mentioned above are both situated near the sea, and the probabilities therefore are that the soil has been saline in both places.

Lyngbya stagnina Kütz.

Lemmermann 1905 p. 146. Lemmermann 1910 p. 139. Kützing Tab. phyc. I, tab. 87, fig. V.

S. Icel. Knararnes $^2/_8$ 1905 (H. J.)!
Area: Eur.

Gomont referred the present species to *Lyngbya æstuarii* which it also closely resembles (Monogr. II p. 128). Gomont, however, had no original specimen at his disposal; Lemmermann (1905 p. 146), on the other hand, succeeded, on the basis of an investigation of a specimen collected by Kützing in Fusina near Venice, in proving that Lyngbya stagnina is not identical with *L. æstuarii* from which it is especially distinguished by the fact that the sheath is coloured intensely blue with chlor-zinc-iodine. In the sample from Knararnes I have now found a *Lyngbya* that, at all essential points, agrees with Lemmermann's description of *L. stagnina* Kütz. However, a few deviations occur, the apex of the trichome, e. g., being briefly tapering (Kützing's figure seems to me to point in the same direction) and provided with a broader or narrower calyptra which is slightly convex. The material was preserved in alcohol and perhaps in consequence there appeared constrictions between the cells in some of the trichomes (fig. 6, a). The trichomes were 8—10 μ in diameter, the cells 1.5—2 μ in length (somewhat shorter than stated by Lemmermann). In the Icelandic sample *Lyngbya lutea*, *Spirulina subsalsa* and *Nodularia Harveyana* were also present. I therefore presume that it has grown either in brackish or in salt water. The locality of Kützing's original specimens also seems to indicate that it is a brackish-water form, Fusina being a small town at the lagoon of Venice.

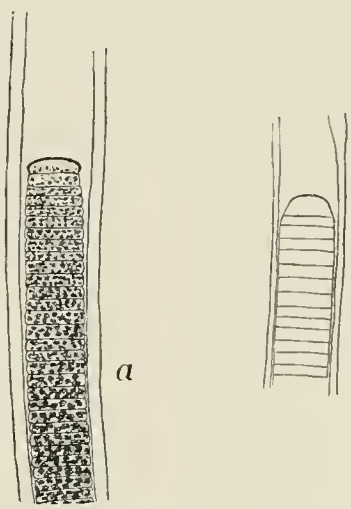

Fig. 6. *Lyngbya stagnina* Kütz. (×600).

Lyngbya lutea (Ag.) Gom.

Gomont, Monogr. II p. 141, pl. 3, figs. 12—13.

S. W. Icel. Knararnes $^2/_8$ 1905 (H. J.)!
Area: Eur., Afr., Am., Færöes.

Belongs to the transition zone between the salt and the fresh water together with *L. æstuarii*, *L. stagnina* as well as *Spirulina subsalsa*.

Lyngbya Martensiana Menegh.

Gomont, Monogr. II p. 145, pl. III, fig. 17. Wittr. et Nordst. Alg. exsicc. Nr. 1524.

N. Icel. Akureyri; hot spring $^{29}/_6$ 1903 (O. P.)!
Area: Eur., Afr., Am., Antarctic.

It is difficult on the basis of statements in the literature to form any clear conception as to which kind of habitat is best suited for this species. It has been found in hot springs (43 ^{0} Bohlin 1901 p. 74) as well as in very cold water, e. g. by West (1911 p. 267, 289), in a lake which never quite thaws out. It has been found in stagnant and running water and also on earth (Esmarch 1911 p. 68).

Lyngbya Rivulariarum Gom.
Gomont, Monogr. II p. 148.

S. Icel. Gljúfurholtsá. Branch with slight current, temp. 15° 17/8 1919.
Area: Eur., Afr., Austr., (Hawaii).

Occurs in the mucilage of various algæ, viz. *Rivularia, Chætophora* and *Schizochlamys*. In the Icelandic sample in a thallus of *Nostoc carneum*.

Lyngbya ochracea (Roth) Thur.

N. W. Icel. Dýrafjörður Hariot (1893 p. 315), Belloc (1894 p. 6).
Area: Eur., As., Afr., Am.

I have not seen this species from Iceland.

Lyngbya Kützingii Schmidle var. **distincta** (Nordst.) Lemm.
Lemmermann 1910 p. 136.

E. Icel. Hallormstað, streamlet in the wood, temp. 20°, on Zygnema and Ulothrix 29/6 1914. — N. Icel. Slútnes in Mývatn, on Cladophora at the water's edge 20/7 1914. — W. Icel. Geitabergsvatn, stone and moss near the margin, temp. 12° 7/8 1914. — S. Icel. Reykjavík, Eiðistjörn, on Cladophora 2/8 1914. Varmá near Reykjafos, on Cladophora, temp. 18° 18/8 1914. Holmsá, on Cladophora and Oedogonium, temp. 14° 14/8 1914.
Area: Eur., Afr., Am., Austr., Lappland, Antarctic.

Occurs as a rule epiphytic on larger algæ, especially on *Cladophora*, *Oedogonium* and *Vaucheria*, in company with species of *Chamæsiphon*.

V. Symploca Kützing.

Symploca Muscorum (Ag.) Gom.
Gomont, Monogr. II p. 110, pl. II, fig. 9.
Oscillatoria elegans. Fl. dan. tab. 2517, 2 (non Agardh).

W. Icel. Helgavatn. At the side of a laug 10/8 1914. — S. Icel. Reykjavík, Laugarnar, edge of hot basin (aqueous vapour 10°?), water 88° (Stp.)!
Area: Eur., As., Afr., Am.

In both of the two Icelandic samples a form was found which deviated to a certain extent from the typical *S. muscorum*. On the siliceous sinter at the side of the hot spring at Helgavatn there grew erect, separated, hardly centimeter-high fascicles, nearly black in colour, issuing from a thin layer extended over the sinter. The trichomes were 4.5—6.1 μ thick, the length of the cells equalled the breadth or were somewhat longer. In the sample from Laugarne at Reykjavik a form occurred, which at times formed short (1—2 mm.) erect fascicles, but as a rule they were procumbent or not visible at all. In this sample the diameter of the trichomes was still smaller, viz. 3.9—4.4 μ; this being thus considerably less than the minimum stated by Gomont (l. c.) with regard to the diameter of the trichomes in this species; but the rather solid sheaths and the length of the cells have, nevertheless, induced me to refer this form to *S. muscorum* and not to *S. muralis* the cells of which are supposed to be shorter than the length. (Fig. 7.) This sample is presumably the original specimen of Fl. dan. table 2517.2, *Oscillatoria elegans.* On the label this name is distinctly written in Liebman's hand, and the locality also agrees. However, several other samples from Iceland exist, collected by Steenstrup (e. g. from Geisir), and on which Liebman has written the same name. I have referred these samples to *Phormidium Corium* as they, according to my investigations, can be distinguished with certainty from the samples from Laugarne at Reykjavik. Thus Liebman was evidently not able to distinguish *Symploca Muscorum* from *Phormidium Corium;* but, judging from the evidence to hand, the probabilities are that it happened to be a specimen of *Symploca Muscorum* which was drawn for Flora danica under the name of *Oscillatoria elegans.* It must also be the same alga which Liebman mentions 1840 p. 337 and 339.

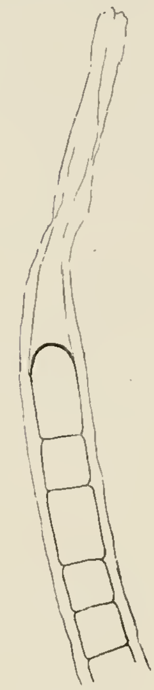

Fig. 7. *Symploca Muscorum* (Ag.)Gom. var. (×1200). From Laugarnar at Reykjavík leg. Steenstrup.

The species in question has previously been found at hot springs; but it is undoubtedly but a chance guest here. It has most frequently been found growing on and among mosses in moist places, but it also occurs on bare, moist earth as well as in water, even free-floating. It has not previously been found in any arctic or antarctic region which might suggest that it is not capable of withstanding extreme cold and at the same explain its occurrence at the hot springs.

Symploca muralis Kütz.
Gomont, Monogr. II p. 112, pl. II, fig. 10.

S. Icel. Laugarne (Reykjavík?), hot spring. (Stp.)!
Area: Eur., As., Afr., Am.

This species is mainly living on moist earth, walls, trunks and the like. Therefore it is under deviating conditions that it was collected by Steenstrup in Iceland, viz. at a hot spring; the probabilities are, however, that it has grown on the earth at the side of the spring although the label does not contain any information as to this. The sample was originally determined by Johs. Schmidt.

Symploca thermalis (Kütz.) Gom.
Gomont, Monogr. II p. 114, pl. II, figs. 15—16.

W. Icel. Stóra-Kroppar, in small laug, temp. 33 ⁰ 8/8 1914.
Area: Eur., As., Afr., Am.

In the hot spring at the farm Stóra-Kroppar in the Reykholts valley this species grew together with *Hapalosiphon laminosus.* The diameter of the trichomes was 1.6—2.0 μ, and it agreed on the whole absolutely with the diagnosis in Gomont (l. c.).

S. thermalis is a true thermal alga. In the cases, where I have found statements concerning the temperature at which it grew, the figures varied between 30° and 35°. Nevertheless, it is probable that the variations in the temperature, at which it is able to grow, are considerably greater.

Symploca sp.?

In a sample collected by J. Steenstrup and labelled: "On siliceous sinter, Geyser, Blesi. Temp. 30°," a form occurred which closely resembled *S. thermalis*; but its sheaths coloured a deep violet with chlorzinc-iodine. Therefore it cannot be identified with the former species, and, as the material is so deficient, I dare neither include it in any of the other thin species of *Symploca*.

V. **Plectonema** Thuret.

Plectonema roseolum (Richter) Gom.

Gomont, Monogr. II p. 102, pl. I, figs. 9—10. Wittr. et Nordst. nr. 1159.
P. carneum Lemmermann 1910 p. 206.

E. Icel. Fljótsdalur, rocky wall over which water was trickling $^{30}/_{6}$ 1914. Hreiðarstaðir, on leaves from the bottom of a pond, temp. 12° $^{1}/_{7}$ 1914. Seyðisfjörður. bog at 300 m. height above sea-level; among mosses $^{23}/_{6}$ 1914. — N. Icel. Úlfsbær, pool with shallow water, temp. 20° $^{15}/_{7}$ 1914.

Area: Eur., Alaska.

All the samples, in which I have found this species, have been preserved in alcohol. Therefore it has been impossible for me to ascertain the colour of the trichomes. On the other hand, the dimensions, the apices and the granules at the transverse walls were seen and corresponded exactly with those in a typical *P. roseolum*. But there is a possibility that it has in fact been, in some or perhaps in all cases, *P. notatum* Schmidle (Simmer 1901 p. 84) that was present.

P. roseolum has most frequently been found on the panes of hothouses; but in Alaska it has been found on dripping rocks. The species thus seems to show aërophilous tendencies, and I have found it under similar conditions in Iceland, but also submersed growing on decaying plants sunk to the bottom of small pools of water.

Plectonema nostocorum Bornet.

Gomont, Monogr. II p. 102, pl. I, fig. 11.

E. Icel. Pond near Grimsá. In Aphanothece stagnina, temp. 16° $^{26}/_{6}$ 1914. — N. W. Icel. Dýrafjörður Hariot (1893 p. 315), Belloc (1894 p. 6). Reykjanes, hot spring (60° Hariot (l. c.), Belloc (l. c.).

Area: Eur., As., Am., Austr.

Gomont writes that this species is very common among other algae. Nevertheless it is but known from comparatively few localities (cr. 15).

Probably it is, however, an Ubiquist, but has frequently been overlooked. It grows in the mucilage of other algae, e. g. in *Nostoc, Gloeocapsa* and *Aphanothece.*

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2. VAGINARIEÆ Gomont.

VI. Schizothrix Kützing.

Schizothrix calcicola (Ag.) Gom.
Gomont, Monogr. I p. 307, pl. VIII, figs. 1—3.
Oscillatoria sp. Liebm. 1841 p. 337?
Oscillatoria rufescens Liebm. (manu scriptum in Herb. Mus. Haun.)?

N. Icel. Hrísey, hot spring over 40 ^{0} C. (45 ^{0}?) $^3/_7$ 1898 (H. J.)! — W. Icel. Deildartungahver. At the margin of the outlet, temp. 66 ^{0} $^9/_8$ 1914. — S. Icel. Reykjavík. Laugarne (Stp.)!?
Area: Eur., Afr., As., Am.

