SMITHSONIAN

15

CONTRIBUTIONS TO KNOWLEDGE.

VOL. X.

EVERY MAN IS A VALUABLE MEMBER OF SOCIETY, WHO, BY HIS OBSERVATIONS, RESEARCHES, AND EXPERIMENTS, PROCURES KNOWLEDGE FOR MEN.—SMITHSON.

CITY OF WASHINGTON:
PUBLISHED BY THE SMITHSONIAN INSTITUTION.
MDCCCLVIII.

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This volume forms the tenth of a series, composed of original memoirs on different branches of knowledge, published at the expense, and under the direction, of the Smithsonian Institution. The publication of this series forms part of a general plan adopted for carrying into effect the benevolent intentions of James Smithson, Esq., of England. This gentleman left his property in trust to the United States of America, to found, at Washington, an institution which should bear his own name, and have for its objects the "*increase* and *diffusion* of knowledge among men." This trust was accepted by the Government of the United States, and an Act of Congress was passed August 10, 1846, constituting the President and the other principal executive officers of the general government, the Chief Justice of the Supreme Court, the Mayor of Washington, and such other persons as they might elect honorary members, an establishment under the name of the "Smithsonian Institution for the increase and diffusion of knowledge among men." The members and honorary members of this establishment are to hold stated and special meetings for the supervision of the affairs of the Institution, and for the advice and instruction of a Board of Regents, to whom the financial and other affairs are entrusted.

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To carry into effect the purposes of the testator, the plan of organization should evidently embrace two objects: one, the increase of knowledge by the addition of new truths to the existing stock; the other, the diffusion of knowledge, thus increased, among men. No restriction is made in favor of any kind of knowledge; and, hence, each branch is entitled to, and should receive, a share of attention.

3. Each collaborator to be furnished with the journals and publications, domestic and foreign, necessary to the compilation of his report; to be paid a certain sum for his labors, and to be named on the title-page of the report.

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1. Physics, including astronomy, natural philosophy, chemistry, and meteorology.
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2. The Institution should make special collections, particularly of objects to verify its own publications. Also a collection of instruments of research in all branches of experimental science.

3. With reference to the collection of books, other than those mentioned above, catalogues of all the different libraries in the United States should be procured, in order that the valuable books first purchased may be such as are not to be found elsewhere in the United States.

4. Also catalogues of memoirs, and of books in foreign libraries, and other materials, should be collected, for rendering the Institution a centre of bibliographical knowledge, whence the student may be directed to any work which he may require.

5. It is believed that the collections in natural history will increase by donation, as rapidly as the income of the Institution can make provision for their reception; and, therefore, it will seldom be necessary to purchase any article of this kind.

6. Attempts should be made to procure for the gallery of art, casts of the most celebrated articles of ancient and modern sculpture.

7. The arts may be encouraged by providing a room, free of expense, for the exhibition of the objects of the Art-Union, and other similar societies.

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In accordance with the rules adopted in the programme of organization, each memoir in this volume has been favorably reported on by a Commission appointed for its examination. It is however impossible, in most cases, to verify the statements of an author; and, therefore, neither the Commission nor the Institution can be responsible for more than the general character of a memoir.

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2. Also, to all foreign libraries of the first class, provided they give in exchange their catalogues or other publications, or an equivalent from their duplicate volumes.

3. To all the colleges in actual operation in this country, provided they furnish, in return, meteorological observations, catalogues of their libraries and of their students, and all other publications issued by them relative to their organization and history.

4. To all States and Territories, provided there be given, in return, copies of all documents published under their authority.

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(* Deceased.)

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[1] Each memoir is separately paged and indexed.

NEREIS

BOREALI-AMERICANA:

OR,

CONTRIBUTIONS TO THE HISTORY OF THE MARINE ALGÆ
OF NORTH AMERICA.

BY

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PROFESSOR OF BOTANY IN THE UNIVERSITY OF DUBLIN; HONORARY MEMBER OF THE LYCEUM OF NATURAL HISTORY, NEW YORK, ETC., ETC.

PART III.—CHLOROSPERMEÆ.

[ACCEPTED FOR PUBLICATION, SEPTEMBER, 1857.]

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

DR. JOHN TORREY,
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Secretary S. I.

SUB-CLASS III.

CHLOROSPERMEÆ, OR GREEN ALGÆ.

DIAGNOSIS. *Plants* almost always grass green ; rarely olivaceous, or lurid purple, still more rarely red. *Propagation* either by simple cell-division ; by the transformation of the colouring matter of the cells of the whole frond, or of some of the cells, into *zoospores;* or rarely by ordinary *spores* developed in proper spore-cases. *Antheridia*, containing spermatozoids, have been observed in some. *Marine, or living in fresh-water streams, ponds, and ditches, or in damp situations.*

It is difficult, in a few words, to give such a diagnostic character of the Algæ included in this sub-class as shall comprise all the exceptional cases. The general *idea* of the group is that it shall contain Algæ of a herbaceous or grass green colour, propagated by zoospores, or by the transformation of some considerable portion of the whole of the endochrome into spores, without these spores being developed within proper spore-cases, distinct from the ordinary cells of the frond. In the great majority of these plants both characters are found ; but some few genera and species which agree with the rest in the dispersed fructification, or in being propagated by zoospores, are of a purple or red colour, thereby approaching the Rhodosperms in appearance ; while others are olivaceous, and thus seem to approach the Melanosperms. It does not appear to be desirable, for the mere variation in colour, to separate plants which are in other respects so closely allied as are the *Porphyræ* to the *Ulvæ*, or the red *Palmellaceæ* to those of a green colour. It would be necessary, were we to remove these aberrant genera and species to the Rhodosperms, to construct special Orders to receive them, nor could we place these new Orders in the series of Orders as at present constructed; but must establish for them a new division of the sub-class, which would be characterised by the absence of cystocarpic fruit and of tetraspores ; that is to say, by the absence of the fructification common to the whole of this sub-class. Thus it would appear that these purpurascent Algæ are more removed from *true* Rhodosperms, notwithstanding the red colour of their spores, than from Chlorosperms ; and consequently we retain them in this division. A graver anomaly, as it appears to me, occurs in the genera which produce *spores* of the ordinary character (not *zoospores)* contained within proper cysts. These have been removed by Endlicher and others to the Melanospermic sub-class ; and certainly they show a considerable approach to that group. But on the other hand, in the characters of their vegetation, in the structure, habit, colour, and general aspect of the frond they are so closely united to true Chlorosperms, that I am unwilling to separate them ; particularly as they do not seem to be equally nearly related to true Melanospermeæ. These exceptional genera were formerly included in *Siphoneæ*, and are in this work separated under the name *Dasycladeæ.*

The Chlorosperms are decidedly the lowest or simplest in structure not only of the Algæ, but of all plants. A very considerable number of them have the frond composed of a single utricle or cell, and all cell-division in such plants issues in the production of new unicellular fronds. The Orders *Diatomaceæ* and *Desmidiaceæ*, of which some hundreds of genera, and perhaps thousands of species are now known to Botanists, are of this character. In the whole of these, the frond consists of what may be called a bivalve cell; the primordial utricle being single while the cellular envelope is divided into two halves by a medial line. When such a cell is about to be multiplied by dividing into two, the two halves of the old cell remain unchanged, and a new growth of two new half-cells originates at each side, along the medial line. While this growth is going on, the old half-cells are gently pushed asunder, and when it is completed, a separation takes place, and two new fronds float apart, each of them composed of an old half-cell and a new growth which gradually acquires all the characters of the opposing valve. But the unicellular structure is not confined to such minute *atoms* as the Diatomaceæ, or such imperfect organisms as the *Protococcus* and its allies. Many of the larger Chlorosperms are essentially unicellular, and in some of these the vegetable cell is found of very much larger size than in any other plants. In *Codium*, *Vaucheria*, and *Bryopsis* single cylindrical cells may be obtained several inches in length, and frequently of considerable diameter. In *Valonia*, saccate cells sometimes as large as a walnut and often as large as a hazel nut, are found. *Botrydium*, a little siphonaceous Alga common on damp ground in Europe, exhibits within the compass of a single branching cell all the ordinary organs of a compound vegetable, as much specialized as is possible within such narrow limits: thus, it has a descending axis or root, an ascending axis or stem, and a vesicular body, within which its spores are developed. In *Caulerpa*, however, if the frond in that genus be really constructed by the evolution of a single cell, we have the vegetable cell assuming its highest development and attaining gigantic size. These unicellular (?) fronds are sometimes two feet in length, and excessively branched; with specialized root, stem, branches, and leaves.

The ordinary fructification of the Chlorospermeæ consists of *zoospores*, or spores endowed with ciliary motion, which have already been spoken of in the General Introduction, (Part I. pp. 13–14). These are usually of very minute size, and are formed within the cells of the frond, by the transmutations of the whole cell-contents. Myriads of moving granules are thus evolved, each of which is pointed at one end, and there furnished with two or four vibratile hairs, which act like oars, and drive the granule through the water. In one instance *(Hydrodictyon)* the zoospores, whilst still retained within the walls of the mother-cell, arrange themselves into a young frond, which issues from the cell perfect in all its parts. But usually they are dispersed in the water, and swim about until they commence germination. In some cases, a solitary zoospore and that of large size, clothed all over its surface with cilia, is formed from the mass of endochrome of the parent-cell. And often, as in *Zygnema* and its allies, the spore is the result of the union of the matter of two cells.