It is doubtful whether the specimen from Laugarne at Reykjavik, which is the original of Liebman's short description cited above, really is S. calcicola. The sheaths are not so distinct as they generally are in this species, but rather much diffluent so that it attains a close resemblance to a *Phormidium.*

S. calcicola has generally been met with on walls (frequently in hothouses) and on rocks; but Tilden (1897 p. 194, pl. VIII, fig. 3) found it at the hot springs in Yellowstone Park, and here it was one of the chief algæ contributing to the formation of the remarkable alga-stalactites.

Schizothrix lardacea (Cesati) Gom.
Gomont, Monogr. I p. 311, pl. VIII, figs. 8—9.
Hypheothrix lateritia Rab. Alg. nr. 153.

E. Icel. Hallormstaðir. Rocky chasm in the forest; on mosses and on rock over which water was trickling. $^{29}/_6$ 1914 (2 samples).
Area: Eur., As., Afr., Am., Alaska.

On the above mentioned locality the species extended over rocks and mosses in company with *Tolypothrix tenuis* and *Mesotaenium* sp. The appearance of the thallus did not correspond with that described by Gomont; it was not thick and stratified, but formed layers hardly 1 mm. thick over moss and rocky ground. Still. I consider the determination correct as the description of the threads and the trichomes agree exactly, *S. lardacea* has been found on rocks and walls over which water was trickling, i. e. just under similar conditions as the Icelandic specimen.

Schizothrix arenaria (Berk.) Gom.
Gomont, Monogr. I p. 312, pl. VIII, figs. 11—12.

S. Icel. Geysír, Viti (Stp.) det. Gomont with the remark: Spec. mancum. — E. Icel. Vestdalur at Seyðisfjörður. Rocky wall, forming dark patches $^4/_7$ 1914.
Area: Eur., Afr., Am., Austr., Spitzbergen.

I have examined other samples from Geysir, collected by Steenstrup, and I find, like Gomont, that they resemble *S. arenaria* closely even though the determination is not quite certain. Especially the apex of the trichome does not seem to be so distinctly conical as the one figured in Gomont (l. c.).

S. arenaria is only recorded from a few localities; but they are scattered over the four continents, so that its distribution is undoubtedly very wide. It seems to grow exclusively on earth and rocks.

In the sample from Vestdalur it grew together with *Desmonema Wrangelii* and *Gloeocapsa Magma* var. *Itzigsohnii*.

Schizothrix Friesii (Ag.) Gom.
Gomont, Monogr. I p. 316, pl. IX, figs. 1—2.

E. Icel. Vestdalur at Seyðisfjörður, among mosses on earth $^{4}/_{7}$ 1914. — N. W. Icel. Botn in Geirþjófsfjörður, lake, temp. 10^{0} $^{26}/_{7}$ 1915 (H. J.)! — S. Icel. Laugarvatn. On earth near little hver $^{16}/_{8}$ 1914.
Area: Eur., Afr., Am., Austr., Antarctic continent.

S. Friesii occurs generally on earth, rocks and similar localities, has also been found on trunks (Wille 1914 p. 10). The Icelandic localities are of the same kind excepting the sample from Geirþjöfsfjörður which is recorded from a lake, i. e. in the water. In none of the three samples fasciculi erecti were found, these being thus undeveloped specimens; but the trichomes and the sheaths are so characteristic that the species can be determined on the basis of these alone (cf. Gomont l. c.).

Schizothrix Mülleri Nägeli.
Gomont, Monogr. I p. 321, pl. X, figs. 5—7.

W. Icel. Reykholt, on Moss over the afflux to Snorralaug from Skrifla, cr. 5 cm. over the surface of the water, temp. 42^{0} $^{9}/_{8}$ 1914.
Area: Eur., As., Am., Lappland.

In the specimen to hand of S. Mülleri the diameter of the trichomes was 6—7.5 μ, i. e. somewhat smaller than the typical ones. Furthermore only one trichome is as a rule found in each sheath; it therefore approaches f. *lyngbyoidea* Gom. l. c. and Gomont 1899 p. 27).

The species may be found on earth as well as on stones and rocks, at and in water, and Gomont arrived at the conclusion that the more dry the species grows, the shorter and the more bent do the threads become, whereas these, when it grows in water, become elongated and nearly always contain but one trichome. The Icelandic specimen grew on moss that was, to be true, very moist, but which nevertheless occurred above the surface of the water. This does not seem exactly to confirm Gomont's explanation.

Schizothrix Heufleri Grun.
Gomont, Monogr. I p. 325, pl. XI, figs. 7—8.

E. Icel. Fljótsdalur, rocky wall, forming thin black layers $^{30}/_{6}$ 1914.
Area: Eur.

The species has only been found a few times, viz. originally by Heufler near Kufstein in the Tyrol, and Grunow described it from this specimen. This is the only one which Gomont knows. Almost simultaneously with the appearance of Gomont's Monographie, Hansgirg (Prodromus II p. 92) published a *Lyngbya nigrovaginata* which later was established by A. Forti (in De-Toni Syll. Alg. V p. 365) as being synonymous with S. Heufleri. Hansgirg has found the species in several places in Bohemia. It grew everywhere on more or less moist rocks.

On the Icelandic locality it grew together with *Gloeocapsa alpina*, *Scytonema crustaceum*, *Calothrix parietina* and *Nostoc* sp. and formed together with those thin black crusts which were scraped of the rock only with difficulty.

Schizothrix sp.

In a sample from Sómarstaðir (E. Icel.) 11/6 1894 (H. J.)! I found among *Zygnema*, *Tribonema* and other algæ a *Schizothrix* with quite thin trichomes (ca. 1 μ in diameter) the cells of which were somewhat longer than the diameter. As a rule only one trichome occurred in each sheath, at times, however, 2—3. Chlor-zinc-iodine coloured the sheaths violet, though not a particularly deep violet, and they were often distinctly closed at the apex.

There is a probability that it may be the finest branches of a *Schizothrix lacustris* A. Braun, but I don't, however, feel justified in identifying the alga from Sómarstaðir with this species as it is so incompletely developed. Besides, there exists so many incompletely described Schizothrix species, the identity of which only will be ascertained with great difficulty, if ever, that I do not feel inclined to increase their number by also describing the present form as a new species.

VII. Hydrocoleum Kützing.

Hydrocoleum homoeotrichum Kütz.

Kützing Tab. phyc. I, tab. 50, fig. 1. Gomont, Monogr. I p. 344.

E. Icel. Vallanes, on stones from the margin of Lagarfljót 17/6 1893 and 14/5 1894 (H. J.)!

Area: Eur., Afr., N. Am., Austr.

The present form seems to differ slightly from the typical *Hydrocoleum homoeotrichum* by its rounded calyptra. Also the dimensions of the trichomes are slightly deviating in that their diameter is 4—7 μ. (Fig. 8.)

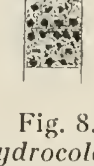

Fig. 8. *Hydrocoleum homoeotrichum* Kütz. forma (×1200)

It occurs as a rule in cold, rapid mountain torrents, often together with *Hydrurus foetidus*. The Icelandic occurrence is in good accordance with the above statement, as Lagarfljót carries the milky water from the inland glaciers and therefore always has a low temp. (8° 26/6 1914).

VIII. Microcoleus Desmazières.

Microcoleus vaginatus Vauch. Gom. var. **monticola** (Kütz.) Gom. Gomont, Monogr. I p. 356.

N. W. Icel. Dyrafjörður, moist places near the shore, $^{30}/_{5}$ 1895 (C. H. O.)!

Area: Ubiquist, Spitzbergen, Alaska.

Concerning the distribution of var. *monticola* hardly anything certain is known; therefore I have given the area of the whole species. It is particularly a terrestrial form, which but rarely has been met with in water. On the Icelandic locality it grew together with *Lyngbya æstuarii* and *Spirulina labyrinthiformis*. The soil has presumably then been somewhat saline.

Microcoleus Steenstrupii Boye P. n. sp.

M. filis 30—65 μ crassis, simplicibus vel parce pseudoramosis; vaginis distinctis hyalinis, vix lamellosis, usque ad 20 μ crassis, chlorozincico jodurato coerulescentibus; trichomatibus intra vaginam plus minusve numerosis, sæpe funiformi-contortis, 3—5 μ crassis, articulis 3—8 μ longis, ad genicula vix constrictis (in sicco); protoplasmate granuloso; cellulis apicalibus usque ad 13 μ longis, obtuse conicis, haud capitatis, sine calyptra. Fig. 9.

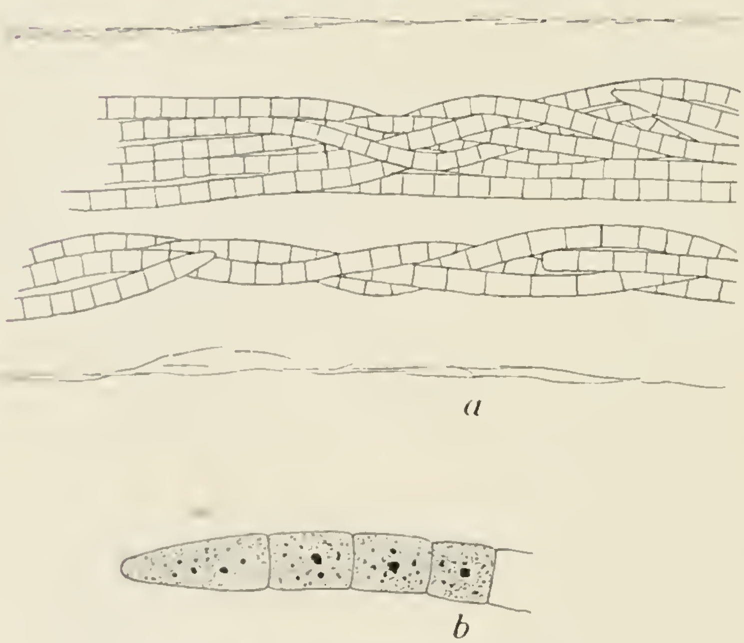

Fig. 9. *Microcoleus Steenstrupii* n. sp.
a. Part of a thread (×600).
b. Apex of a trichome (×1200).

S. Icel. Hot spring at Reikir, on the margin itself, temp. of spring 100°—102° (Stp.)! Laugarnar Reykjavik (Stp.)! Gullfoss, moist earth $^{24}/_{8}$ 1922 (M. L.)!

The present form resembles in certain respects *M. vaginatus*, but is distinguished from it by the absence of calyptra and by the fact that chlor-zinc-iodine colours the sheath intensely violet. It seems to be closer related, however, to *M. lacustris* (Rab.) Farl.; but it differs partly in having an other habitat, in that *M. lacustris* lives in water, whereas *M. Steenstrupii* grows on land, partly in several morphological features, especially (1) the cells being shorter in *M. Steenstrupii* and (2) chlor-zinc-iodine colouring the sheath beautifully violet which is not the case in *M. lacustris*. This is stated by Gomont in his Monogr. I p. 359, and I have examined the sample in Phycotheca Boreali-Americana nr. 307 myself and arrived at the same conclusion.

M. Steenstrupii is distinguished from *M. subtorulosus* (Bréb.) Gom. by (1) thinner trichomes, (2) cells longer than the diameter, (3) distinct, not diffluent sheaths, and (4) the apical cell being apparently of a much more pronounced conical form judging from the figures in Gomont.

M. Steenstrupii grew at Reykir together with *Scytonema mirabile*, *Phormidium Treleasei* as well as *Stigonema* sp. on stratified silicious sinter.

In the sample from Laugarne at Reykjavík it occurred, inter alia, in company with *Bryum argenteum*. In this sample the chlor-zinc-iodine reaction took effect more slowly and did not at all attain such a rich colouration as in the sample from Reykir.

At Gullfoss it grew on earth among *Collema* sp. in places moistened by the fine spray from the waterfall.

In spite of the fact that this species in two places has been found at hot springs it is hardly a true thermal alga, for in that case it would presumably not have been able to thrive at Gullfoss. It is rather the constant supply of moisture — at the hot springs in the form of vapour, at the waterfall in the form of the fine spray — which conditions its vigorous growth.

II. NOSTOCACEÆ.

I. **Nostoc** Vaucher.

The determination of the *Nostoc* species often offers great difficulties, nay, is frequently impossible to undertake. A safe determination is especially conditioned upon the presence of spores; but these are in the majority of species of rare occurrence. In a great number of samples I have therefore found *Nostoc* thalli which were impossible to determine. Some uncertainty has even been unavoidable in the following determinations.

Nostoc carneum Ag.
Bornet et Flahault, Revision IV p. 196.

S. Icel. Ýtri Skógar $^{21}/_{7}$ 1901 (H. J.)! Drangshlið $^{20}/_{7}$ 1901 (H. J.)! Gljúfurholtsá on stones, light current, temp. 15° $^{17}/_{8}$ 1914. — E. Icel. Stöð $^{12}/_{8}$ 1894 (H. J.)!
Area: Eur., Afr., Am., Færöes, Alaska.