Among the more interesting observations recently made on the development of these Algæ, Pringsheim's memoirs on the fertilization of their spores by means of spermatozoids are specially worthy of notice. Male organs of unquestionable character have now been discovered in several, leading to the inference that they exist in all. In some cases the spermatozoids are directly formed within the cells of the frond, from which they are dispersed in the water, and find their way to the enlarged cell in which the nucleus of the future spore, or rather *sporangium*, is contained, and which they penetrate, and effect the fertilization of the contents. In other cases there are formed within the cells of the frond and emitted into the water, solitary male-producing bodies resembling zoospores in form, but of smaller size, to which Pringsheim gives the name *androspores*. These *androspores*, after swimming freely for some time, like the zoospores, affix themselves (in *Œdogonium*) to the surface of the enlarged cell containing the female nucleus, or in its immediate neighborhood ; and then develope into minute frondlets, consisting of two or three cells, the lowest of which contains endochrome, and acts as a mother-cell, while the uppermost becomes an *antheridium* in which spermatozoids are formed. After a time both the female-cell and the antheridium open at the summit ; the spermatozoid is liberated and enters the aperture of the ovarian cell and fertilizes the enclosed nucleus ; from which there results the large, immoveable spore characteristic of the genus. The whole process is described and its various stages elaborately figured in Pringsheim's memoir, republished in a French translation in *An. Sc. Nat. 4th ser., vol.* 5, *p.* 250, *t.* 15, to which I must refer for a fuller account. A previous memoir by the same author in *An. Sc. Nat., vol.* 3, describes the fertilization of the spores of *Vaucheria* by an analogous process. Various memoirs have also recently appeared by Thuret, and by Derbes and Soliere, describing the process of the fertilization of the spores, and the development of the frond in other classes of the Algæ ; and from the large number of species which have been investigated by these excellent observers, we may perhaps be warranted in drawing the general inference, that a process of fertilization, by two opposing sexes, exists in all the Algæ. It certainly exists in the Melanosperms, Rhodosperms, and in many of the inferior Chlorosperms. There is much variety, however, in the appearance of the *antheridia* in different classes ; in some no spermatozoids have yet been discovered, in others they are of considerable size, and very active and well formed. In some cases each spore is separately fertilized ; in others it is a body which afterwards developes spores. One important observation has been made by Pringsheim which is specially interesting from its bearing on the disputed question of the origin of the embryonic vesicle in the higher plants, namely, that in no instance has he observed any growth to proceed from the spermatozoid, but that its function seems to have been performed when its contents have mixed with those of the nucleus ; the spermatozoid itself being wholly absorbed and dissolved in the mass.

Much still remains to be done in tracing the development of these Algæ, more especially in studying the transformations which many of them undergo. Very many have two or three different modes of re-producing the species, as by self-division, by zoospores or gemmæ, and by properly fertilized spores ; and the individuals resulting from these various modes of growth are not always similar. Thus there is in many an "alternation of generations," to be studied, such as has been noticed among lower animals ; and probably when the subject has been properly worked out, a large number, not only of species, but of genera, especially among the fresh water kinds, must be erased from our lists. It now appears probable to Pringsheim that many of the minute unicellular Algæ of Braun are the male organs or *androspores* of other Algæ. I think it can hardly be questioned that multitudes of the Palmelloid forms are either spores or imperfectly developed fronds ; and the same is probable of many Confervoids. As yet the subject, except in a few able hands, has been confused rather than rendered more clear by the labour bestowed by authors upon it. There has been too great an anxiety to establish new genera and species, without due regard being had to circumstances of growth and development ; and the unfortunate student who now attempts to study the fresh water Algæ is oppressed by an accumulating mass of bad species and genera, which all have to be in some degree mastered before he can make *clean work*. Add to this, that in the present state of our knowledge it is absolutely necessary, in most instances, to have the living plant at hand, and it will be understood what a difficult task it must be to give a good account of the Chlorospermatous series of the Algæ.

No one can be more sensible than I am myself of the very imperfect nature of the sketch attempted in the present memoir. I write at a distance from my subject, and have rarely had more than dried specimens to examine. Though many of them were personally collected by myself in 1850, when travelling in America, on very few have I preserved notes taken from the recent plant. This is perhaps of less account among the marine kinds, which formed the staple of my personal collections, for the marine species recover their characters on re-immersion much more perfectly than the fresh water kinds. But the want of living specimens has seriously barred my attempts to describe the fresh water species, with the exception of such easily preserved kinds as *Hydrodictyon*, *Batrachospermum*, *Lemanea*, *Petalonema*, &c. The Zygnemaceæ, of which I have received several, and which are probably numerous in America, so completely lose their distinctive characters in drying, that I have been forced to omit them altogether. So also it has happened with the species of *Oscillatoria*, and of the Confervoid Algæ generally. I must therefore leave the task of describing the fresh water Algæ of America to other hands ; to some one living among them, and having eyes fully open to the difficulties of his task, and zeal and ability to work it faithfully. And here I cannot omit a slight tribute to the memory of one in whom were combined in no common degree the qualifications which make an able naturalist, and who, had he lived, would probably have taken up the broken thread.

I allude to the late Professor J. W. Bailey of Westpoint, one of the earliest explorers of American Algæ, and whose very able memoirs on the *Diatomaceæ* have won for him an imperishable name in the annals of science. To me his loss is more personal than to most of his botanical friends, for from the hour we first met there grew up between us a warm friendship which death has interrupted, but which I trust it has not ended. He it was who first suggested to me a Memoir on the American Algæ ; he arranged with the Smithsonian Institute the terms of its publication ; he supplied me with a multitude of specimens ; and to his influence I owe the assistance I have received from many American algologists who looked up to him for direction in their studies. He was, as far as the Algæ are concerned, my chief American referee, to whom I could apply when seeking information on local matters, connected with this branch of study. With him I constantly associated my work, and to his approbation I looked forward as the most grateful reward of my labours ; and now that he is removed, my interest in the work has sensibly flagged, and I am not sorry that it is brought to a conclusion.

Since the previous part was issued, two other of my correspondents have been numbered with the dead—Professor TUOMEY of Alabama, and Dr. BLODGETT of Key West, to both of whom I was indebted for very valuable contributions of specimens. Many of these have been noticed in the two former parts, and several more will be found described in the present. It has given me a melancholy pleasure to perpetuate the memory of the assistance I obtained from these gentlemen, by giving their names to the only new genera described in the present part.

Whilst thus I have to deplore the loss of a dear friend, and of two of my most valued correspondents, I have to acknowledge obligations to two new contributors of specimens, Mr. SAMUEL ASHMEAD of Philadelphia, and Mr. A. D. FRYE of New York. From Mr. Ashmead I have received a collection of the Algæ of New Jersey, and a very interesting series of those of Key West, including some new species ; the most remarkable of which are a new *Caulerpa*, and a new and very beautiful *Dasya*. To Mr. FRYE I have to return my thanks for a collection of the Algæ of California, very well prepared, communicated to me through Professor Henry in 1854 ; and to this gentleman I also owe an apology for not having mentioned his name in a previous notice of Californian Algæ, which were sent to me by Captain Pike of New York in 1852, and which I supposed had been collected by him. A letter addressed by Mr. Frye to Professor Henry, and forwarded to me since the publication of the notice referred to, informs me that the packet of Californian Algæ attributed to Captain N. Pike was collected by Mr. Frye, and indeed formed part of a fasciculus exhibited by Mrs. Frye at the American Institute in 1851, and for which she obtained a gold medal. There were several other exhibitors at the fair, but Mrs. Frye's were considered the most rare. " After the close of the fair," says Mr. Frye, " I furnished Mr. Pike with a large number of specimens which I collected in California. He professed to send them to Professor Harvey of Dublin, stating to me that he would send them in my name, and that I should be credited for them in Professor Harvey's work. In looking over the work I found Professor Harvey received a collection of Californian Algæ, and they were credited to Captain Pike. I was told by Mr. Pike and other algologists in New York that mine was the only collection they had ever seen or heard of from the Pacific, and I had made the first collection in California. This, I think, after making much enquiry is correct, as I cannot find that there has as yet been any brought from thence except mine, which I collected with my own hands. I exhibited them to the ladies where I was then boarding, at Jones's Hotel in San Francisco : they afterwards borrowed them to show at their parties, and sent a gentleman, Mr. W. Ball, to purchase 20 specimens for 20 dollars—which I furnished to them, and also spent several days in teaching him how to collect and prepare them. I should be glad if Professor Harvey could know the facts, as I think he would be glad to give me credit for the specimens." Justice to Mr. Frye compels me to give these facts as much publicity as my former erroneous notice has obtained. The plants were sent to me by Captain Pike, without mentioning any other person, and I naturally supposed they had been collected by himself. Nor did I hear of Mr. Frye as a collector of Algæ, until his letter, quoted above, was received on my return from

Australia in 1856. I now take the earliest opportunity of acknowledging the merit of his package, and trust that he will acquit me of any intentional suppression.

Should I be favoured with any further donations of specimens from America, I trust that I may be correctly informed of the circumstances under which they were obtained. Justice shall then be fully done to the merits of the collectors. The Algæ of the Pacific coast have as yet been very imperfectly explored, and probably many curious and beautiful species, still unknown to botanists, remain to reward the future exertions of Californian collectors. Possibly, in the collections of those Californian ladies and gentlemen mentioned by Mr. Frye, new species remain undescribed and unrecorded; and should these remarks meet the eye of any one possessed of such things, and who may wish to see them duly published, I shall be glad to receive and acknowledge all contributions of Algæ if sent to me through Professor Henry or Professor Asa Gray: and the donors may rest assured that all such communications will be faithfully acknowledged.

W. H. H.

TRINITY COLLEGE, DUBLIN,
1 *Dec.* 1857.

SYNOPSIS OF THE ORDERS OF CHLOROSPERMEÆ.

1. Siphoneæ. *Rooting* or basifixed. *Frond* simple or compound, formed either of a single, filiform, branching cell, or of many such cells united together in a spongy frond. *(Marine or fresh-water.)*
2. Dasycladeæ. *Rooting. Fronds* consisting of a simple or branched inarticulate axial thread, whorled with articulated ramelli. *Spores* spherical, developed in proper fruit-cells. *(Marine.)*
3. Valoniaceæ. *Rooting. Fronds* polymorphous, formed of large vesicated cells, filled with watery endochrome. *(Marine.)*
4. Ulvaceæ. *Basifixed. Fronds* tubular or flat, membranous, formed of minute quadrate cells. *(Marine or in fresh water.)*
5. Batrachospermeæ. *Basifixed. Fronds* filiform ; the axis inarticulate, composed of minute cylindrical or polygonal cells, naked, or whorled with articulated ramelli. *Spores* in moniliform strings, naked. *(In fresh water.)*
6. Confervaceæ. *Basifixed* or floating. *Fronds* filamentous, articulated. *Endochrome* diffused. *Zoospores* minute, formed in all the cells. *(Marine or in fresh water.)*
7. Zygnemaceæ. *Floating. Fronds* filamentous, articulated. *Endochrome* of some definite figure. *Zoospores* large, formed by the union of two endochromes (of different cells), or by the bisection of a single endochrome. *(In fresh water.)*
8. Hydrodictyeæ. *Floating. Frond* forming a net-work with polygonal meshes ; each side of the mesh formed of a single cell. *Viviparous. (In fresh water.)*
9. Oscillatoriaceæ. *Basifixed* or free. *Frond* formed of subsimple filaments, having a membranous inarticulate tubular sheath, enclosing an annulated medulla, composed of very short, lenticular, cellules.
10. Nostochineæ. *Basifixed* or free. *Fronds* consisting of moniliform jelly-coated threads, free or enclosed in a gelatinous matrix.
11. Desmidiaceæ.* Microscopic, unicellular, green ; wall of the cell membranous : growth by semisection of the cell, and the evolutions of two new half-cells at the medial line.
12. Diatomaceæ.* Microscopic, unicellular, yellow-brown ; wall of the cell silicious : growth and fructification as in the preceding Order.
13. Palmellaceæ. *Cells* globose, or ellipsoidal, free, or lying in a gelatinous matrix, not forming either threads or membranes. *Propagation* by division of the endochrome.

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* These Orders are not included in the present work. The North American species have been ably worked out by the late Professor J. W. Bailey of Westpoint, whose numerous memoirs on the subject have a world-wide reputation. The species are all of microscopic size, and some of them, from their extreme minuteness, and the delicate sculpturing on their cell walls, form admirable *test-objects* for microscopes.

[illegible] OF THE ORDERS OF CHLORO[illegible].

1. SIPHONEÆ. *[illegible] or [illegible]. Frond single or branched, [illegible]* single [illegible], branching cell, or of many, each cell united [illegible] a spongy frond. (*[illegible] or [illegible].*)
2. DASYCLADEÆ. *[illegible].* *Frond consisting of a simple or [illegible]* axial thread, whorled with articulated ramuli. [illegible] developed in [illegible]. (*[illegible].*)
3. [illegible]. *[illegible].* *Frond polymorphous, formed of single [illegible]* filled with watery endochrome. (*[illegible].*)
4. [illegible]. *[illegible].* *Frond saccular or flat, membranous, formed of* [illegible] cells. (*[illegible].*)
5. [illegible]. *[illegible].* *Frond filamentous; the [illegible]* of minute cylindrical or polygonal cells, [illegible] *[illegible]* in [illegible], united. (*[illegible].*)
6. CONFERVACEÆ. *Attached or floating.* *Frond filamentous, [illegible]* [illegible]. *[illegible]*, formed in all the cells. (*[illegible]* [illegible].)
7. ZYGNEMACEÆ. *Floating.* *Frond filamentous, [illegible]* definite figures. *Zoospores large, formed by the union of [illegible]* different cells, or by the [illegible] of a single [illegible].
8. HYDRODICTYEÆ. *Floating.* *Frond forming a network with polygonal [illegible]*, each side of the mesh formed of a single cell. (*[illegible].*)
9. [illegible]. *[illegible] or free.* *Frond formed of* [illegible] during a [illegible] tubular [illegible], [illegible] composed of very short, [illegible] cells.
10. [illegible]. *Attached or free.* *Frond consisting of [illegible]* threads, free or enclosed in a gelatinous matrix.
11. DESMIDIEÆ.* Microscopic, unicellular, green; wall of [illegible] growth by [illegible] of the cell, and [illegible] the medial line.
12. DIATOMACEÆ.* Microscopic, unicellular, yellow-brown; wall of the cell siliceous; growth and fructification as in the preceding Order.
13. PALMELLACEÆ. Cells globose, or ellipsoidal, free, or lying in a gelatinous matrix, not forming either threads or membranes. Propagation by division of the endochrome.

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* [illegible] *The North American [illegible]* [illegible] by the late Professor [illegible] [illegible] [illegible].

Order I.—SIPHONACEÆ.

Siphoneæ and Caulerpeæ, Grev. Alg. Brit. p. 183. *J. Ag. Alg. Medit. p.* 17. *Endl.* 3*rd Suppl. p.* 16. *Dne. Class, p.* 32 ; *(also Halymedeæ, Dne.) Lindl. Veg. Kingd. p.* 18, *and Vaucherieæ, in part, p.* 22. *Vaucherieæ, Caulerpeæ, Codieæ (in part), Kütz. Sp. Alg. pp.* 486, 494, 500.

Diagnosis. Green, marine or fresh water Algæ, naked or coated with carbonate of lime, composed either of a single, filiform, branching cell, or of many such cells united together into a spongelike frond.

Natural Character. *Root*, where it is developed, formed of many branching fibres interwoven together and entangled ; sometimes penetrating deeply into the sand in which the plant grows, and attaching itself to the separate grains of sand, which serve further to consolidate the mass of fibres. *Frond* very variable in appearance, and differing much in complexity of structure, but always formed of very long, branching, inarticulate filaments, which arise from the continued growth and evolution of a single, undivided cell. In the genera of simplest structure, such as *Bryopsis* and *Vaucheria*, the frond consists of a single branching filamentous cell, with a thin, membranous, hyaline cell-wall ; its cavity being filled with a granular semifluid colouring matter or endochrome, which may be wholly discharged if the tube be wounded and slightly pressed. In *Bryopsis* the unicellular fronds stand apart from each other, though many often rise nearly from the same base. In *Vaucheria* several such fronds are interwoven together at the base, but remain distinct in their upper branches. In *Chlorodesmis* there is a further union of many such threads, whose lower portion unite together to form an evident stipes or trunk, which is crowned with a pencil of free filaments ; the whole frond resembling a little tree. This habit, however, is not so obvious in the American species as it is in *Ch. comosa*, the first described species of the genus. Again, in *Codium*, we find a structure essentially the same as in *Vaucheria* and *Chlorodesmis*, but the union of the filaments is still more intimate. To the naked eye, the species of *Codium* resemble green sponges or pieces of green cloth or velvet, having a perfectly definite outline and closely interwoven substance, and it is only when we tear or cut them asunder under the microscope that we perceive their true structure. We then find that all the central part of the substance of the frond is composed of innumerable interwoven, longitudinal branching cells, and that the velvetty pile which constitutes the surface is formed of the tips of excurrent branches of the axial cells, lying close together and presenting only their extremities to the eye. In all these genera the component filaments remain in the ordinary state of cellular tissue, having their membranous walls composed of cellulose, and filled with endochrome. The only further change which the plants of this group exhibit in structure consists in a secretion of carbonate of lime, which in several genera is found coating the external surface of the cells; and sometimes, as in *Halimeda* and some species of *Udotea*, surrounding the cells in such abundance as to cover the whole frond with a smooth coat of plaister, and obliterate all appearance of filaments. In such cases it is necessary, in order to see the structure, to macerate a portion of the frond in hydrochloric acid, until the lime be removed. When so treated, the component cells may be extracted and will be found to be of similar nature to those of *Codium* or *Bryopsis*. Indeed through some species, such as *Udotea membranacea*, there is an almost direct passage into *Codium*.

A more compound structure exists, as will be afterwards more fully described, in the sub-order *Caulerpeæ*, where from the inner face of the cell-wall innumerable branching and anastomosing processes issue, and fill up the cavity of the cell with a spongy, filamentous substance, unlike any structure noticed within the cavity of any other vegetable cells; so far as I am aware. On this remarkable character several authors propose to separate these plants into a distinct Order, and to this proceeding my only objection is that it appears to be an unnecessary multiplication of Orders.

The fructification of these Algæ has been observed in several but not in all, and presents some modifications in the different genera. In some, as in *Bryopsis*, the whole substance of the endochrome in fruiting specimens is changed into minute *zoospores*, which when emitted from the parent have an apparent voluntary movement like that of infusoria; swimming backwards and forwards by means of retractile cilia, which only disappear when the zoospore finds a point of fixture, and commences to germinate. In others, as in *Codium*, similar zoospores are developed within special encysted fruit-cells or vesicles, called by Agardh *coniocystæ*, which arise from the branches and are divided by a diaphragm from the branch on which they are formed. In others, as in *Vaucheria*, zoospores of a higher development are formed within similar cysts; and in this genus the cyst (or ovary) is accompanied by a well formed *antheridium*.

The process of fertilization of the spore in *Vaucheria* has recently been ably investigated by Pringsheim, a French translation of whose memoir on the subject will be found in Ann. Sc. Nat. Ser. IV. vol. 3, p. 363. The existence of two organs in *Vaucheria*, one of which was supposed to be an antheridium, had been noticed originally by Vaucher half a century ago, and they have passed under the eyes of succeeding observers; but no one appears to have actually watched the process of fertilization until it was discovered and published by Pringsheim in 1855. I shall merely give an abstract of the process, referring for full particulars, illustrated by beautifully executed figures, to the above quoted memoir. The *anther* or *corniculum* in *Vaucheria* consists of a small, cylindrical spirally curved or helicoid process rising from one of the branches of the frond, and at first not differing from an ordinary branchlet except in size. But gradually a change takes place in its contents, at first manifested by a loss of colour in the matter filling the upper portion of the young antheridium. Then a diaphragm is formed, which walls off the portion toward the extremity of the antheridium from the lower half, which retains its union with the branch: and now the change is complete. The anther thus formed consists of an isolated, curved, cylindrical, nearly colourless but not empty cell, supported on a pedicle of variable length and curvature. In the anther-cell spermatozoids are gradually evolved out of the contained matter, and are at maturity emitted through an opening at the summit of the cell. So much for the structure of the anther. The *sporangium*, or female organ, is placed on the branch close to the *antheridium*, and like it, at first consists of a papilla, or minute ramulus rising from the branch. It does not, however, lengthen into a cylinder, but assumes an ovoid form; its contents become dense and granular; a diaphragm separating it from the branch is formed across its base, and thus it becomes a separate egg-shaped cellule, sessile on the branch from which it has been formed. A beak-like attenuation, directed toward the adjacent antheridium, is now formed, and becomes at length perforated. At the same time the antheridium, having curled round, directs its extremity toward the sporangium; its summit opens, aud the enclosed spermatozoids are discharged into the water, close to the orifice of the sporangium, which they enter and effect the fertilization of the matter aggregated within. A cell-wall is then formed round the fertilized substance, which thus becomes a spore, which gradually ripens and is detached on the bursting or decay of the membranous cyst within which it was formed. In its process toward ripening it loses its green colour, and at length becomes nearly colourless, except for one or more brown masses which it contains. In this state it remains, often for a considerable time, till germination takes place, when it suddenly resumes its green, and then elongates into a tubular cell, which assumes the form and ramification of the parent plant.