According to literature it has most frequently been found in stagnant water, attached as well as free-floating. In a single case it is recorded as growing on dripping rocks.

Nostoc muscorum Ag.
Bornet et Flahault, Revision IV p. 200.

W. Icel. Hveravellir, temp. 55° C. West (1902 p. 244).
Area: Eur., As., Afr., Am., Alaska.

Grows generally on earth and among or on Mosses. B. Muriel Bristol (1919 p. 99) found it alive in a soil-sample from 1846. It has thus been capable of withstanding 73 years torpor. Is undoubtedly a chance guest in the hot spring.

Nostoc humifusum Carmichael.
Bornet et Flahault, Revision IV p. 201.

S. Icel. Laugarvas? (=Laugarnar at Reykjavik?); near the margin of the northern spring, temp. 100 C. (Stp.)! — N. W. Icel. Reykjanes in Isafjarðardjúp, hot spring (60°) Hariot (1893 p. 315), Belloc (1894 p. 6).
Area: Eur., Afr., Am., Spitzbergen.

This species is but rarely recorded in literature, and its distribution is undoubtedly known to a slight extent only. Most frequently met with on earth, but also at times in water. In Iceland it was both times found at the hot springs. The fact that it thrives well here may perhaps be ascribed to the heated ground and the moisture from the vapour. Otherwise it is undoubtedly not a thermal alga.

Nostoc commune Vaucher.
Bornet et Flahault, Revision IV p. 203.

E. Icel. Ekkjufell. Fissure in a rock with trickling water $^{2}/_{7}$ 1914. Fljótsdalur, rocky wall over which water was trickling, among mosses $^{30}/_{6}$ 1914. Hangar 1894 (H. J.)! — N. Icel. Glerárfos (Akureyri), on rocks dashed with water $^{12}/_{7}$ 1914. — S. Icel. Ytri Skógar $^{21}/_{7}$ 1901 (H. J.)! Krókur $^{4}/_{7}$ 1901 (H. J.)! Grimstaðir, on mud in a "Floi", $^{30}/_{7}$ 1905 (H. J.)!
Area: Ubiquist.
It is a pronounced terrestrial and petrophilous species which but as a rare exception is met with in water. It belongs to the most common species in arctic regions (Borge 1899 p. 765).

Nostoc sphæricum Vaucher.
Bornet et Flahault, Revision IV p. 208.

W. Icel. Hvalfjörður; stream at Litlisandur; on stones, temp. 13° $^{6}/_{8}$ 1914. — S. Icel. Holmsá; on stones, temp. 14° $^{14}/_{8}$ 1914. Kambar; on stones in stream, temp. 14° $^{18}/_{8}$ 1914. Gljúfurholtsá near Kotströnd; slight current, temp. 15° $^{17}/_{8}$ 1914. Varmá at Reykir in Ölfús, temp. 17° $^{18}/_{8}$ 1914. ? Hófsfjall. $^{21}/_{9}$ 1897 (Ó. D.)! Fossarnir in Hófsa $^{12}/_{6}$ 1898 (Ó. D.)!
Area: Eur., Afr., Am., Austr., Antarctic, Alaska, Greenland.

To the present species I have referred a number of samples containing spherical, solid *Nostoc*-colonies, 1—5 mm. in diameter, trichomes 4—6 μ in diameter, and heterocysts 6—7 μ in diameter. In no case did I observe spores. Hence it is just possible that some of the specimens mentioned above may in fact represent developmental stages of other Nostoc-species.

Nostoc sphæricum has most frequently been found in still water; but it also occurs on land and has been found on trunks, on soil and on damp rocks. On the majority of the Icelandic localities mentioned above it grew in running water, in some cases even in streams with rather rapid current.

Nostoc pruniforme Ag.
Bornet et Flahault, Revision IV p. 215.

N. Icel. Mývatn, Ostenfeld and Wesenberg-Lund (1906 p. 1140) (Nostoc sp., presumably N. pruniforme.). — N. W. Icel. Lake between Brjánslækur and Hagi $^{15}/_{7}$ 1915 (H. J.)! — W. Icel. Hveravellir, temp. 49° C. West (1902 p. 244). — S. Icel. Apavatn, washed ashore, spherical colonies up to 3 cm. in diam. $^{16}/_{8}$ 1914. Laugarvatn, washed ashore, smaller thalli $^{16}/_{8}$ 1914. Ditch at Eyðistjörn near Reykjavíkur $^{20}/_{6}$ 1896 (C. H. O.)! ? Kappastaðavatn in Sljettuhlið $^{12}/_{8}$ 1897 (Ó. D.)!
Area: Eur., As., Afr., Am., Antarctic, Færöes.

In the sample from Apavatn trichomes, 6—8 μ in diameter with heterocysts 10 μ in diam., were found in some of the thalli. To establish a new species or variety on account of this seems hardly necessary. The form from Hveravellir recorded by West is perhaps not a *Nostoc pruniforme* at all. West himself denominates it as a var., and neither its thallus nor its habitat agree by any means with those typical of the species which generally occurs in larger lakes free-floating or lying on the bottom.

Nostoc verrucosum (L.) Vaucher.
Bornet et Flahault, Revision IV p. 216.

S. Icel. Varmá at Reykir in Ölfus, temp. 17° $^{18}/_{8}$ 1914 (2 samples).
Area: Ubiquist.

Apparently always occurring in streams with rapid current. This also applies to the Icelandic locality.

II. **Anabæna** Bory.

The genus *Anabæna* is as a rule but sparingly represented in the floras from arctic and subarctic countries published up to the present. Of the plankton-forms *A. flos-aquæ* is almost the only one mentioned, and of the benthos species but a few are recorded. Bachmann (1921 p. 14), however, has in Greenland found 7 species, four of these being plankton-forms. This seems to indicate that in fact a greater number of species occur in these regions than can be seen from the literature. The reason why these species are not recorded in the lists of the species is probable that specimens with well-developed spores are of comparatively rare occurrence, and in their absence any determination is out of the question.

On basis of dried material it is often very difficult to obtain a distinct impression of the appearance of the *Anabæna* species; in alcohol material, on the other hand, the structure of the cells generally stands out beautifully. All the *Anabæna* species mentioned in the following are found in samples preserved in alcohol or formalin. In the dried samples I have often met with *Anabæna*-threads; but I have not succeeded in determining them.

Anabæna variabilis Kütz.
Bornet et Flahault, Revision IV p. 226.
A. oscillarioides Wittr. et Nordst. Alg. exsicc. nr. 196.

S. Icel. Reykholt $^{13}/_{7}$ 1897 (H. J.)! Thingvallavatn, erratic in plankton (Ostenf. et Wesenb.-L. 1906 p. 1107). Mentioned by E. Belloc 1894.
Area: All continents, Greenland, Færöes.

As to the habitat of this species the Icelandic occurrences do not offer much information. In the literature it is stated to have been found under highly varying conditions, in pure fresh water as well as in brackish water, moreover in hot springs (temp. 32°—42° C. Bohlin 1901 p. 75) and finally in earth from various regions of the world at a depth of until 30 cm. (Esmarch 1914 p. 270, Bristol 1920 p. 62).

Anabæna flos-aquæ (Lyngb.) Bréb.
Bornet et Flahault, Revision IV p. 228. Lemmermann, Kryptogamenflora d. Mark Brandenburg III p. 185.

N. Icel. Mývatn, plankton; "water-bloom" $^{17}/_{7}$ 1914, temp. 17°. $^{19}/_{7}$ 1914 temp. 16°. Grímstaðir at Mývatn, pond, plankton $^{20}/_{7}$ 1914, temp. 18°. Slútnes in Mývatn, pond, plankton $^{20}/_{7}$ 1914. Geiteyjarströnd at Mývatn, pond, plankton $^{18}/_{7}$ 1914, temp. 18°.
Area: Eur., As., Afr., Am., Greenland, Antarctic.

A. flos-aquæ and *A. Lemmermanni* Richt. are very closely related, in fact so closely related that I doubt whether they actually can be distinguished from each other. The form, which occurred in Mývatn and in several of the smaller ponds in its vicinity, was in the main *A. flos-aquæ*, although it is impossible for me to say whether *A. Lemmermanni* may also have been present. As the main difference between the two species Lemmermann (1910 p. 177) mentions the occurrence of the spores in series or in ones at the side of the heterocysts. On the present material, however, this feature is difficult to observe as the mass of spores is very dense. Should an attempt be made to separate the trichomes by a pressure on the cover glass, they go as a rule quite to pieces, and we do not succeed in this manner either to see the arrangement of the spores in the trichomes. However, in a number of cases I have seen the spores distinctly in ones at the side of the heterocysts, and I therefore refer the species in question to *A. flos-aquæ*.

When Ostenfeld and Wesenberg-Lund in 1903—04 had plankton collected every fortnight in Mývatn, this species was not found in the lake which on the whole proved to be destitute of phyto-plankton (Ostenf. and W.-L. 1906 p. 1143). When I visited the lake in 1914, it sprang, on the other hand, a great surprise upon me in the form of a rather extensive "water-bloom" formation of *Anabæna flos-aquæ*. In the plankton samples this species prevailed almost exclusively, excepting a small number of Rotiferæ (Anuræa).

There are now two conceivable ways of explaining this strange discrepancy. Wesenberg-Lund opines that all living beings in the lake were killed at the eruption in 1729, and that the present fauna and flora must have immigrated since that time. It is then conceivable that new forms are still immigrating and finding good conditions, and that the Anabæna thus has arrived some time in the period between 1904 and 1914.

The other explanation, which also has some probability, concerns the temperature. Ostenfeld and Wesenberg-Lund (1906 p. 1141) give the following statements regarding the temperature of the lake: ice-bound until May 28.

July	15,	$12^1/_2{}^0$ C.	(highest temp.).
Aug.	1,	$12^1/_2{}^0$ —	—
—	15,	8^0 C.	—
Sept.	18,	6^0 —	—

In July 1914 I measured 16^0—17^0 C. at various places in the lake. The measurements were undertaken from a boat out on the lake, and they can thus hardly have been influenced by hot springs (Ostf. and W.-L., 1906 p. 1142). This summer temperature, which undoubtedly is exceptionally high for Mývatn, may perhaps also serve as an explanation of the occurrence of the *Anabæna*, at any rate it is certainly the cause of the "water-bloom" formation. It is not improbable, that the Anabæna spores, in case the temperature does not rise to a certain degree, may remain through a series of years without germinating in order to awaken to new growth during an exceptionally warm summer (cf. Bristol 1919 p. 29 ff.). Wesenberg-Lund mentions 16—18^0 C. as the most favourable to the development of the species, and a similar statement (14,5—18^0 C.) exists from Finland (Wahlberg 1913 p. 29). As seen above, the temperature in Mývatn did not in 1904 reach the optimum temperature of the species as it did in 1914. Unfortunately the lowest temperature, at which the spores may germinate, is unknown; but it is not improbable that the low summer temperature in 1904 may have been the cause of the non-appearance of the Anabæna that year. During the summer 1922 Poul Larsen visited Mývatn and observed great quantities of Anabæna in the water. The summer 1922 was not particularly warm; it is to be regretted that he did not measure the temp. of the water.

Anabæna flos-aquæ is a pronounced plankton-form thriving by preference in fresh water, but it may also occur in brackish water. It has been found in lake- as well as river-plankton.

Anabæna inæqualis (Kütz.) Born. et Flah.
Bornet et Flahault, Revision IV p. 231. Lemmermann 1910 p. 181.

S. Icel. Þingvellir, pool, temp. 4^0 $^{15}/_8$ 1914. Geitaberg, pool, temp. 16^0 $^7/_8$ 1914. — E. Icel. Arnkilsgerði $^{22}/_6$ 1894 (H. J.)!
Area: Eur., Afr., N. Am., Austr.

This species, which generally is found epiphytic on other algae, especially larger Chlorophyceæ, sometimes in stagnant water, at other times in but slowly moved water, occurs in a similar way in Iceland. B. Muriel Bristol (1920 p. 62) has found it as a common occurrence in samples of cultivated soil from England.

Anabæna Poulseniana Boye P. n. sp.

A. strato gelatinoso, ad lapides submersos expanso, vel elongato-cylindrico, vel libere natante; vaginis sæpe conspicuis; trichomatibus rectis vel leviter curvatis; articulis sphæricis vel doliiformibus, 4—4.5 μ crassis et longis vel paulo longioribus, cellula apicali obtuse conica; heterocystis cylindricis, 5—5.2 μ crassis, 11—17.6 μ longis; sporis cylindricis, apicibus rotundato-truncatis, 6.4—7.4 μ crassis, 15—44 μ longis, sæpe 2—4 seriatis, ab heterocystis plerumque remotis; episporio lævi in sporis maturis pallidissime fuligineo.

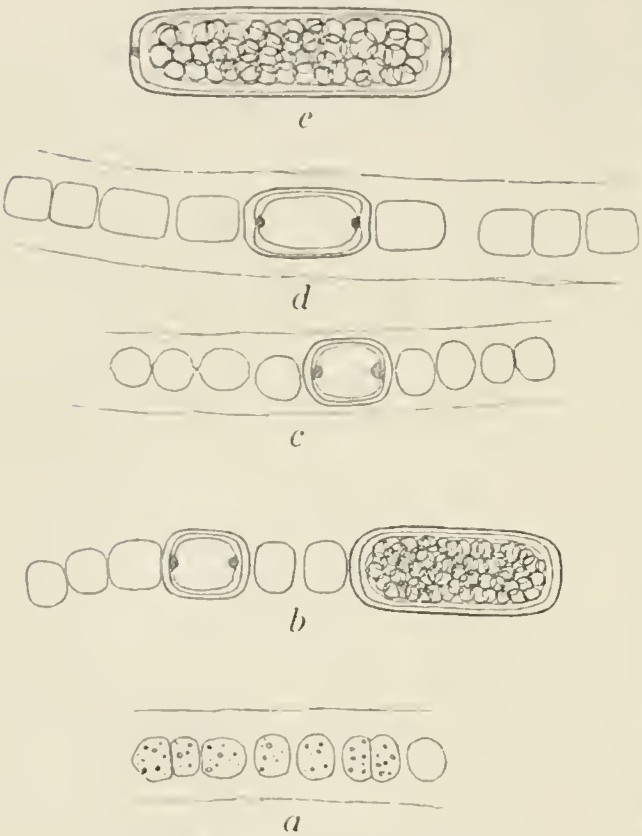

Fig. 10. *Anabæna Poulseniana* n. sp. (×1200).

E. Icel. Mývatn, on stones (1—4 ft. water) and washed ashore, temp. 16° 17—19/7 1914. Mývatn, on Cladophora, washed ashore 17/7 1914. Skútustaðir, small pool of water, into which a spring flows, temp. 7° 17/7 1914.

On the last mentioned locality projected from the bottom of the pool straggling wisps rounded at the top, supported by an air-bubble. These tufts were composed of *Cyanophyceæ*, especially *Anabæna Poulseniana*, *Oscillatoria limosa* and *sancta*, *Tolypothrix* sp. as well as numerous *Diatomeæ*.

Anabæna Poulseniana belongs to sect. II *Dolichospermum* (Born. et Flah., Rev. IV p. 225) and approaches especially to *A. laxa* A. Br. and *A. inæqualis* (Kütz.) Born. et Flah. However, it differs distinctly from both these species which can easily be seen from the diagnosis. The leading characteristic of *A. laxa* is the almost identical thickness of its vegetative cells, heterocysts and spores. The same applies to *A. laxa* var. *hortensis* Playfair (1918 p. 505) which is especially characterized by its elongated, cylindrical heterocysts and long spores. But as there is, in fact, a great difference in diameter between the vegetative cells and the spores of *A. Poulseniana*, I do not consider it to be identical with any variety of *A. laxa*. During the later years a number of *Anabæna* species, all of which belong to the same affinity, have been established. Of these I shall mention: *A. augstumalis* Schmidle (Hedwigia 1899 p. 174), *A. oblonga* De Wildeman (Ann. du Jard. bot. de Buitenzorg Suppl. I, 1897 p. 50), *A. Hieronymusii* Lemm. (1910 p. 182).

The mode of growth of *A. subcylindrica* Borge (1921 p. 12) corresponds almost exactly to *A. Poulseniana*, but the former species belongs to Sect. *Sphærozyga*.

I have named this species after the late Professor, Dr. phil. V. A

Poulsen who always showed great interest in my work on the Icelandic Algæ.

Anabæna catenula (Kütz.) Born. et Flah.

Bornet et Flahault, Revision IV p. 232. Wittr. et Nordst. Algae exsicc. nr. 197.

E. Icel. Hallormstaðir, pool, temp. 11 ^{0} $^{28}/_{6}$ 1914. Fljótsdalur; rocky wall over which water was trickling, facing south-east $^{30}/_{6}$ 1914. — N. Icel. Akureyri. Stream, on moss $^{12}/_{7}$ 1914.

Area: Eur., N. Am., S. Afr., Alaska.

According to Fritsch and Rich (1913 p. 81) this species is a pronounced summer-form in England which might suggest that it requires a rather high temperature or perhaps an intense illumination in order to thrive well.

In Wittr. et Nordstedt's sample, cited by Bornet et Flahault (l. c.) I found ripe spores 44 μ in length, whereas the maximum according to the specific diagnosis is 30 μ in length. The Icelandic specimens, however, were but possessed of spores 26 μ in length at their maximum.

Anabæna catenula is an attached species which generally is found among other plants in stagnant or slowly running water. Its occurrence on a dripping rock seems uncommon.

Anabæna Jonssoni Boye P. n. sp.

A. filis solitariis ad alias algas crescentibus, sæpe evaginatis vel arcte vaginatis, vaginis ægre conspicuis, circa heterocystas sæpe distinctis, hyalinis; trichomatibus 2—2.5 μ crassis, rectis vel curvatis, articulis brevicylindicis vel sphærico-depressis, 1 – 3 μ longis, cellula apicali rotundata; cellulis contentu granuloso sine pseudovacuolis (»vacuolis aërogeniis«) farctis; heterocystis hexagonalibus, 2—2.5 μ crassis, usque 4 μ longis; sporis ab heterocystis remotis, solitariis, cylindricis, apicibus rotundato-truncatis, circiter 3—5 μ crassis, usque ad 15 μ longis, episporio lævi, hyalino.

N. W. Icel. Lake. Botn in Geirþjófsfjörður (H. J.)! $^{26}/_{7}$ 1915 temp. 10 ^{0}.

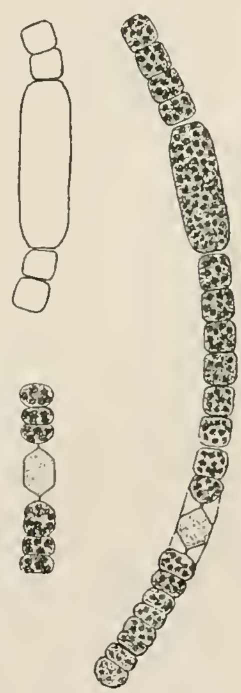

Fig. 11. *Anabæna Jonssoni* n. sp. (×1200).

This species, which I name after the collector, is closely related to *A. catenula* (Kütz.) Born. et Flah. and *A. minutissima* Lemm.; but I feel nevertheless justified in establishing it as a new species as it is sufficiently deviating from the latter species. It is specially distinguished by the form of the vegetative cells and the heterocysts, whereas it bears close resemblance to *A. minutissima* Lemm. in the dimensions. Finally, I draw attention to the fact that the sample, in which it occurred, was preserved in formalin.

Anabæna verrucosa Boye P. n. sp.

A. trichomatibus rectis, vaginis sæpe conspicuis, arctis, hyalinis; articulis cylindricis, ad genicula constrictis, 3—4 μ latis, 4—8 μ longis; cellula apicali rotundata; heterocystis cylindricis, apicibus rotundatis, cellulis vegetativis æquilatis, 3—4 μ latis, 5—8 μ longis; sporis cylindricis solitariis vel geminis, apicibus rotundato-truncatis, 6—7 μ latis, 12—15 μ longis; episporio sæpissime verrucoso, fusco-luteo.

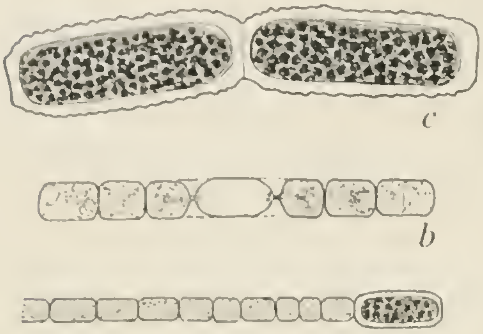

Fig. 12. *Anabæna verrucosa* n. sp.
a. Trichome with a spore (×600).
b. — — heterocyst (×1200).
c. Two spores (×1200).

N. Icel. Squeezed out of *Sphagnum* at the margin of Mývatn near Geiteyjarströnd; react. acid. $^{17}/_{7}$ 1914.

This species is specially characterized by the diameter of the heterocysts corresponding exactly to that of the vegetative cells in that it looks as if the whole trichome is firmly encased by a close, cylindrical sheath which, however, is not always distinctly visible. The spores, on the other hand, are almost twice as thick as the trichome. They have often a minutely papillose membrane; but I have seen them quite smooth in a few cases. According to my opinion it is most closely related to *A. Felisii* (Men.) Born. et Flah.

Finally it should be remarked that the sample, in which it occurred, was preserved in formalin.

Anabæna oscillarioides Bory.

Bornet et Flahault, Revision IV p. 233. Lemmermann 1910 p. 189.

E. Icel. Dripping rocks, Fljótsdalur $^{30}/_{6}$ 1914. "Dý" near Egilsstaðir, temp. 4° $^{25}/_{6}$ 1914. Spring near Hallormstaðir, temp. 8° $^{28}/_{6}$ 1914. Stream in the Hallormstaðir forest, temp. 20° $^{28}/_{6}$ 1914. Lake ibid., $^{28}/_{6}$ 1914. Stöð $^{12}/_{8}$ 1894 (H. J.)! — N. Icel. Washed ashore on an island in Mývatn off Skútustaðir $^{17}/_{7}$ 1914. — N. W. Icel. Pool near Isafjörður, temp. 12° $^{31}/_{7}$ 1914. — S. Icel. Gljúfurholtsá near Kotströnd, temp. 15° $^{17}/_{8}$ 1914. Varmá near Reykjafos, temp. 18° $^{18}/_{8}$ 1914. Pool at Þingvellir, temp. 4° $^{15}/_{8}$ 1914.

Var. *tenuis* Lemm. 1910 p. 189.

E. Icel. Rocky wall over which water was trickling, Fljótsdalur $^{30}/_{6}$ 1914. Ekkjufell $^{2}/_{7}$ 1914. Lake in the Hallormstaðir forest, temp. 20° $^{29}/_{6}$ 1914. Branch of Lagarfljót $^{26}/_{6}$ 1914. — N. Icel. Spring near Halldorstaðir at Laxá, temp. 9° $^{21}/_{7}$ 1914.

Area: All continents, Antarctic, Lappland, (Borge: var. *stenospora*).

As far as its distribution is concerned *A. oscillarioides* must be designated an Ubiquist. However, it is strange that it has been recorded but once from a subarctic region. In Iceland I have found it on highly varied habitats in running as well as in stagnant water, in water permanently rather warm (Varmá 18° C.) as well as in permanently cold water ("Dý"). Further it occurred as a semi-aërobiotic form on dripping rocks.

In the literature smaller pools with stagnant water are recorded as its usual habitat; however, it is also recorded from rivers and thermæ even. As to more remarkable occurrences it should be mentioned that it was found by Esmarch (1914 p. 271) in various earth-samples, and by Bristol (1919) alive in more than 60 years old earth-samples. Hodgetts (1922 p. 20) arrived at the conclusion that *A. oscillarioides* is a typical summer-form and is apparently of the opinion that its vigorous development is due to the high summer-temperature. Some of his own observations (p. 21), however, seem to indicate that it may just as well be due to the greater intensity of the light during the summer. My own observations from Iceland mentioned above seem to point in the same direction in that, according to them, the development of the species is apparently but slightly dependent upon the temperature of the water.

Anabæna torulosa Lagerheim.
Bornet et Flahault, Revision IV p. 236. Ostenfeld 1899 p. 241.

S. Icel. Krísuvík. Outlet from the solfataras $^{15}/_{6}$ 1896 (C. H. O.)!
The specimen has been determined by Johs. Schmidt. I have re-examined it, but I have not been able to ascertain the correctness of the determination with certainty.
Area: Eur., S. Afr., Am.

As the species lives by preference in brackish water the Icelandic locality is slightly peculiar. The water in the outlet from solfataras is usually highly acid. Moreover, the species has been found by Esmarch (1914 p. 270) in numerous earth-samples from Germany, even from at a depth of 50 cm.

III. Nodularia Mertens.

Nodularia Harveyana (Thwaites) Thur.
Bornet et Flahault, Revision IV p. 243. Bornet et Thuret, Notes algologiques II p. 122, tab. 29, figs. 14—16.