This Order is dispersed, under one or other of its forms, over most parts of the world, and its species are found either in the sea, in fresh water, or occasionally on damp soil; some species of *Vaucheria* and the curious little *Botrydium* being terrestrial. The geographical range of several species is very extensive. *Codium tomentosum* and *Bryopsis plumosa* are common to the Northern and Southern Oceans and to the Eastern and Western Hemispheres, and are both found in the warmest parts of the tropical seas, as well as in high latitudes of the temperate zones. *Caulerpa* is specially characteristic of the tropical ocean, where its species are numerous, some of the more common kinds forming the principal algoid covering of rocks or sands in shallow water. Some of its species are widely scattered, and others apparently limited to a few spots. Several of the fossil algoid plants appear to have been *Caulerpæ*, and the fossil figured by Brongniart *(tab.* 9, *bis*, *fig.* 1*)*, under the name "*Fucoides hypnoides*," bears a very striking resemblance to *Caulerpa hypnoides* of the Australian coast.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

Sub-order I. CAULERPEÆ. *Frond* with prostrate, rooting, primary stems *(surculi)*, and erect branches, membranous, unicellular; cell within filled with a network of branching fibrils.

I. CAULERPA.

Sub-order II. CODIEÆ. *Frond* uni- or pluri-cellular. *Cells* filled with granular endochrome (without internal fibrous network).

* *More or less coated with carbonate of lime.*

II. HALIMEDA. *Frond* branching, articulate ; the joints flattened.
III. UDOTEA. *Frond* stipitate, fan-shaped, simple or cleft.

** *Destitute of carbonate of lime, soft and flaccid.*

IV. CODIUM. *Frond* spongelike, of definite form, composed of closely interwoven, irregularly branching filaments.
V. CHLORODESMIS. *Frond* stipitate (or subsessile), pencil-shaped, composed of dichotomous filaments, interwoven at base, and free in their upper portion.
VI. VAUCHERIA. *Filaments* numerous, tufted and somewhat matted at base, free above, irregularly branched.
VII. BRYOPSIS. *Filaments* free, tufted or solitary, pinnately branched.

I. CAULERPA, *Lamour.*

Frond consisting of prostrate *surculi*, rooting from their lower surface, and throwing up erect branches (or secondary fronds) of various shapes. *Substance* horny-membranous, destitute of calcareous matter. *Structure* unicellular, the cell (or *frond*) continuous, strengthened internally by a spongy network of anastomosing filaments, and filled with semi-fluid grumous matter. *Fructification* unknown.

The genus *Caulerpa* was founded by Lamouroux in 1810, and referred by him to his family of Ulvaceæ, though with doubt ; for he seems to have thought the structure of these plants so anomalous that he hesitates to pronounce them vegetables, notwithstanding their strictly vegetable form, immobility, and green colour. He had not, however, made himself master of their real structure, for he describes the frond as "consisting of an epidermis, and a cellular tissue consisting of cells so small that it has been impossible to determine their form" *(Ess. p. 67)*. Turner appears to have been the first author who noticed the fibrous spongelike network which fills up the cavity of the membranous frond. This he describes under his *Fucus hypnoides*, but in terms which show that he supposed this structure peculiar to that species. To Dr. Montagne we owe the first and best account of the structure of the *Caulerpæ*. This able algologist, in a paper read before the French Institute in 1837 and published in An. Sc. Nat. for March, 1838, has given a full history of the genus, both as to its organization and what he believed to be its fructification. To this memoir I refer the reader who wishes for full information of all that was then known of these plants, and shall content myself in this place with briefly describing their habit, structure, and geographical distribution.

The character seized on by Lamouroux as essential to a definition of the genus, and happily indicated by him in the name *Caulerpa* (derived from *χαυλος*, a stem, and *ερπω*, to creep) consists in the prostrate, primary stems or *surculi* in which the frond originates, and which are furnished at intervals throughout their length with branching and fibrous roots that penetrate deeply into the sand in which the plant vegetates, or attach themselves firmly to the rock in such species as grow on rocks and corals. These roots are fibrous prolongations of the under surface of the prostrate stems, and are probably, notwithstanding their great development, chiefly useful for fixing the plant in its position. From the upper side of the surculi rise erect branches or secondary fronds, which are very various in form, and are either sessile or supported on stalks or *stipites* of greater or less length. Some recent writers on these plants have proposed to divide the genus into several, assigning to them characters taken from the form and ramification of the branches ; and those who wish to know what can be done in this way may consult a memoir by Count Trevisan in the 22nd vol. of Schlechtendahl's Linnæa, where subdivision is pushed to an extreme. I have not adopted these views of arrangement, being unwilling to break up what appears a natural assemblage, and thus needlessly to multiply generic names. By employing artificial characters it is very easy to split up any genus of several species, but unless the number of species included in a genus be inconveniently large, it seems undesirable to do so. The genus *Caulerpa*, as defined by Lamouroux, includes about fifty species which agree in all essential characters of structure and development. The differences among them are obviously of a very minor character, and though proper enough for the definition of sections, are we think of too trivial a nature to afford stable generic diagnoses. For instance, let us take one of the proposed new genera, *Corradoria*, which differs from another, *Chauvinia*, merely in having bifarious instead of multifarious leaves or ramenta. But the feebleness of this character is shown by several species which are imperfectly bifarious ; so that bifarious and tri- or multifarious ramenta may occasionally be found on one and the same specimen. *C. cupressoides* of the North American coast has ramenta sometimes bifarious, sometimes trifarious ; and *C. falcifolia* of the tropical Pacific, which is normally bifarious, is frequently quadrifarious on part of the same individual.

In all the North American species the ramenta are confined to the upright branches or secondary fronds, and the surculi are smooth and glossy except in *C. lycopodium*, where both the surculus and the stalks of the fronds are densely clothed with branching, woolly hairs. In several Australian and some Pacific species the surculi are equally ramentiferous with the fronds, though the ramenta they bear are often of a different shape. The forms and ramifications of the upright fronds are much varied. In our *C. prolifera*, the type of Kutzing's genus *Phyllerpa*, we have an example of membranous, expanded, leaflike, simple fronds, perfectly entire at the margin; in *C. denticulata* and *C. scalpelliformis* there are similarly flattened fronds, but deeply pinnatifid ; in *C. mexicana* the marginal incisions are so deep that the frond becomes pinnate, and thus we are led, by easy transitions, to *C. taxifolia* and *C. plumaris* where the pinnate character is perfectly developed. Again, in *C. falcifolia*, Bail. & Harv. there is a passage from the species with pinnate fronds to those having filiform ramenta imbricated on all sides ; for, as already mentioned, the ramenta on some of the fronds are strictly distichous, and on others tristichous or quadrifarious. A further step brings us to *C. Selago*, *C. Lycopodium*, and their allies, in which the branches are thickly set with imbricating ramenta ; and the highest development of this type is reached in *C. obscura*, *C. Muelleri*, and *C. hypnoides*, where pinnate and imbricated characters are combined. Another group of species, like our *C. paspaloides*, is characterised by having pinnate or multifid ramenta ; and in another, the ramenta are baglike, either round, pyriform, or topshaped. Of this type we have an American example in *C. clavigera*, one of the most widely dispersed and most variable of the species. By depressing the apex of a baglike ramentum it becomes top-shaped, and by further depression peltate, and this form distinguishes *C. chemnitzia* and *C. peltata* ; and again, peltate ramenta becomes perfoliate in *C. nummularia* and *C. stellata* by the development of young ramenta from the centre of the discs. In such species as *C. ericifolia* and *C. cupressoides* the gradual evolution of ramenta from mere prominent points of the frond is illustrated; and such species lead us to *C. Freycinetii* where the ramenta remain in this rudimentary condition. And thus we are conducted, by almost insensible gradations, through a considerable number of forms, back to those from which we started, and which had naked fronds destitute of ramenta or marginal incisions. And so, after a survey of all the species, we become more reconciled to the generic group as limited by Lamouroux, than if we had merely compared together such extreme forms as *C. prolifera* and *C. paspaloides.*

We have already said that the structure of all these plants is essentially the same. It remains to describe more particularly what that structure is. I am not aware that any observer has yet noted the early development of the frond, nor is the mode of reproduction as yet clearly made out. The spores are presumed to be similar to those of *Bryopsis*, and to be formed in any portion of the grumous matter that fills the frond, and most probably from that of the ramenta. When we take a fully formed frond, distinguishable into creeping stem, roots, upright branches and ramenta, we find that it is every where coated or encased in a homogeneous, hyaline, tough membrane destitute of further structure than this ; that it may be seen in the thicker parts to be composed of several layers of cellulose, equally deposited one within another, as in the wood-cells of higher plants. There is no *septum* throughout the plant, and no appearance of cellular structure in the membrane of the walls. The frond, with all its ramifications, is strictly "*continuous*," forming a closed sac ; and so far as we know it is formed by the evolution of a single cell, extending itself indefinitely without cell-division, and showing in excess the same structure as we find in a minor degree in such plants as *Botrydium*, *Bryopsis* and the like. This closed sac, frond or cell, in *Caulerpa*, is filled as in *Bryopsis*, with a semi-fluid, semi-gelatinous, bright-green endochrome containing starch-grains mixed with what seem to be oily particles, and obviously highly organized, but its chemical composition remains to be examined. Most probably it is highly nitrogenous, for it bears considerable resemblance in substance to the glairy semi-fluid of many sponges ; and hence probably the reason of Lamouroux's supposition that these plants were of a semi-animal nature. If the structure of *Caulerpa* were merely what we have described, a closed membrane filled with grumous matter, it would not essentially differ from that of *Codium* and *Bryopsis.*

But there is found in *Caulerpa* a supplementary structure of a very peculiar and curious kind, which has induced several systematic writers to separate this genus, as the type of a family distinct from the other Siphoneæ. An unwillingness needlessly to multiply families, and a belief that *synthesis*, much more than *analysis*, ought to be the study of a system framer, has prevented my adopting these views. The structure alluded to is this : from the inner face of the wall of the membrane covering the frond there issue innumerable, cylindrical, filamentous processes, which seem to be merely internal extensions of the cell walls, and not new cells. These branch and anastomose together into a kind of spongy net-work that fills the whole cavity of the frond, and is bathed and its fibres keep apart by the grumous fluid. This spongy net-work may be regarded as the proper frame-work of the plant, intended to give strength and unity to all parts of the frond. The filaments appear to be tubular, but are empty and colourless. This peculiar modification of structure is so like that of a sponge, that we may almost regard a *Caulerpa* as a vegetable sponge enclosed in a membranous epidermis.

The genus *Caulerpa* is eminently characteristic of the tropical and subtropical oceans and seas of both hemispheres. Very few species extend far into the temperate zone. The most northern are found in the Mediterranean Sea ; and the most southern on the shores of New Zealand. Many species exist on the southern coast of Australia, in lat. 35° or 36° ; but the greater number are found within 35° of the equator. They inhabit the littoral zone, from near high-water to low-water marks ; and some extend into the laminarian zone, or even to that of the Nullipores. Their favorite locality is on hard sand, or on sand-covered rocks ; and in the crevices of coral on the coral reefs, and more particularly in hollows left on the surface of the reef, where the corals have ceased to grow. Most of the American species grow within tide marks, but are not luxuriant except at low-water mark, or a little below it. *C. clavifera* commences to grow nearly at high water mark, and is continued throughout the whole littoral zone and into the laminarian. It consequently varies greatly in size and in general aspect, and accordingly appears under several names in botanical works ; but these "book-species," however distinct they may look in the herbarium, cannot be recognized on the shore, where all the forms gradually blend together. Some of the species are very local. Others are found in both hemispheres, and in the Atlantic and Pacific Oceans. Of the North American species *C. plumaris*, *C. clavifera*, *C. ericifolia and C. cupressoides* are the most widely dispersed, being found in all tropical waters ; *C. prolifera* is found in the Mediterranean Sea ; *C. paspaloides* on the coast of Brazil, while *C. Ashmeadii* and *C. lycopodium*, so far as is yet known, are peculiar to the Keys of Florida. *C. mexicana* very closely resembles *C. asplenioides*, Grev. a native of the Indian Sea, and it is questionable whether these are distinct ; and *C. lycopodium* also is nearly allied to *C. selago*, a native of the Red Sea, but appears to be essentially characterised by its woolly stems. The Red Sea, the Persian Gulf, the shores of tropical Asia and those of New Holland, with the coral reefs of the Pacific furnish many local species, some exceedingly curious and beautiful. Several species are eaten by the natives of the Pacific archipelagoes ; and all furnish a favourite food to the turtle, whose green fat they serve to nourish.

We shall distribute the nine American species into three sections, characterised as follows :—

Sect. 1. Phyllerpa. Kutz : *Fronds* plano-compressed, or flat, leaflike, very entire.

1. Caulerpa *prolifera*, Lamour.; surculi naked, glabrous ; fronds erect, petiolate, flat, leaflike, nerveless, entire, tongue-shaped, rarely once forked, proliferous from the disc or apex. *Lamour. Ess. p.* 67. *Ag. Sp. Alg.* 1, *p.* 444. *Trevis. in Linn. vol.* 22, *p.* 129. *Phyllerpa prolifera*, *Kütz. Sp. Alg. p.* 494. *Fucus Ophioglossum*, *Web. and Mohr. Turn. Hist. t.* 58. (Tab. XXXVIII. B.)

Hab. Keys of Florida, on submarine sands. Key West, *W. H. H.*, No. 95. *Mr. Ashmead.* Soldier's Key, *Professor Tuomey*, No. 83 in part. (v. v.)

Surculi prostrate, throwing out from their under surface branching and fibrilliferous roots, simple or branched, twice as thick as hog's bristle, glabrous, glossy, cylindrical, shrinking, and longitudinally channelled when dry. *Fronds* stipitate, the *stipes* filiform, from a quarter-inch to an inch in length, of equal diameter with the surculi, compressed at the apex, and gradually passing into the base of the oblong or obovate, tongue-shaped obtuse lamina. The *frond* or lamina is flat and leafllike, two to four inches long, from half to three-quarter inch wide, either quite simple or once forked, with a perfectly entire flat margin. Occasionally similar stipitate fronds spring proliferously from any point of the disc or from the base or apex, especially if the latter has been wounded. The *substance* is membranaceous, somewhat horny and translucent, with a very glossy surface when dry. The *colour* is a full grass-green, becoming oil-green and variously tinged with yellow in a dried state. It does not adhere to paper in drying.

This species is rather rare at Key West. My specimens were picked up on the beach, after a southerly gale in the month of February. They closely correspond with specimens from the Mediterranean Sea, where, as well as in the subtropical Atlantic, this plant is not uncommon. *C. prolifera* has a very different habit from the other American species, but is closely related to the Australian *C. parvifolia*, and to *C. anceps* from the coral reefs of the Pacific. It appears to be still more closely akin to *C. costata*, Kütz, a Mediterranean species unknown to me, and said to differ in having a semi-nerved lamina.

Plate XXXVIII. B. *Fig.* 1. Caulerpa *prolifera ;* the *natural* size.

Sect. 2. Ptilerpa. *Fronds* plano-compressed, inciso-serrate, pinnatifid or pinnate.

2. Caulerpa *Mexicana*, Sond. ; surculi naked, glabrous ; fronds erect, subsessile, pinnato-pinnatifid ; rachis (broad), plano-compressed ; pinnæ opposite, vertically

flattened, two-edged, oblongo-falcate, mucronulate, scarcely constricted at base, their margin entire. *Sonder in Kütz. Sp. Alg. p.* 496. (Tab. XXXVII. A.)

Hab. Keys of Florida, on submarine sands and sand covered rocks. Key West, *W. H. H.* (No. 94.) *Professor Tuomey*, No. 72. *Mr. Ashmead.* (v. v.)

Surculi prostrate, extensively creeping, rooting from their under surface, branched, twice as thick as hog's bristle, glabrous, glossy, longitudinally furrowed when dry. *Fronds* springing from the upper surface of the surculi, nearly sessile, or on very short stipites, broadly linear (in outline), 4–6 inches long, $\frac{1}{4}$–$\frac{1}{2}$ inch wide, either simple or with one or two branches, pinnate or rather very deeply pinnatifid, from just above the base to the bifid or emarginate extremity. *Rachis* plano-compressed, from one to two lines wide, somewhat thick and fleshy when recent, horny and longitudinally rugulose when dry, closely set throughout with the opposite, distichous pinnæ. *Pinnæ* from two to four times as long as broad, patent, the lower ones somewhat ovate, the upper gradually more and more oblong and incurvo-falcate, vertically flattened, two edged, mucronulate, entire ; the margin quite free from denticulations. *Substance* when dry horny, membranaceous and glossy, semi-transparent. *Colour* a brilliant grass green, variously tinged with yellow, and becoming slightly olivaceous when dry.

This beautiful plant abounds at Key West, particularly under the bridge, where it forms widely spreading patches. Sonder's specimens were sent from Mexico, but the exact locality is not given. It is nearly related on the one hand to *C. denticulata, Dne.* from the Red Sea ; and on the other to *C. asplenioides, Grev.* (in *An. Nat. Hist. vol.* 12. *tab.* 1. *f.* 1.) a native of the East Indies, if indeed that species be really different. It also bears much resemblance to *C. taxifolia*, Ag., but the pinnæ are broader, more sharply two-edged, and distinctly mucronulate.

Plate XXXVII. A. *Fig* 1. Caulerpa *Mexicana* ; the *natural* size. *Fig.* 2, a pair of pinnæ, *magnified.*

3. Caulerpa *plumaris*, Ag. ; surculi naked, glabrous ; fronds erect, subsessile, distichously pectinato-pinnate ; rachis (narrow) filiform ; pinnæ opposite, slender, filiform, setaceous, incurved, or subfalcate, either acute or sub-obtuse. *Ag. Sp. Alg.* 1, *p.* 436. *Kütz. Sp. Alg. p.* 496. *Bory, Voy. Coq. tab.* 22, *f.* 4. *Corradoria plumaris, Trevis. in Linn.* 22, *p.* 133. *Fucus taxifolius, Turn. t.* 54 *(excl. syn.) Fucus plumaris, Forsk.* (Tab. XXXVIII. C.)

Hab. Sandy shores, on the Florida Keys. Key West, *W. H. H.*, *Professor Tuomey*, *Mr. Ashmead*, (v. v.)

Surculi prostrate, rooting from the under surface, a line or more in diameter, branched, glabrous, glossy, collapsing, and becoming longitudinally furrowed when dry. *Fronds* numerous, rising from the upper side of the surculi, erect, simple or with one or two branches, scarcely stipitate or subsessile, linear (in outline), 2-6 inches long, less than half an inch wide, pectinato-pinnate from a short distance above the base to the extremity. *Rachis* filiform, scarcely thicker than hog's bristle, closely set with pinnæ. *Pinnæ* opposite, sometimes a little obliquely inserted, setaceous, 2-3 lines long, rarely straight, generally more or less incurved or falcate, their apices sometimes very acute, ending in a sharp mucro, sometimes bluntish. *Substance* when dry horny and semitranslucent. *Colour* a deep and rather dark green, the tips of the pinnæ often yellowish or orange.

A native of the tropics generally, both of the eastern and western hemisphere ; occasionally straggling into the warmer parts of the temperate zone. It varies much in the diameter of the surculi, and somewhat in the length of the pinnæ, but is easily recognised by the closely pectinate fronds, which resemble small green feathers. The specimens from Key West are peculiarly robust, and if compared with some slender varieties from the Pacific, might pass for different. But at Vavau, in the Friendly Islands, where this plant is common, I collected specimens both of the robust and slender form.

Plate XXXVIII. C. Fig. 1. CAULERPA *plumaris*, the *natural* size. Fig. 2, a pinna, *magnified.*

4. CAULERPA *Ashmeadii ;* surculi naked, glabrous ; fronds erect, shortly stipitate, distichously pectinato-pinnate ; rachis subcompressed ; pinnæ opposite (or suboblique), erecto-patent, straight, linear, somewhat incrassated at the very obtuse extremity. (Tab. XXXVIII. A.)