E. Icel. Hvalnes. Mucilaginous masses; spring, nearly at highest high-water mark $^{11}/_{8}$ 1894 (H. J.)! — S. Icel. Knararnes $^{2}/_{8}$ 1905 (H. J.)! Einarsnes $^{16}/_{8}$ 1905 (H. J.)!
Area: Eur., As., Afr., Am.

The Icelandic localities are probably all situated close to the sea, at places where the salt water presumably is able to assert itself. The species has repeatedly been found on similar localities in other countries, but it also occurs in pure fresh water and finally as a more or less aërophilous alga on bark of trees and in earth. Esmarch (1911 p. 69), e. g., found it in samples of cultivated soil from S. W. Africa, and B. Muriel Bristol (1919 p. 97) in dried, up to 70 year's old earth-samples. Its spores thus seem capable of retaining their power of germination for a very long time.

Nodularia spumigena Mert.
Bornet et Flahault, Revision IV p. 245.

S. Icel. Einarsnes $^{16}/_{8}$ 1905 (H. J.)!
Area: All continents, Antarctic.

Is mainly a marine- and brackish-water form; but it has, however, been found in pure fresh water at several places. The Icelandic sample originates undoubtedly from the shore or adjacent regions.

IV. Cylindrospermum Kützing.

Cylindrospermum muscicola Kütz.

Bornet et Flahault, Revision IV p. 254. Rabenhorst Algen nr. 93.

N. Icel. Hot stream in Námuskarð, water alkaline, temp. 35 ^{0} $^{18}/_{7}$ 1914. On the margin of an outlet (temp. 54 ^{0}) from Uxahver $^{22}/_{7}$ 1914. S. Icel. Laugarnar at Reykjavík (Stp.)!

Area: Eur., As., Afr., Am.

The species of *Cylindrospermum* do not seem capable of thriving in arctic and antarctic regions to any great extent. The species in question grows as a rule on earth, but has also been met with in water, however, and even in brackish water (West 1909 I p. 242). That I have found it in Iceland at and in hot springs is undoubtedly not due to its being a true thermal alga, but simply due to the fact that it cannot grow in the country except in places where the hot springs cause a higher temperature all the year round. Therefore it may presumably be included in that group of southern species which in Iceland are met with but at the hot springs (Ostenfeld 1899 p. 243).

III. SCYTONEMATACEÆ.

I. Scytonema Agardh.

Scytonema varium Kütz.

Bornet et Flahault, Revision III p. 97.

S. chrysochlorum Kütz. Species Algarum p. 305; Tab. phyc. II, tab. 19, fig. II.

S. Icel. Laugarvatn; outlet from hot spring $^{16}/_{8}$ 1914.

Area: Eur., As., Am., Austr., Alaska.

The outlet from the hot spring at Laugarvatn formed a kind of delta before it flowed out in the lake of the same name. Right in the middle of this delta, half in water and half out of it, the alga in question grew and formed cushions about 1 cm. thick and up to 5 cm. in diameter. The temperature of the outlet was 72 ^{0} C.: but in the algal cushions the temp. was but about 21 ^{0} C. These cushions proved later to consist of a *Scytonema* with thin, colourless, somewhat gelatinous sheaths that, when dried, were not capable of retaining the form of the threads, shrinking consequently to a great extent. After having been soaked out in lactic acid they resumed their original form. The branching was scanty; sometimes two branches were seen issuing side by side, at other times a solitary branch appeared. The threads were 9—11 μ in diam., the trichomes 6.6—8 μ in diameter. The transverse walls of the cells were often scarcely distinct. Cells one-half to twice as long as broad. Cell contents granular. The cells were sometimes cylindrical, at times somewhat barrel-shaped. Heterocysts 10—11 μ in diameter, 22—39.6 μ in length. The colour of the plant mass (when dried) was macroscopically seen blue-green corresponding to codex nr. 352.

On the assumption that *Sc. varium* Kütz. is synonymous with *Sc. chrysochlorum* Kütz., which Bornet et Flahault have proved through their examination of authentic specimens, I now identify the plant in question with *Sc. varium* Kütz. It bears namely a specially close resemblance to Kützing's figure of *Sc. chrysochlorum* in Tab. phyc. l. c. On the other hand, it does not seem to me that his figure of *Sc. varium* represents an absolutely good resemblance. The Icelandic alga is also, with regard to habitat, in accordance with *Sc. chrysochlorum* which has been found at Euganeæ, undoubtedly at the hot springs. Strangely enough do neither Bornet et Flahault nor De-Toni (Sylloge Alg. V p. 513) record this locality. *Sc. samoense* Wille (1913 p. 145; 1914 p. 11, tab. I, figs. 15—18) is probably also related to this species.

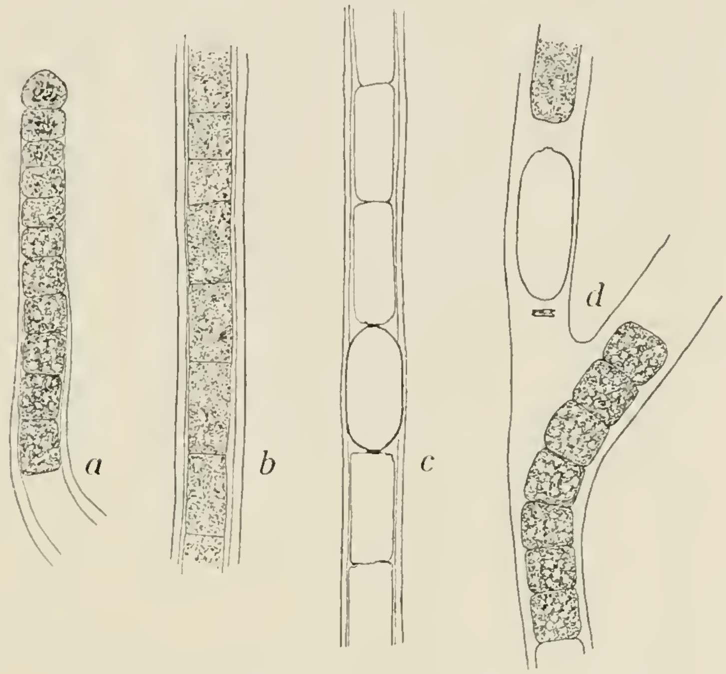

Fig. 13. *Scytonema varium* Kütz. (×600).

Scytonema tolypotrichoides Kütz.

Bornet et Flahault, Revision III p. 100. Wittr. et Nordst. Alg. exsicc., nr. 768.

E. Icel. Seyðisfjörður, bog at 300 m., moss with algæ 23/6 1914. — S. Icel. Grímstaðir, mud from "Floi". 30/7 1905 (H. J.)!

Area: Eur., Afr., N. Am.

This species, which has been found but rarely, thrives best in water, floating free. According to Allorge (1921 p. 621) it is characteristic of the water in Sphagnum-bogs which is but poor in mineral. On one of the Icelandic localities it was found under such conditions that it is permissible to conclude that it will dry up during the summer.

Scytonema mirabile (Dillw.) Bornet.

S. figuratum Bornet et Flahault, Revision III p. 101.

S. Chthonoplastes Liebm. Fl. dan., tab. 2398.2. Liebm. 1841 p. 339; Born. et Flah., Rev. III p. 111.

S. chrysochlorum Rab. Algen, nr. 1096.

E. Icel. Fljótsdalur, on rock with running water 30/6 1914. — S. Icel. "Laugarvas"? leg. Stp.! near margin of northern spring, temp. = 100° C. Reykir, temp. of spring, 100—102° (Stp.!

Area: All continents, Lappland, Færöes, Alaska.

In Museum Botanicum Hauniense a specimen exists (collected by Steenstrup on the label of which is written: "Reikum. Temp. of spring 100°—102°? Coriaceous stratified Oscillatorium-felt from the margin". On the outside of the capsule is written in Liebman's hand: "*Scytonema Chthonoplastes* Liebm." with a short diagnosis which in the main agrees with that in Flora danica (l. c.) and in Liebman 1841. An examination of the sample proved that it actually was a Scytonema the threads of which were 9—22 μ in diameter, measured on the same thread. When young, the sheaths are thin, colourless, later they become brown, and the layers are scarcely diverging. There can then be little doubt that (1) we here have to do with the original specimen of *S. Chthonoplastes* Liebm. and that (2) this species is identical with *S. mirabile* (Dillw.) Born.

This species has generally been found on moist rocks and on moss, but rarely in water. Steenstrup found it in South Iceland on two localities at hot springs. That this species thrives well here is presumably due to the fact that the earth around the hot springs is kept regularly moist by the vapour. For the rest, no statements exist as to whether it thrives particularly well at higher temperatures.

Scytonema myochrous (Dillw.) Ag.

Bornet et Flahault, Revision III p. 104.

S. gracile Rabenhorst Algen, nr. 977.

E. Icel. Fljótsdalur. Rocky walls over which water was trickling 30/6 1914 (4 samples).

Area: All continents, Spitsbergen, Greenland, Alaska.

The species is often found on localities corresponding to the Icelandic ones; but it is also found in lakes forming felted coatings over the stones (Baumann 1911 p. 58), and detached pieces of such coatings may sometimes form *Ægagropila*-formations (Ljungqvist 1915 p. 1). E. Bachmann (1915 p. 51) refers to the species as calcivorous when living on limestone. On the other hand, if it grows in water it seems to be incrusted with lime (Le Roux 1907 p. 346).

In the Fljótsdalur it occurred on several perpendicular surfaces of rocks forming a thick, almost black coating, often of great extent. In some places an abundance of water streamed down over the growths, others remained rather dry. During the summer they are undoubtedly often liable to suffer from a considerable drought as the walls of the rocks faced south-east, i. e. might be heated by the sun to a high degree.

Scytonema crustaceum Ag.

Bornet et Flahault, Revision p. 106.

E. Icel. Fljótsdalur, black, thin coatings on the rocky wall 30/6 1914.

Area: Eur., As., Am., Lappland.

Together with *Calothrix parietina*, *Gloeocapsa alpina*, *Schizothrix Heufleri* it formed thin, black coatings which but with difficulty were scraped off the stone. The rocks were here but slightly damp. It has generally been found under similar conditions. It is recorded as calcivorous by E. Bachmann (1915 p. 51).

II. **Tolypothrix** Kützing.

Tolypothrix distorta (Fl. dan.) Kütz.

Bornet et Flahault, Revision III p. 119. Kützing, Tab. phyc. II, tab. 33, fig. V.

E. Icel. Arnkelsgerði $^{23}/_{6}$ 1894 (H. J.)! — N. Icel. Skútustaðir, small pool into which a spring flows out, temp. 7° $^{17}/_{7}$ 1914.

Area: All continents, Lappland, Alaska.

In the sample from Arnkelsgerði *T. distorta* occurred in company with *Zygnema* sp. and *Tribonema* sp. Presumably it has then grown in rather quiet water as is the habit of the species. For the rest, it is hardly possible to distinguish *T. distorta* from *T. penicillata* (Ag.) Thuret, as already pointed out by Lemmermann (1910 p. 23 and 218).

Tolypothrix tenuis (Kütz.) Johs. Schmidt emend.

Johs. Schmidt, Botanisk Tidsskr. vol. 22 p. 383. Bornet et Flahault, Revision III p. 122.

T. lanata ibidem p. 120.

E. Icel. Seyðisfjörður $^{29}/_{6}$ 1893 (H. J.)! Hallormstaðir, at the margin of a forest lake, temp. 20° $^{29}/_{6}$ 1914. Hallormstaðir $^{24}/_{7}$ 1893 (H. J.)! Pond near Álftatjörn, on decaying plants from the bottom $^{2}/_{7}$ 1914. Hreiðarstaðir, on leaves from the bottom of a pond, temp. 12° $^{1}/_{7}$ 1914. — N. Icel. Halldorstaðir at Laxá, in spring, temp. 9° $^{21}/_{7}$ 1914. Húsavik, lake; the algæ at the margin partly lying loose, partly attached on plants in a small cove, temp. 12° $^{26}/_{7}$ 1914. Grímstaðir, in pond on decaying plants $^{20}/_{7}$ 1914. — N. W. Icel. Reykjanes, hot spring (Isafjarðardjúp) Dýrafjörður, Hariot 1893 p. 315, Belloc 1894 p. 6. Brekkudal in Dýrafjörður $^{29}/_{6}$ 1896 (C. H. O.)! — W. Icel. Glammastaðavatn, on stones at the shore, temp. 15° $^{7}/_{8}$ 1914. Mödruvellir, eyjatjörn, plankton net dragged through plant growth, temp. 15° $^{7}/_{8}$ 1914. — S. Icel. Varmá in Ölfús at Reykir, temp. 17° $^{18}/_{8}$ 1914. (4 samples). Miðhús (Torfavatn), in small bays at the lake-margin, floating as small balls at the water's edge $^{7}/_{8}$ 1905 (H. J.)!

Area: Cosmopolite, Antarctic, Lappland, Novaya Zemlya, Færöes, Greenland, Alaska.

This species is one of the most common Cyanophyceæ and has a world-wide distribution. Its proper habitat is undoubtedly the littoral region of the lakes where it forms thin coatings on stones and plants; at times it form Ægagropila-formations (Ljungquist 1915 p. 11), attempts of which are also known from Iceland (Miðhús). Further it seems capable of thriving on land, on dripping rocks, among damp mosses, nay even on earth (Esmarch 1914 p. 272). Finally it has been found in various places in brackish water.

f. **terrestris** n. f.

In a sample from Hallormstaðir in a fissure of a rock in the forest, at a place over which water was trickling, a remarkable form grew which I think should be referred to *T. tenuis*. It formed extensive, felted cushions or coatings about $^1/_2$ mm. in thickness. The sheaths firm, to begin with colourless, later yellowish brown. Diameter of threads 7—12.8 μ, diameter of trichomes 4—6.6 μ. False branches are of frequent occurrence; the majority being of the *Tolypothrix*-type, a few, however,

Fig. 14. *Tolypothrix tenuis* Ag. f. *terrestris* n. f. (×600).

of the *Scytonema*-type. Heterocysts as a rule solitary, at times in pairs. Cells quadratic or shorter than the diameter. Apical cell of the trichome semi-globular. Fig. 14.

It is distinguished from the ordinary form of the species by its more vigorous sheaths, thinner trichomes and frequently solitary heterocysts. It is perhaps influenced by the particular habitat.

Tolypothrix limbata Thuret.

Bornet et Flahault, Revision III p. 124.

E. Icel. Vallanes, collected with plankton net which dragged a little on the bottom, temp. 13° $^{26}/_6$ 1914. — N. Icel. Skútustaðir, small pond, temp. 19° $^{17}/_7$ 1914. Grímstaðir, small ponds, on old decaying plants $^{20}/_7$ 1914 (2 samples). — S. Icel. Apavatn, in plankton, temp. 11° $^{16}/_8$ 1914.

Area: Eur., Afr., Am., Greenland.

T. limbata has hitherto only been found on about half a dozen various localities and is thus a "rare" species. Most frequently it occurs under similar conditions as *T. tenuis* or even in company with this species. In Iceland I have caught it a couple of times in a plankton net, but it originated undoubtedly in both cases from the bottom and is by no means plankton species.

Tolypothrix helicophila Lemm.

Lemmermann, Kryptogamenfl. d. Mark Brandenburg III p. 219, p. 198 fig. 10.

N. W. Icel. Botn in Geirþjófsfjördur, lake, water 10°, air 12°, $^{20}/_7$ 1915 (H. J.)!

Area: Germany.

In the above mentioned sample a copiously branched *Tolypothrix* occurred; threads 10—12 μ in diameter, sheaths gelatinous, and trichomes 4—5 μ in diameter. The sample is preserved by means of formalin. The species has hitherto only been found by Lemmermann in some lakes in Brandenburg.

III. **Desmonema** Berkeley et Thwaites.

Desmonema Wrangelii (Ag.) Born. et Flah.
Bornet et Flahault, Revision III p. 127. Wittr. et Nordst. Alg. exsicc., nr. 675. Lemmermann 1910 p. 201, p. 198, fig. 3.

E. Icel. Vestdalur at Seyðisfjörður, slightly damp rocky wall, forming dark patches $^4/_7$ 1914. Ekkjufell, dripping rocks $^2/_7$ 1914.
Area: Eur., As., Am., Austr., Færöes, Alaska.

The habitat most favourable to this species is said to be cold mountain streams (Lauterborn 1910 p. 493, Lemmermann l. c.). In Iceland I found it in places on which it undoubtedly will desiccate completely during the summer. At the time when I visited the localities, water was trickling down in abundance over the rocks from the melting snow.

IV. **Hydrocoryne** Schwabe.

Hydrocoryne spongiosa Schwabe.
Bornet et Flahault, Revision III p. 128. Lemmermann 1910 p. 222, p. 198, fig. 4.

E. Icel. Vallanes $^{30}/_5$ 1893; two samples, one of them from "Síki". (H. J.)! — W. Icel. Glammastaðavatn at Geitaberg, on stones at the shore, temp. 15^0 $^7/_8$ 1914.
Area: Eur., South-Patagonia.

This species occurs almost always attached to plants or other solid objects in fresh water. Its distribution is apparently but little known; presumably it has often been overlooked.

IV. SIROSIPHONACEÆ.

I. **Hapalosiphon** Nägeli.

Hapalosiphon laminosus (Cohn) Hansg.
Bornet et Flahault, Revision III p. 56.
Aulosira thermalis West 1902 p. 244, figs. 1—10.
Mastigocladus laminosus West l. c. figs. 11—16.
Sphærozyga Japeti Liebm.
S. thermarum Liebm. 1840 p. 338; Fl. dan., tab. 2399.

N. Icel. Námuskarð, in hot stream, water alkaline, temp. 35^0 $^{18}/_7$ 1914 f. anabænoides and f. phormidioides. Ibid., at the source of the hot spring, temp. 45^0 f. typica. Uxahver, on silicious sinter at the hot spring $^{22}/_7$ 1914 f. typica. Ibid., in outlet from spring, temp. 35^0—54^0 $^{22}/_7$ 1914 f. anabænoides. Reykhús, S. of Akureyri, hot spring, temp. 48^0 $^1/_7$ 1914 f. anabænoides. Akureyri, hot spring (O. P.)! $^{29}/_6$ 1903 f. anabænoides. — N. W. Icel. Reykhólar, margin of hot spring, in the surface of the algal layer 20^0 $^8/_7$ 1915 (H. J.)! f. typica. Reykjanes, hot spring (58^0) (Th. Th.)! f. typica. — W. Icel. Hveravellir (55^0—61^0)

West 1902 f. typica and anabænoides. Helgavatn, in water at 55° and at the margin of springs 60°—65° 10/8 1914 f. phormidioides. Stóra Kroppar, temp. 39° 6/8 1914 f. typica; 26°—35° f. anabænoides. Reykholt, on moss at the margin of the outlet from Skrifla 9/8 1914 f. anabænoides. In outlet from Skrifla, temp. 25° 9/8 1914 f. anabænoides. — S. Icel. Reykjavík Laugarnar leg. Stp., det. C. Flahault! f. anabænoides. Geysir, outlet, temp. 40°, West 1902 p. 244 f. typica. Laugarvatn, outlet from a "hver", temp. 40° 16/8 1914 f. anabænoides.

Area: All continents, almost exclusively in hot springs.

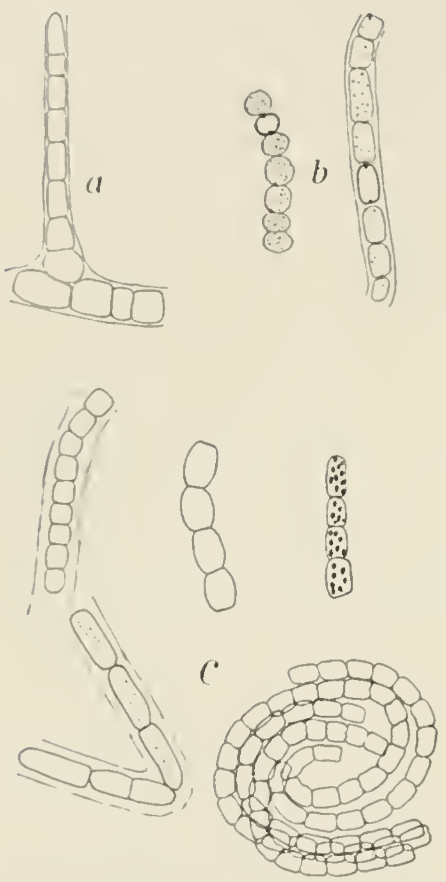

Fig. 15. *Hapalosiphon laminosus* (Cohn) Hansg. (×600).
a. f. typica.
b. f. anabænoides.
c. f. phormidioides.

Bornet et Flahault (Revision III p. 56) direct attention to the exceptional richness in forms of this species. If one examined a number of specimens of it, one might feel inclined to refer it to several varying genera in that it now occurs as a distinct Sirosiphoniacea with branchings, now resembles an *Anabæna*, and now a *Phormidium* of the group *Moniliformia* Gom., the heterocysts being but faintly developed or totally lacking. This species has therefore an exceptionally long series of synonyms — which are constantly increased.

Thus I do not doubt that *Aulosira thermalis* West (1902 p. 244, tab. 439, figs. 1—10) is, in fact, the *Anabæna*-like form of *Hapalosiphon laminosus* It is, as already mentioned, by no means possible to discover branchings in all samples of this species (cp. Schmidle 1900 p. 177), and we have then but the basal threads left, these being highly *Anabæna*-like. I have ascertained that such forms are found among the exsiccata cited by Bornet et Flahault, e. g., Wittr. et Nordst. nr. 758 of which especially b. and c. contain *Anabæna*-like forms. Whether those larger cells with granular cell contents mentioned by West actually are spores is rather doubtful. Judging by West's figures they do not seem to possess any distinct spore membrane. In the Icelandic samples I have often observed such larger granular cells; but I do not believe they are spores.

For the rest it is strange that West referred this species to the genus *Aulosira*, the chief distinguishing character of which is "vaginæ membranaceæ arctæ", these giving the whole thread a *Tolypothrix*-like appearance. This is absolutely not the case in *Aulosira thermalis* West which is supposed to have "vagina delicatissima hyalina", the sheaths being not visible at all in the figures. When West furthermore (l. c. p. 244) records that *Mastigocladus laminosus* from Hveravellir and the great Geysir are to some extent encrusted with lime this is probably due to a misunderstanding in that none of the Icelandic hot springs deposits lime, but exclusively silicious sinter (Thoroddsen 1910 p. 117).

I can still mention two more synonyms, viz.: *Sphærozyga Japeti* Liebm. and *Sphærozyga thermarum* Liebm. Both species are figured in Flora danica, tab. 2399, and were referred to by Liebman (1840 p. 338). In the herbarium Johs. Schmidt already directed attention to the fact that these two species were identical with *Hapalosiphon laminosus*, and I have had opportunity of examining some samples, collected by Steenstrup on the localities mentioned by Liebman, and upon which was written *Sphærozyga* n. sp. in Liebman's hand. I take it for granted that these are the original specimens of the two species established by Liebman and can thus verify Schmidt's note regarding the actual position of these species in the system.

As already alluded to, the species in question can be found under three essentially different forms:

1. f. **typica,** the typical *Hapalosiphon* form with branchings, distinct difference between the primary and secondary threads, the latter being thinner and more cylindrical than the former the cells of which are inflated and more or less spherical. Heterocysts well developed. Sheaths, as a rule, firm, distinct, and colour a pronounced violet with chlor-zinc-iodine (fig. 15, a).

2. f. **anabænoides,** the *Anabæna*-like form (= *Aulosira thermalis* West) without any branching. All the threads almost similar, with more or less spherical cells and distinct heterocysts. The cells are largest in the middle of the trichome, decreasing as a rule towards the apices. In this as well as in the last form spirally coiled threads are not infrequently met with as already described and figured by Schwabe (1837 p. 126, tab. II, fig. 14 a).

   The vaginæ are as a rule more or less confluent and colour faintly or not at all with chlor-zinc-iodine (fig. 15 b).

3. f. **phormidioides,** the phormidium-like form in which all the threads are almost similar, without heterocysts, with constrictions between the cells which often are feebly constricted in the middle. The sheaths confluent, do not colour with chlor-zinc-iodine (fig. 15 c).

Between these forms numerous transitions exist, and I therefore presume, like Bornet et Flahault, that they all belong to the same species. The proof of this can hardly be adduced in any other way than by means of pure cultures, but as far as I know nobody has as yet attempted this with regard to *Hapalosiphon laminosus*.

This species is a cosmopolite among the thermal algæ (Elenkin 1914). It has been found on all continents, but up till now in no arctic or antarctic region, e. g., neither at the hot springs in Greenland nor Spitsbergen. From two places only is it recorded as an occurrence of nonthermal water, viz., the Rhine (Lauterborn) and a stream on Celebes (Weber-van Bosse 1913).

Löwenstein (1903 p. 317) experimented on and closely investigated the limits of temperature within which this alga might thrive. He found that 52° C. was its maximum, whereas it is capable of withstanding

÷ 19.8° without dying, and that it also may be capable of thriving at ordinary room temperature.