Hab. Key West, rare. *W. H. H.*, *Samuel Ashmead, Esq.* (v. v.)

Surculi prostrate, distantly rooting, one or two lines in diameter, glabrous and glossy, collapsing, and mostly channelled when dry. *Fronds* scattered, rising from the upper side of the surculi, erect, each furnished with a stipes from half an inch to upwards of an inch in length, and closely pectinato-pinnate throughout. Each frond, pinnæ included, is about an inch in breadth, and from four to six inches in length. The *pinnæ* are half a line in diameter, three-fourths of an inch long, terete, and nearly linear, but more or less thickened towards the extremity, which is very obtuse, without trace of mucro or acumination. The substance when dry is horny and semi-transparent. The colour, when recent, is grass green, but in drying it turns to olive.

The roots, Mr. Ashmead remarks, penetrate so deeply, and fix themselves so firmly in the hard sand, that it is with difficulty obtained, except in fragments. I regard the present as a distinctly marked new species, and have much pleasure in inscribing it to Mr. Samuel Ashmead of Philadelphia, a gentleman who has already made some interesting discoveries among the Algæ at Key West, and from whom many more may be expected. It is a much larger and stronger growing plant than *C. plumaris*, and remarkable for the very obtuse and almost club-shaped ends of the nearly straight pinnæ.

Plate XXXVIII. A. *Fig.* 1, CAULERPA *Ashmeadii*, the *natural* size. *Fig* 2, a pinna, *magnified.*

SECT. 3. CHAUVINIA, Bory ; *Fronds* terete, simple or branched, set with tri-multifarious, leaflike, saccate, or thornlike ramuli *(ramenta).*

5. CAULERPA *clavifera*, Ag. ; surculi naked, glabrous, robust ; fronds erect, simple, short or elongate, more or less densely set on all sides with scattered, clubshaped, pyriform, or nearly topshaped ramenta. *Ag. Syst.* 1. *p.* 437. *Chauvinia clavifera, Kütz. Sp. Alg. p.* 498. *Ahnfeldtia racemosa, A. Lamourouxii, and A. uvifera, Trevis. l. c. pp,* 141-142. *Fucus clavifer, Turn. Hist. t.* 57. *F. Lamourouxii, Turn. t.* 229. *F. uvifer, Turn. t.* 230.

HAB. Sand covered rocks, about low-water mark, and at a greater depth. Key West and Sand Key, *W. H. H.*, *Professor Tuomey* ; Conch Key and Key Biscayne, *Professor Tuomey* (v. v.)

Surculi robust, glabrous, glossy, one or two lines in diameter, spreading in dense mats, copiously supplied on the under surface with dense, excessively divided, fibrous, and deeply penetrating roots. *Fronds* erect, crowded, varying very much in length, according to the depth of water at which the plant grows, and from other circumstances affecting its luxuriance. Sometimes the erect portion of the frond is scarcely an inch in length, sometimes it is six, eight, or even ten inches long. It varies also in diameter from half a line to a line or more, and is more or less densely set on all sides with scattered, incrassated, very obtuse saccate ramenta. In the variety called *Lamourouxii* these ramenta are inserted in a distant spiral so as to look almost distichous ; in other varieties, and especially in that called *uvifer*, they are densely crowded and inbricated, like grapes in a cluster. Numerous intermediate forms connect these extreme ones. The shape of the ramenta is also very variable. When young, they are simply clavate; but with advancing age they become more and more swollen at the ends, and at length are pear-shaped, or, in some stunted specimens, top-shaped. Stunted specimens somewhat resemble *C. sedoides*, and have been mistaken for that species, which, however, differs in several respects.

This plant is common to the tropics of both hemispheres, and is particularly abundant on the coral reefs of the Pacific, where it puts on many different forms, and varies much in luxuriance. It is one of the species eaten as a salad by the natives, and some of the European residents, of the Friendly and Feejee Islands, who call it *Limu* (Lee-moo). I cannot consent to separate specifically the forms figured by Turner, and above indicated as varieties. I fear also that *C. oligophylla*, Mont., if I rightly understand that species, must be regarded as an extreme form, nearly destitute of ramenta. I gathered what I take to be Montagne's plant at Vavau, in the Friendly Islands, where its peculiarities seemed to arise from the circumstances of its habitat, which was in a very rapid tide-stream between two islets.

6. CAULERPA *Lycopodium ;* surculi and stipites of the fronds tomentose with brand-

ing hairs ; fronds erect, stipitate, scattered, simple or slightly branched, densely set on all sides with imbricated, erect, setaceous, acute, or mucronulate ramenta. (Tab. XXXVII. B.)

Hab. On sand-covered rocks at Key West, abundant, *W.H.H.* (v.v.)

Surculi prostrate, widely creeping and rooting from the lower side, everywhere densely clothed with woolly, branching hairs, which are slightly viscid and collect particles of sand ; the whole mass of surculi forming a dense mat. *Fronds* rather distantly scattered, erect, stipitate. *Stipes* 1–2 inches long, filiform, tomentose, the hairs branching. *Frond* simple, or rarely once-forked, two to four or six inches long, very densely beset on all sides with slender, setaceous, erect, incurved, imbricated, acute, or mucronulate simple ramenta, which are two or three lines long, and nearly of capillary diameter. *Substance* somewhat horny when dry. *Colour*, a deep and rather a dull green, paler in the surculi and stipites.

I had at first taken this plant for *Caulerpa Selago*, but Turner expressly says of that species that the creeping stems or surculi are "smooth, shrinking, and wrinkled when dry ;" whereas in our Key West plant they are everywhere densely clothed with branching, woolly hairs. His figure *(Hist. Fuc. t.* 55) also represents the fronds as sessile, or ramuliferous to the very base. With no other species can the present be confounded. *C. Selago* is a native of the Red Sea. Two Australian species, *C. Brownii* and *C. furcifolia*, have been sometimes confounded with it, but in both of these the surculi are clothed with ramuli resembling those of the erect branches.

Plate XXXVII. B. *Fig* 1. Caulerpa *Lycopodium*, the *natural* size. *Fig.* 2, whorled ramenta in situ. *Fig.* 3, a ramentum, detached. *Fig.* 4, portion of the woolly stipes. *Fig.* 5, branching hairs from the same. The latter figures more or less *magnified.*

7. Caulerpa *ericifolia*, Ag. ; surculi robust, naked and glabrous ; frond shortly stipitate, irregularly much branched ; branches scattered, repeatedly divided, clothed on all sides with short, ellipsoidal, succulent, mucronulate, erecto-patent ramenta, set in 3, 4, or 5 ranks. *Ag. Sp. Alg.* 1, *p.* 442. *Chauvinia ericifolia*, *Kütz. Sp. Alg. p.* 497. *Trevis. l. c. p.* 137. *Fucus ericifolius*, *Turn. Hist. t.* 56. (Tab. XXXIX. A).

Hab. Key West, *W. H. H.* Conch Key, *Prof. Tuomey.* (v. v.)

Surculi prostrate, robust, as thick as crow quill or thicker, branched, extensively creeping, glabrous, glossy, shrinking and deeply channelled longitudinally when dry, rooting from the under surface ; the roots distant and very long, branched and fibrilliferous. *Fronds* erect, scattered, with short, simple or forked stipites, much and irregularly branched ; branches scattered, once, twice, or thrice compounded, very erect, as are also all their lesser divisions, all the angles being close and acute ; ramenta densely set, tri-, quadri-, or quinquefarious, short, somewhat intricated, the lowermost reduced to mamillæform tubercles, the upper more perfectly formed, ellipsoidal, saclike, and mucronulate. The branch, including its ramenta, is not more than a line in diameter. The substance is rather rigid, and is horny when dry. The colour is dull green, inclining to olivaceous.

I have much doubt whether this plant, which was originally described and figured by Turner, be permanently distinct from the following, of which it has very much the habit, but from which it differs, at least in typical specimens, by the more numerous rows of the ramenta and their more ellipsoidal shape. Specimens however vary in both these respects, and I could be well content to unite both forms under one specific name.

PLATE XXXIX. A. *Fig.* 1. CAULERPA *ericifolia*, the *natural* size. *Fig.* 2, small fragment of a branch with its ramenta. *Fig.* 3, a ramentum; the latter figures *magnified.*

8. CAULERPA *cupressoides*, Ag.; surculi robust, naked and glabrous; frond shortly stipitate, irregularly much branched; branches scattered, once or twice compounded, set with short, conoidal, mucronate, sub-bifarious or bifarious ramenta. *Ag. Sp. Alg.* 1, *p.* 441. *Chauvinia cupressoides, Kütz. Sp. Alg. p.* 497. *Trevis. l. c. p.* 137. *Fucus cupressoides, Esper. t.* 161. *Turn. Hist. t.* 195. (TAB. XXXIX. B.)

HAB. Key West, with the preceding. *Prof. Tuomey.* (v. v.)

Except in the less imbricated, di-tristichous, and shorter ramenta, this species does not differ from *C. ericifolia.* But these characters are variable. If the two species be united, the name *cupressoides*, as the older, must be preserved. Both forms are natives of the West Indies, and of the Pacific Ocean. *C. ericifolia* was first brought from Bermuda; and *C. cupressoides* from St. Croix.

PLATE XXXIX. B., *Fig.* 1. CAULERPA *cupressoides*, the *natural* size. *Fig.* 2, apex of a branch with tristichous ramenta. *Fig.* 3, portion of another branch with distichous ramenta. *Fig.* 4, a ramentum; the latter figures *magnified.*

9. CAULERPA *paspaloides*, Bory.; surculi robust, naked and glabrous; fronds with a long naked stipes, flabellately branched, the branches once or twice forked, or simple, fastigiate, densely beset in 3 or 4 ranks, with plumose, patent or recurved ramenta; ramenta sub-bipinnate, pinnæ opposite turned to one side, subulate or mucronulate, mostly pectinated with similar mucronulate pinnules on their inferior sides. *Chauvinia paspaloides, Bory, Coq. p.* 205, *tab.* 23, *fig.* 1. *Kütz. Sp. Alg. p.* 500. *Trevis. in Lin.* 22, *p.* 137. *Caulerpa Wurdemanni, Harv. MS.*—Var. β; ramenta simply pinnate, the pinnæ very long and straight, destitute of pinnules.