My observations regarding its occurrence in Iceland are in perfect accordance with the above, in that I found it growing in water of up to 55° C. If the temperature of the water exceeded this, the algæ grew but at the margin of the springs where the temp. was lower. I have not been able to prove any connection between the temp. and the form under which the alga occurs. I presume the forms to be developmental stages, f. *phormidioides* being the youngest, f. typica the oldest form, but in case the conditions are unfavourable for its growth is remains presumably at its first stage of development.

Hapalosiphon intricatus W. and G. S. West.
Journ. Linn. Soc. vol. XXX p. 271, pl. XV, figs. 16—28.

N. Icel. Skútustaðir, small pond, on parts of old plants, temp. 16° 17/7 1914.
Area: West Indies, Eur., Greenland.

West found originally this species among the leaves of a *Leucobryum* on trees; but later it has also been found under similar conditions as in the above mentioned Icelandic sample, viz. in water on parts of old plants.

The sheaths assumed a distinct violet tint when treated with chlor-zinc-iodine.

II. **Fischerella** (Bornet et Flahault) Gomont.

Fischerella thermalis (Schwabe) Gom.
Gomont 1895 p. 52.
Stigonema thermale Bornet et Flahault, Revision III p. 66.

S. Icel. Reykjanes, warm soil (20—30°) near the springs 13/6 1896 (C. H. O.)!
Area: Eur., Am., Austr.

The specimen from Reykjanes was originally determined by Johs. Schmidt and later on revised by Flahault. I have also examined it and have arrived at the conclusion that the dimensions of the threads are, on the whole, somewhat large for the species. I found no hormogones.

The species has often been found in and at hot springs; but also on stones and earth away from the springs. On Reykjanes undoubtedly only acid sulphureous springs are found, and presumably it must have been in the vicinity of those that F. thermalis has grown. This is the more remarkable as the soil around this kind of springs generally is absolutely destitute of plants.

Fischerella muscicola Thur., Gom. var. **minor** Boye P. n. var.
F. filis primariis 8—12 μ crassis, secundariis 4—5 μ crassis, hormogoniis usque ad 50 μ longis, sæpissime brevioribus; vaginis chlorozincico jodurato coerulescentibus.

N. Icel. Pond near Grímstaðir (Mývatn), on parts of old plants $^{20}/_{7}$ 1914. — N. W. Icel. Botn in Geirþjófsfjörður (lake), temp. 10° $^{26}/_{7}$ 1915 (H. J.)!

The form found in these two samples bears an extremely close resemblance to *Fischera muscicola* Thur. (Bornet et Thuret: Notes algologiques p. 155, pl. 36) (= *Fischerella m.* Gom.), but is especially distinguished from it by its smaller dimensions and shorter hormogones. The bearings of chlor-zinc-iodine on the sheath of *F. muscicola* are up to the present unknown. On the other hand Gomont (1902 p. 299, pl. I) states with regard to *Fischerella major* that its vaginæ do not assume a bluish tint with this reagent. By an examination of the authentic sample: Kryptogamae exsiccatae nr. 333, I have convinced myself of the correctness of this statement. The habitat of the new variety is also different to that of *F. muscicola* in that it grows on earth whereas the other is found in water.

Fig. 16. *Fischerella muscicola* (Thur.) Gom. var. *minor* n. var. (×600).

III. **Stigonema** Agardh.

Stigonema ocellatum Thur.
Bornet et Flahault, Revision III p. 69.

N. W. Icel. Arnarfjörður, Hariot (1893 p. 316), Belloc (1894 p. 6).
Area: All continents, Lappland, Færöes, Alaska, Greenland.

This species, which I have not seen in Iceland myself, is often recorded as characteristic of sphagnum-moors, the water of which is poor in mineral (Allorge 1921 p. 621).

Stigonema panniforme (Ag.) Born. et Flah.
Bornet et Flahault, Revision III p. 71. Hieronymus 1895 p. 164.
S. tomentosum ibidem. p. 166.
Sirosiphon compactus Rabenhorst Algen nr. 694.

W. Icel. Kleppjárnsreykir, almost dry crusts $^{8}/_{8}$ 1914 (2 samples). Deildartungahver, not moistened by the water, $^{9}/_{8}$ 1914. — S. Icel. Almannagjá, on rocks over which water frequently was dripping $^{15}/_{8}$ 1914.
Area: All continents. Færöes, Novaya Zemlya!

Bornet et Flahault incorporate S. tomentosum with *S. panniforme*. Hieronymus (1895), on the other hand, attempts to separate *S. tomentosum* from *S. panniforme;* but the position of the heterocysts is the only important difference which he is able to state, in that these in *S.*

panniforme nearly always are lateral, in *S. tomentosum*, on the other hand, intercalary, at times, however, lateral. Thus a sharp distinction between the two species can evidently not be drawn, and I therefore prefer to follow Bornet et Flahault in considering them as one species.

In the Icelandic specimens the diameter of the threads was 17—31 μ, possesing intercalary as well as lateral heterocysts.

S. panniforme is apparently an exclusively terrestrial form thriving on walls, rocks, and trees, but frequent moistening is, however, undoubtedly a condition of existence.

Of the 4 Icelandic samples which contained the species in question, three originated from the hot springs. I assume that it is rather the vapour from the spring than the heat which is favourable to the growth of this alga. To my knowledge it has not previously been found in the vicinity of hot springs.

Stigonema minutum Hass.

Bornet et Flahault, Revision III p. 72. Wittr. et Nordst. Alg. exsicc., nr. 1608.

E. Icel. Vallanes, among mosses on a knoll in bog $^{26}/_{6}$ 1914. — S. Icel. Almannagjá, on rocks; in a place over which water frequently was trickling $^{15}/_{8}$ 1914. Reykjavík, on a stone in a depression with water (H. J.) ! $^{28}/_{4}$ 1897.

Area: All continents, Greenland, Alaska, Færöes, Lappland.

S. minutum grows most frequently on rocks, stones, walls or trunks of trees and generally in places where it may be moistened rather often. However, it is able to grow in water, too. In the sample from Vallanes it appeared in a corallaceous branched form, mentioned by Bornet et Flahault (l. c. p. 74) and corresponding to some extent to *S. coralloides* Kütz. (Tab. phyc. II, tab. 34, VI). The uppermost branchings, however, exhibited distinctly the features characteristic of *S. minutum*, but it may be extremely difficult to recognise it in this form.

Stigonema turfaceum (Berk.) Cooke.

Bornet et Flahault, Revision III p. 74.

Sirosiphon pulvinatus Kütz. Tab. phyc. II, tab. 36, fig. I.

E. Icel. Bog at 300 m. above sea-level behind Seyðisfjörður, moss with algæ $^{23}/_{6}$ 1914.

Area: All continents, Færöes, Greenland.

Most frequently found as a terrestrial plant, on earth, rocks, trees etc. that are more or less damp. On the above-mentioned Icelandic locality it was but scantily represented. At the time when the collection took place the locality was still very wet owing to the fact that the snow on the mountains was still thawing; but later in the summer the algæ on this locality will undoubtedly be liable to suffer from a considerable drought.

Stigonema informe Kütz.
Bornet et Flahault, Revision III p. 75.
Sirosiphon lacustris Rab. Alg. nr. 611.

N. Icel. Skútustaðir, small pond, temp. 19° $^{17}/_{7}$ 1914.
Area: Eur., As., Am., Austr., Lappland, Færöes, Greenland.

The specimen found had the following dimensions: main threads c. 75 μ in diam., lateral branches c. 45 μ, cells 10—15 μ, hormogones c. 13 μ in diam. and varying length, frequently very long which may be due, however, to the fact that we have to do with chains of hormogones. These dimensions are, on the whole, in accordance with the diagnosis in Bornet et Flahault (l. c.) The hormogones only are somewhat thinner than those recorded by the afore-mentioned authors. Stockmayer (1909 p. 66), who has had abundant material of this species at his disposal, states that he has often found hormogones 8—12 μ in diam., 15 μ, on the other hand, but a few times. He opines that *St. mamillosum* may perhaps be but a variety of this species.

S. informe has generally been found on moist rocks, but also in water or on trunks of trees. The Icelandic specimen originates from water, and this may probably account for its sheaths not being so brown as in Rab. Alg. nr. 611.

Stigonema mamillosum (Lyngb.) Ag.
Bornet et Flahault, Revision III p. 77.

E. Icel. Seyðisfjörður, bog at 300 m. above sea-level, on moss $^{23}/_{6}$ 1914. — Fljótsdalur, on rocky wall over which water was trickling $^{30}/_{6}$ 1914. Rauðará, in puddles of water on stones $^{12}/_{4}$ 1897 (H. J.)!
Area: Eur., As., Am., Færöes, Lappland.

In all 3 samples the species was but scantily represented, but it was abundantly provided with hormogones, 11—13 μ in diam. and up to 84 μ in length. I have compared the samples with an original specimen in Herb. Lyngbye, exhibiting short hormogones, but otherwise bearing a close resemblance to the Icelandic specimens, as well as with a sample determined by Flahault.

On the original specimen in Herb. Lyngb. numerous hormogones occurred, being all about 13 μ in diam. and 45 μ in length. Bornet et Flahault particularly emphasize the length of the hormogones, being of the opinion that this dimension is very constant. Stockmayer (1909 p. 66) pronounced against this view in that he actually found a considerable variation in the length of the hormogones in *S. informe.* (The exact relationship between *S. informe* and *S. mamillosum* may be left an open question until more detailed investigations can be undertaken.) Personally I am inclined to believe that the diameter of the hormogones should be a much more constant character than their length, as seriated, more or less confluent hormogônes are a common occurrence in e. g. *S. informe.* But even the diameter of the hormogones may, of course, be somewhat variable. I have therefore no hesitation in referring the specimens found to the species in question.

On the strength of their knowledge regarding the distribution of *S. mamillosum,* Bornet and Flahault state that it appears to be confined to more northern regions. The species has, however, now been found in Italy, nay even in tropical regions, e. g. at Singapore and on Koh Chang. Hence it may be considered as a settled fact that no definite climatic limits can be stated with regard to this species.

S. mamillosum has been found submersed as well as on moist rocks among mosses and the like. This is also the case on the Icelandic localities.

V. RIVULARIACEÆ.

I. Calothrix Agardh.

Calothrix clavata West.
West 1914 p. 1019, pl. XXI, figs. 6—7.

Fig. 17. *Calothrix clavata* West (×600).

E. Icel. Hvalnes, in a mucilaginous mass, spring near high-water mark 11/8 1894 (H. J.)!
Area: S. Am.

West's description of this species, which to my knowledge has been found only by the author, agrees exactly with the specimens which I found in the sample from Hvalnes. The only difference appears in the basal heterocyst which in West's figure apparently is of the same diameter as the lower part of the thread, whereas its diameter in the Icelandic specimens is considerably smaller. The thread here was 6—9 μ in diam. at the utmost, whereas the heterocyst was but about 4 μ in diam. (fig. 17). West does not mention anything as to the relation of the sheath to chlor-zinc-iodine. The sheaths of the Icelandic specimens assumed a deep violet when treated with this reagent. In this we possibly possess an important character by means of which *C. clavata* can be distinguished from *C. minuscula* Weber-van Bosse (1913 p. 42) which otherwise seems to be closely related to the former.

It does not appear distinctly from West's statements (l. c.) whether this species was found in fresh or in salt water. Its Icelandic occurrence seems to indicate that it may be capable of enduring salt-water spray. It grew here in company with *Nostoc* sp. and *Nodularia Harveyana*.

Calothrix epiphytica W. et G. S. West.
Journ. of Bot. vol. 35, 1897 p. 240.

Hveravellir, temp. 38° C. (West 1902 p. 243).
Area: Eur., Afr., Am., Antarctic.

This species, which I have not seen, has been found on widely differing localities in tropical as well as in very cold antarctic regions. Thus it is evidently not an actual thermal alga, but it must be capable of developing at highly variable temperatures. Esmarch (1914 p. 273) records it from earth-samples originating from clayey and marshy ground at the shores of the Elb at a depth of 25 cm.

Hveravellir is a group of hot springs situated in the middle of the country between Hófsjökull and Lángjökull i. e. in the uninhabited region.

Calothrix parietina Thuret.
Bornet et Flahault, Revision I p. 366.

E. Icel. On more or less moist rocky walls, Ekkjufell 2/7 1914, Vestdalur near Seyðisfjörður 4/7 1914, Fljótsdalur 30/6 1914. — S. Icel. Geysir, temp. about 30° C. (Stp.)!

Area: Eur., As., Am., Afr., Austr., Greenland.

As far as its geographical distribution is concerned, this species may be denoted as an ubiquist. Besides it is a rather pronounced aërophilous alga which, however, probably requires a comparatively great quantity of moisture in its substratum. It therefore thrives best in places where in any case at certain seasons water trickles down over the rocks or where these are dashed with spray from a waterfall or the like. However, it has also been found on rocks and stones under the surface of the water.

The sample collected by Steenstrup at Geysir contains a *Calothrix* (attached to siliceous sinter) with threads about 10 μ in diam. and thick stratified brown sheaths that are somewhat infundibularly expanded upwards. I therefore opine that it can hardly be referred to *C. thermalis* as originally done by Johs. Schmidt, but that it must belong to *C. parietina.* However, it cannot be identical with the following variety as this is said to be characterised by its colourless sheaths.

Calothrix parietina Thur. var. **thermalis** G. S. West.
West 1902 p. 243, tab. 439, figs. 17—20.
Hveravellir, temp. 24° C. On rocks and stones.

Calothrix thermalis (Schwabe) Hansg.
Bornet et Flahault, Revision I p. 368.
Mastichonema thermale Kütz. Tab. phyc. II, tab. 46, fig. I.

W. Icel. Sturlureykir, on siliceous sinter at little Hver (temp. 76°); the algæ were not overfloved by the water. 9/8 1914.

Area: Eur., Afr., N. Am., S. Am.

The mentioned sample consists in the main of a *Calothrix* which I refer to *C. thermalis* in spite of the threads being often somewhat thicker (up to 13.2 μ) than they usually are in this species.

Has hitherto only been found in hot springs.

II. **Dichothrix** Zanardini.

Dichothrix Orsiniana (Kütz.) Born. et Flah.
Bornet et Flahault, Revision I p. 376. Lemmermann 1910 p. 247. Rabenhorst Algen nr. 1177.

W. Icel. Glammastaðavatn, on stones at the margin, temp. 15°. $^{7}/_{8}$ 1914.

Area: Eur., As., Afr., N. Am. Beeren-Eiland.

The species in question seems to thrive best in rapidly running water, but has also been found in stagnant water and on moist earth or moist rocks. On its Icelandic occurrence it mostly grew in the surf-zone.

Dichothrix compacta (Ag.) Born. et Flah.
Bornet et Flahault, Revision I p. 378.
Hveravellir, temp. 55° C. (West 1902 p. 243).

Area: Eur., N. Am., Færöes.

Dichothrix compacta is evidently a species which is not readily distinguished (cp. Tilden 1910 p. 277). This is perhaps the reason why it is so rarely mentioned in the literature.

III. Rivularia (Roth) Agardh.

Rivularia Biasolettiana Menegh. (Lemm. emend.).
Lemmermann 1910 p. 250.
R. minutula Bornet et Flahault, Revision II p. 348.
R. Biasolettiana ib. p. 352.

N. Icel. Gásir, on mud $^{19}/_{7}$ 1899 (Ó. D.)!
Area: Eur., N. Am., Alaska, Lappland, Greenland.

It is but with great reservation that I refer the form in question to *R. Biasolettiana*. The thallus is composed of 1—2 mm. large spherical thalli, more or less confluent, not encrusted with lime, rather soft and easily crushed under cover glass. Trichomes generally 4.4—5 μ in diam., at the base, which as a rule is somewhat swollen, up to 7.9 μ in diam. Lower cells almost quadrate or slightly longer than their diameter, upper cells shorter than wide. Heterocysts basal, solitary or in pairs, 8—11 μ in diam. Sheaths yellowish-brown, in the outermost part hyaline, at times distinctly stratified and with dilated ochreation at the apex. Threads with sheaths up to 30 μ in thickness. Hormogones formed in abundance, about 50 μ in length, 4—5 μ in diam. This plant evidently in certain respects resembles *R. minutula* (Kütz.) Born. et Flah. var. *Orsiniana* (Men.) Forti (Sylloge Alg. V p. 673); but in other respects, such as the appearance of the thallus, it is different.

As the points of difference are so insignificant I should consider it as aimless to establish a new species on the basis of this specimen. The differences consist chiefly in the trichomes being thinner and in the absence of lime-incrustation. With regard to the first point it should be noted that the trichomes in the *Rivularia*-species probably are considerably variable in thickness on the whole, and, as to the second, that Bornet and Flahault's diagnosis of *R. minutula* (l. c.) admits of the thallus being "mollis", i. e. not encrusted with lime.

Gásir, where the sample in question was collected, is a peninsula between Hörgá and Eyjafjörður, and there is thus a possibility of salt as well as fresh-water. I have tested the adhering, dried mud in order to see whether it contained much chloride of sodium, but this did not seem to be the case. I therefore conclude that the alga originated from pure fresh water.

R. Biasolettiana, in Lemmermann's emendation, occurs in salt water as well as in brackish and pure fresh water. It may also grow on earth, on dripping rocks etc.

The following species of *Cyanophyceæ* are recorded by Lauder Lindsay (1861). In the cases when the species has not retained the same name, I add the name according to the nomenclature of our days.

Coccochloris Grevillei Hass. var. *botryoides* Hass. = *Aphanocapsa Grevillei* (Hass.) Rab.
Nostoc commune Vauch.
Nostoc verrucosum Vauch.
Nostoc lichenoides Vauch. = *Collema* sp.
Rivularia atra Roth (is a marine species).
Raphidia angulosa Hass. = *Rivularia natans* (Hedw.) Welw.
Oscillatoria tenuis Ag.
Oscillatoria autumnalis Ag. = *Phormidium autumnale* (Ag.) Gom.
Microcoleus repens Harv. = *Microcoleus vaginatus* (Vauch.) Gom.

Of these species I have not found *Aphanocapsa Grevillei* (Hass.) Rab. and *Rivularia natans* (Hedw.) Welw. in the Icelandic material which has been at my disposal.

The same species are recorded again by Lindsay in 1867 (p. 200).

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LIST OF THE SPECIES.

(SYNONYMS IN ITALICS).

Anabæna catenula (Kütz.) Born. et Flah. 299.
— flos-aquæ (Lyngb.) Bréb. 296.
— inæqualis (Kütz.) Born. et Flah. 297.
— Jonssoni n. sp. 299.
— oscillarioides Bory 300.
— Poulseniana n. sp. 298.
— torulosa Lagerheim 301.
— variabilis Kütz. 296.
— verrucosa n. sp. 299.
Aphanocapsa Elachista W. et G. S. West var. irregularis n. var. 265.
— Grevillei (Hass.) Rab. 317.
Aphanothece microscopica Näg. 266.
— *Mooreana* (Harv.) Lagerh. 266.
— *prasina* A Br. 266.
Aulosira thermalis West 307.
Calothrix clavata West 314.
— epiphytica W. et G. S. West 314.
— parietina Thuret 315.
— — var. thermalis G. S. West 315.
— thermalis (Schwabe) Hansg. 315.
Chamæsiphon curvatus Nordst. 272.
— cylindricus n. sp. 272.
— incrustans Grun. 272.
Chroococcus chalybeus Rab. 263.
— helveticus Näg. 264.
— macrococcus (Kütz.) Rab. 264.
— turgidus (Kütz.) Näg. 263.
— — var. *chalybeus* Hauck et Richter 263.
— — var. *dimidiatus* Hauck et Richter 264.
— var. *violaceus* W. West 263.
Clastidium setigerum Kirchn. 271.
Coccochloris Grevillei Hass. var. *botryoides* Hass. 317.
— *stagnina* Spr. 266.
Coelosphærium Kützingianum Näg. 270.
Cylindrospermum muscicola Kütz. 302.
Desmonema Wrangelii (Ag.) Born. et Flah. 307.
Dichothrix compacta (Ag.) Born. et Flah. 316.
— Orsiniana (Kütz.) Born. et Flah. 315.
Fischera muscicola Thur. 311.
Fischerella muscicola (Thur.) Gom. var. minor n. var. 310.
— thermalis (Schwabe) Gom. 310.
Gloeocapsa alpina (Näg.) Brand emend. 266.
— atrata (Turp.) Kütz. 265.
— Magma (Bréb.) Kütz. var. Itzigsohnii (Bornet) Hansg. 266.
— rupestris Kütz. 265.
— *lepidariorum* A. Br. 261.
Gloeothece confluens Näg. 261.
— rupestris (Lyngb.) Bornet 261.
— *lepidariorum* Lagerh. 261.
Hapalosiphon intricatus W. and G. S. West 310.
— laminosus (Cohn) Hansg. 307.
Hydrocoleum homoeotrichum Kütz. 291.
Hydrocoryne spongiosa Schwabe 307.
Hypheothrix lateritia Rab. 289.
Lyngbya æstuarii (Mert.) Liebm. 284.
— Kützingii Schmidle var. distincta (Nordst.) Lemm. 286.
— lutea (Ag.) Gom. 285.
— Martensiana Men. 285.
— ochracea (Roth) Thur. 286.
— Rivulariarum Gom. 286.
— stagnina Kütz. 285.
Mastichonema thermale Kütz. 315.
Mastigocladus laminosus West 307.
Merismopedia glauca (Ehr.) Näg. 271.
— tenuissima Lemm. 271.
Microcoleus repens Harv. 317.
— Steenstrupii n. sp. 292.
— vaginatus (Vauch.) Gom. 317.
— — var. monticola (Kütz.) Gom. 292.

Nodularia Harveyana (Thwaites) Thur. 301.
— spumigena Mert. 301.
Nostoc carneum Ag. 293.
— commune Vauch. 294, 317.
— humifusum Carmich. 294.
— *lichenoides* Vauch. 317.
— muscorum Ag. 293.
— pruniforme Ag. 295.
— sphæricum Vauch. 294.
— verrucosum (L.) Vauch. 295, 317.
Oscillatoria amphibia Ag. 275.
— anguina Bory 274.
— *autumnalis* Ag. 317.
— beggiatoiformis (Grun.) Gom. 277.
— brevis Kütz. 275.
— curviceps Ag. 274.
— *elegans* Fl. Dan. 286.
— formosa Bory 276.
— irrigua Kütz. 274.
— limosa Ag. 274.
— numidica Gom. 276.
— proboscidea Gom. var. Westii De-Toni 273.
— *rufescens* Liebm. 289.
— sancta Kütz. 273.
— tenuis Ag. 275, 317.
— terebriformis Ag. 276.
Palmella rupestris Lyngbye 261.
Phormidium ambiguum Gom. 283.
— angustissimum W. et G. S. West. 279.
— autumnale (Ag.) J. Schmidt emend. 283, 317.
— Corium (Ag.) Gom. 282.
— fragile (Men.) Gom. 277.
— laminosum (Ag.) Gom. 278.
— luridum (Kütz.) Gom. 278.
— ramosum n. sp. 281.
— subcapitatum n. sp. 282.
— subfuscum Kütz. 283.
— subuliforme Gom. 279.
— tenue (Men.) Gom. 279.
— Treleasei Gom. 280.
— *uncinatum* Gom. 283.
Plectonema carneum Lemm. 288.
— nostocorum Born. 288.
— roseolum (Richt.) Gom. 288.
Pleurococcus turgidus Rab. 264.
Raphidia angulosa Hass. 317.
Rivularia atra Roth 317.
— Biasolettiana Menegh. 316.
— *minutula* Born. et Flah. 316.
— natans (Hedw.) Welw. 317.
Schizothrix arenaria (Berk.) Gom. 289.
— calcicola (Ag.) Gom. 289.
— Friesii (Ag.) Gom. 290.
— Heufleri Grun. 290.
— lardacea (Cesati) Gom. 289.
— Mülleri Näg. 290.
Scytonema chrysochlorum Kütz. 302.
— — Rab. 303.
— *Chthonoplastes* Liebm. 303.
— crustaceum Ag. 304.
— *figuratum* Born. et Flah. 303.
— *gracile* Rab. 304.
— mirabile (Dillw.) Bornet 303.
— myochrous (Dillw.) Ag. 304.
— tolypotrichoides Kütz. 303.
— varium Kütz. 302.
Sirosiphon compactus Rab. 311.
— *lacustris* Rab. 313.
— *pulvinatus* Kütz. 312.
Sphærozyga Japeli Liebm. 307.
— *thermarum* Liebm. 307.
Spirulina labyrinthiformis (Men.) Gom. 277.
— subsalsa Ørst. 277.
Stigonema coralloides Kütz. 312.
— informe Kütz. 313.
— mamillosum (Lyngb.) Ag. 313.
— minutum Hass. 312.
— ocellatum Thur. 311.
— panniforme (Ag.) Born. et Flah. 311.
— *thermale* Born. et Flah. 310.
— *tomentosum* Born. et Flah. 311.
— turfaceum (Berk.) Cooke 312.
Symploca muralis Kütz. 287.
— Muscorum (Ag.) Gom. 286.
— thermalis (Kütz.) Gom. 287.
Tolypothrix distorta (Fl. dan.) Kütz. 305.
— helicophila Lemm. 306.
— limbata Thuret 306.
— tenuis (Kütz.) Johs. Schmidt emend. 305.
— — f. terrestris n. f. 306.