HAB. Key West, abundantly. *Dr. Wurdemann, W. H. H., Prof. Tuomey, Mr.*

Ashmead. Conch Key and Key Biscayne, *Prof. Tuomey.*—Var. β cast ashore at Key West. *W. H. H.* (v. v.)

Surculi prostrate, robust, sometimes nearly as thick as a goose's-quill, sometimes as a crow-quill, glabrous, glossy, shrinking much in drying and becoming longitudinally furrowed, vaguely branched, rooting at intervals of one or two inches ; the root long, branched, and fibrilliferous. *Fronds* rising from the upper surface of the surculi, scattered, on long, glabrous, naked stipites, flabelliform in outline, pedate or digitate, the branches spreading, simple or forked, fastigiate, densely set throughout with imbricated, four or five-ranked ramenta. *Ramenta* one to four lines long, varying much in length and somewhat in ramulification on different specimens. Normally they are patent or recurved and sub-bipinnate, or pinnate with pectiniform pinnules ; that is, the ramentum is oppositely pinnate, the pinnæ closely set, straight, subulate, or filiform, mucronulate, and furnished along one (the lower) side with unilateral ramuli of similar form. In different specimens the number and development of the processes of the pinnæ vary ; sometimes they are 5 or 6, and of considerable length ; sometimes but 2 or 3, and these very short. In var. β they are absent altogether, and the ramenta of much greater length than is usual in var. α ; but I have seen specimens so completely intermediate that I dare not make two species of these seemingly different forms, particularly as both occur in the same locality. The normal form has been admirably figured by Bory in the plate above quoted. I fear that *C. phlæoides* of that author can only be regarded as a variety of the present species.

II. HALIMEDA. *Lamour.*

Root fibrous, much branched. *Frond* erect, dendroid, branching, articulato-constricted, with flattened internodes (or *articulations*), coated with a smooth calcareous crust, and composed internally of a plexus of longitudinal, sub-parallel, unicellular, branching filaments. (These filaments, which constitute the medullary stratum of the compound frond, are constricted at intervals, and at each constriction emit a pair of opposite, horizontal, di-trichotomous, corymbose ramelli, whose apices cohere together into a false epidermis or periphery.)

The species comprised in this genus were placed by Ellis and Linnæus in the genus *Corallina*, where they remained till 1812, when Lamouroux very properly separated them to form the present group. The resemblance to *Corallina* is merely external. Both genera have jointed fronds, encrusted with calcareous matter, but here the resemblance ceases. The structure, colour, substance and fructification, which determine affinities, are widely different in *Corallina* from what they are in *Halimeda*. In this latter genus, after the lime has been removed by acid, there remains a plexus of unicellular, branching filaments, filled with green endochrome, and essentially of the same structure and nature as those of *Codium*. In *C. Opuntia* these filaments are easily extracted, and may readily be pulled asunder ; in *C. Tuna* they adhere more closely and require to be carefully manipulated. The *Halimedœ*, like the *Caulerpœ*, are confined to the warmer portions of the globe, and are particularly abundant on coral reefs, in both hemispheres. As many as thirteen species are described by authors, but several appear to have been founded on very insufficient data ; and probably they might be reduced by one-half. *C. Opuntia* is the most widely dispersed, being found abundantly in the tropical Atlantic and Pacific, and in the Mediterranean and Red Seas. *C. incrassata* and *C. Tuna* occur in the Pacific as well as in the Atlantic, but are less universally dispersed than *C. Opuntia*. When seen in herbaria the species are frequently bleached white, but all are of a bright grass-green when growing. They are furnished with deeply descending, fibrous, much branched roots, whose capillary rootlets firmly grasp particles of sand, and with them form a solid ball, not easily broken asunder.

1. HALIMEDA *Opuntia*, Lamour. ; frond very much branched, diffuse ; articulations reniform, flat, obscurely lobed or repando-crenate along the upper margin. *Lamour. Exp. Meth., p.* 27, *t.* 20, *fig.* 6. *Dne. Cor. p.* 90. *Kütz. Phyc. Gen. t.* 43, *fig.* 2. *Kütz. Sp. Alg. p.* 504. *Corallina Opuntia, Ellis and Sol. p.* 110, *t.* 20, *fig. b. Ellis, Cor. t.* 25, *a.* (TAB. XL. B.)

HAB. On rocks and in tide-pools, near high water mark, on the Florida Keys. Key West, *W. H. H.*, *Prof. Tuomey.* (v. v.)

Root deeply descending, fibrous, densely compacted into a fusiform mass, 1–2 inches long. *Stems* very numerous from the crown of the root, weak, but supporting each other by their proximity, and thus forming very dense tufts, much and irregularly branched ; the branches spreading. *Articulations*, except one or two of the basal ones, which are oblong or cylindrical, broadly reni-form, the more normal ones twice as broad as their length, from $\frac{1}{8}$ to more than $\frac{1}{4}$ inch across, flat, rather thin, but much incrusted with calcareous matter, with a more or less evident or obsolete longitudinal ridge through the middle ; the superior margin somewhat repando-crenate or lobed. After the calcareous matter of the frond has been removed by acid, a spongy vegetable structure remains, made up of a plexus of slender, longitudinal, unicellular filaments, constricted at intervals, and at the constrictions emitting a pair of opposite, decompound, dichotomous, corymboso-fastigiate, horizontal ramelli, whose apices cohere together, and form a thin epidermal or peripheric stratum of cells, over the surface of the frond. When the surface is viewed vertically, the cohering tips of the ramelli appear like the areoli of a continuous membrane. The substance of the filaments is tough, and they are filled with green matter. No fructification has been observed.

Plate XL. B. *Fig.* 1. Halimeda *Opuntia*, the *natural* size. *Fig.* 2, portion of the branching, unicellular filaments of which the frond is composed; *magnified.*

2. Halimeda *incrassata*, Lamour.; fronds solitary, erect, fruticose, somewhat flabelliform, much branched; articulations thickened, the lowermost compresso-terete, quadrate; the middle cuneate; the upper (mostly) compressed, obscurely repando-crenate. *Lam. Exp. Meth. p.* 25. *Lam. Polyp. p.* 307. *Dne. Cor. p.* 91. *Kütz. Sp. Alg. p.* 504. *Corallina incrassata, Ell. and Sol. p.* 111, *t.* 20, *d.*—Var. *β, monilis;* all the upper branches moniliform, composed of small, roundish, beadlike articulations. *H. monilis, Lx. Dne., Kütz.*, &c. *Corallina monilis. Ell. and Sol. p.* 110, *t.* 20, *Fig. C.*

Hab. Florida Keys. Key West, *W. H. H.* (chiefly var. *β.*). (v. v.)

Root a globose or oblong, bulblike, fibrous mass. *Stems* generally single, with a short, undivided, compressed or subterete *bole* (or *stipe*) composed of two or more incrassated and confluent articulations; then expanding and divided into numerous branches, which are repeatedly di-, tri-, or polychotomous at short intervals, spreading generally in one place and thus forming a flabelliform frond. In the lower part of the frond the articulations are very thick and almost confluent, a slender line merely defining the limits between each; they are oblong or quadrate, and more or less cylindrical. The middle articulations are more cuneate and less confluent; and the upper ones, in typical specimens, are still flatter and somewhat crenato-lobate. In the variety most common at Key West, and which constitutes the *H. monilis* of authors, the upper branches are slender and moniliform, composed of small, globose, or truncate, thick articulations of variable size, and somewhat varying in form, the terminal ones on a branch being frequently cuneate. The structure of the frond is similar to that of *H. Opuntia.*

Both varieties, as indicated above, are excellently figured by Ellis and Solander, and by them and succeeding authors are kept as distinct species. Lamouroux indeed observes (*Pol. flex. p.* 307) that the characters attributed to each are frequently confounded on the same specimen. This I find to be the case in specimens collected at Key West, and I have, therefore, united the two forms under one specific name.

3. Halimeda *tridens*, Lamour.; frond solitary, erect, flabellately branched; articulations compressed, the lower ones quadrate or oblong; the middle cuneate; the upper three lobed or tri-crenate. *Lam. Exp. Meth. p.* 27. *Pol. Flex. p.* 308. *Dne. Cor. p.* 91. *Kütz. Sp. Alg. p.* 505. *Corallina tridens, Ell. and Sol. p.* 109. *Tab.* 20, *fig. a.* (Tab. XLIV. C.)

Hab. Key West, *Prof. Tuomey.* (v. s.)

Fronds solitary, erect, with a cuneiform stipes composed of several confluent articulations and dividing at the summit into numerous branches, which soon again subdivide in a di-poly-chotomous manner, all the branches lying in one plane, so as to form a flabelliform frond. The articulations are all compressed, the middle ones more or less cuneate ; the upper usually tridentate or three-fingered, and frequently bearing articulations from the summit of each lobe. *Colour* rather a bright green. *Calcareous* incrustation thin.

This is nearly related to *H. incrassata*, and perhaps only a variety. But the crust is not so dense, and the distinctly three-lobed upper articulations are characteristic. Ellis's figure correctly represents a small branch.

PLATE XLIV. C. HALIMEDA *tridens ;* the *natural* size.

4. HALIMEDA *tuna*, Lamour. ; frond much branched, diffuse, di-trichotomous; articulations flat, thin, very broad, roundish or somewhat reniform, mostly entire; the middle ones sometimes cuneate. *Lamour. Pol. Flex. p.* 309, *t.* 11. *fig.* 8. *Dne. Cor. p.* 91. *Kütz. Sp. Alg. p.* 504. *Corallina Tuna, Ell. and Sol. tab.* 20, *fig. e. Hal. platydisca, Dne. ? p.* 90. (TAB. XL. A.)

HAB. Key West, *W. H. H.* Key Biscayne, *Prof. Tuomey.* (v. v.)

Root deeply descending. *Stipes* scarcely any, consisting of a single, cuneate or flabelliform articulation, which is sometimes more than an inch across, from the upper margin of which spring numerous other articulations, forming the bases of so many irregularly dichotomous branches. The articulations vary much in form and size. Their usual shape is roundish or sub-reniform, and they are from half to ¾ inch broad, quite flat, smooth, and thinner than in most species. They are joined together by very much constricted nodes, and are usually broader than their length. In some of my specimens, however, some of the medial articulations are narrow-cuneate or almost clavate. There is less incrustation in this species than in most ; the colour is a bright green, and the substance somewhat flexible.

The original *H. Tuna* is a native of the Mediterranean ; and possibly the plant now described may be referable to *H. platydisca*, Dne., but some of my Key West specimens so closely resemble what I have received from the Mediterranean, that, habitat apart, I cannot find a character to distinguish them. Others are certainly of larger size, with more discoid articulations. If, however, every slight variation in form and size is to be made the foundation of a new species, and dignified with a special description and name, the number of species to be established would only be limited by the number of specimens examined ; for scarcely two are to be found identical at all points.

PLATE XL. A. HALIMEDA *Tuna*, the *natural* size.

III. UDOTEA. *Lamour.*

Root fibrous, much branched. *Frond* erect, stipitate, expanded, flabelliform, more or less incrusted with calcareous matter, concentrically zoned, composed internally of a plexus of longitudinal, subparallel, unicellular, branching filaments. *Sporangia* "lateral, globose." (*Kütz.*).

The genus Udotea is intermediate between *Halimeda* and *Codium*, differing from the former in habit and from the latter in having the filiform cells of which it is composed incrusted with carbonate of lime. The amount of incrustation varies much in different species. In *U. flabellata*, which very closely agrees in structure with *Halimeda*, the calcareous matter forms a solid, smooth, and somewhat polished crust, completely concealing the filaments of which the frond is constructed ; in *U. conglutinata* the lime forms a thin coat round each individual filament, but does not conceal the filamentous structure of the frond ; and in *U. Desfontanesii* there is scarcely any calcareous deposit, and except in habit the plant is almost a *Codium*, in which genus it was placed by Agardh. Ten species of *Udotea* are known, all of them natives of the warmer parts of the sea. Our *U. flabellata* is found in the Indian Ocean, and I have received *U. conglutinata* from Port Natal, S. Africa.

1. Udotea *flabellata*, Lamour. ; stipes simple, short, terete or sub-compressed, expanding into a broadly flabelliform, simple or lobed, wavy, concentrically zoned, smooth frond ; the margin either quite entire, undulato-repand, crenate, or deeply lobulate, sometimes proliferous ; surface thickly incrusted ; concentric zones evident, closely set or sub-distant. *Dne. Cor. p.* 93. *Lamour. Pol. Flex. p.* 311. *Kütz. Sp. Alg. p.* 502. *Corallina flabellata*, *Ell. and Sol. Cor. p.* 124. *tab.* 24 (*excellent!*).

Hab. Key West, *W. H. H.* Abundant between Key West and Cape Florida, *Prof. Tuomey.* (v. v.)

Root a fusiform mass of intricately interwoven fibres, one to two inches long. *Stipes* half an inch to an inch long, terete, a quarter-inch or more in diameter, simple, erect, terminating in the broadly cuneate or reniform base of the frond. *Frond* sometimes six inches across, but our specimens are mostly smaller, usually broader than its length, more or less cuneate at base, the lateral margins prolonged downwards in old fronds, which, therefore, are somewhat reniform ; flabellate, either quite entire with a flat margin, or more frequently undulate, lobed at the margin or deeply divided (as Ellis's figure represents) into numerous laciniæ, which take the form of the primary frond, and imbricate each other at the edges. The surface is thickly coated with a calcareous crust, and quite smooth ; it is marked at short, but very uncertain intervals, with concentric lines or furrows, much more obvious in some specimens than in others, but always to be found. The substance is as thick as calfskin and leathery to the touch.

The *structure*, after removal of the lime, is seen to consist of closely packed, parallel, longitudinal, unicellular filaments, branching and interlaced together, and emitting toward the surface, or periphery, short, horizontal, rootlike, fastigiate, branching processes, of whose cohering apices the surface of the frond is composed. *Colour*, a pale grass green, bleaching to a dirty white.

2. Udotea *conglutinata*, Lamour. ; stipes short, simple, smooth, expanding into a broadly flabelliform, simple or lobed, flat, scarcely incrusted, strigose frond, composed of longitudinal, parallel, agglutinated, dichotomous filaments, constricted at the furcations. *Lamour. Pol. Flex. p.* 312. *Kütz. Sp. Alg. p.* 502. *Corallina conglutinata, Ell. and Sol. p.* 125, *t.* 25, *fig.* 7. *Udotea Palmetta ? Dne. p.* 93. (Tab. XL. C.)

Hab. Key West, *W. H. H.* (v. v.)

Root deeply descending, long and fibrous. *Stipe* terete or compressed, about half-an-inch to ¾ inch long. *Frond* flabelliform, 1–2 inches broad, flat, cuneate or cordate at the base, either entire or somewhat lobed, or irregularly torn, but slightly incrusted with lime ; the filaments of which it is composed being everywhere visible, and giving to the surface a strigose, fibrous appearance. These filaments are longitudinal, parallel, conglutinated together, but readily separable when the lime has been removed by acid. They are dichotomous, constricted at the forkings almost as if jointed, very slender, and destitute of lateral horizontal annuli, or of rooting processes. They more resemble the threads of a *Codium* than of a *Udotea*, and may almost be compared to those of a *Penicillus*.

I have not seen any authentically named specimen of Solander and Ellis's plant, but have little or no doubt of the correctness of my reference. The strigose or filamentous surface at once distinguishes our plant from *C. flabellata ;* and Solander truly observes, " We can plainly distinguish all the dichotomous branches" (filaments) " of this Coralline on its surface, which are each of them separately covered with a thin calcareous substance full of pores ; these, by growing so close to one another, become glued or united together by their covering."

Plate XL. C. *Figs.* 1, 2, and 3. Udotea *conglutinata*, different varieties, the *natural* size. *Fig.* 4. Portions of the branching, unicellular, constricted filaments of which the frond is composed ; *magnified. Fig.* 5. Small portions of the same, more highly *magnified.*

IV. CODIUM. *Stackh.*

Frond sponge-like (globular, cylindrical or flat ; simple or branched) composed of a plexus of unicellular, branching filaments, filled with green semifluid endochrome. *Sporangia* lateral, on the ramuli of the filaments (forming the surface of the frond), and containing innumerable zoospores.

The frond in this genus, though it assumes a well-defined shape, characteristic of the particular species, does not form a solid, compact body as in *Udotea*, but consists altogether of innumerable slender, unicellular, branching filaments, inextricably interlaced or woven together. In the centre of the filamentous mass these filaments are threadlike, branching at longish intervals, curled or sinuous, filled with slimy fluid, and only partially supplied with green colouring matter. In the elongated species, as in *C. tomentosum*, these axial filaments take a longitudinal direction ; in the globose ones they radiate from a central point, as in the singular *C. mammillosum* of Australia; and in the incrusting species, like *C. adhærens*, they spread horizontally over the surface of the rock on which the plant grows. In all cases they throw out more or less club-shaped ramuli, which spread in a direction vertical with the surface of the frond, and their apices lying close together, but not cohering, constitute the periphery. There is no calcareous incrustation as in *Udotea*, and no false epidermis as in *Halimeda* ; but with these exceptions there is much similarity in structure. The external habit is remarkably varied. In *C. tomentosum*, the type of the genus, and the most widely dispersed species, the frond is somewhat cylindrical, and dichotomously branched ; in a form (or species ?) called *C. elongatum* a similarly branching frond is extravagantly dilated and flattened especially at the axils ; in *C. laminarioides* a stipitate frond suddenly expands into a flat lamina a foot or two across, resembling nothing so much as a piece of green friese-cloth ; in *C. amphibium* a number of minute papilliform branches rise from a flat adherent surface ; and in *C. adhærens* there is a flat, clothlike crust, destitute of branches, and indefinitely covering rocks and woodwork. In *C. bursa* the frond is sessile, gradually becoming globose and at length hollow ; and lastly, in *C. mammillosum* the frond is either exactly spherical or egg-shaped, composed of filaments radiating from a central point, and being, so far as known, destitute of any root-like attachment.

The fructification in *Codium* consists of an oblong, ovate *sporangium*, formed of a single cell, separated from the ramulus near the base of which it is developed, by a diaphragm, and containing, at first, a dense, dark-green endochrome, and finally a multitude of *zoospores.* These latter are ovate, of a deep green colour, with a minute " rostrum" at one end, which carries a pair of cilia, that serve as organs of locomotion till the spore becomes fixed and germinates. This fruit is exquisitely figured by Thuret, in his memoirs on the Zoospores of Algæ, in *An. Sc. Nat.* 3*rd Series*, *Bot. vol.* 14, *tab.* 23, where a full account of the evolution is given.

1. Codium *tomentosum*, Stack.; frond linear, dichotomous, cylindrical or compressed. *Ag. Sp. Alg.* 1. *p.* 542. *Wyatt*, *Alg. Danm. No.* 35. *Kütz. Sp. Alg. p.* 500. *Harv. Phyc. Brit. t.* 93. *Fucus tomentosus*, *E. Bot t.* 712. *Turn. Hist. t.* 135.

Hab. Apalachicola, *Captain Pike.* Manatee River, *Mr. Ashmead.* Key West, *W. H. H.* Sitcha, *Ruprecht.* California, *Dr. Coulter.* (Not received from the east coast). (v.v.)

Fronds rising from an expanded, velvetty incrustation, solitary, or gregarious, from three inches to one or two feet in length, varying much in diameter, erect, dichotomous, with or without lateral accessory branches. *Branches* cylindrical or compressed, obtuse, clothed with hyaline, spreading, soft, byssoid hairs, which, when the plant is expanded in water, stand out vertically on all sides, and give to the branches the *tomentose* character commemorated in the trivial name. The *axis* is composed of innumerable, interwoven, irregularly branched, slender filaments, from whose sides issue radiating, horizontal, clubshaped ramuli, whose apices, closely placed, but not cohering, form the surface of the spongy frond. To the sides of these ramuli are attached the *sporangia*, which are oval or ovato-lanceolate, and subsessile.

It is a singular fact, (if it be *really* a fact) that this well-known and common species, which is found in every latitude from the Equator to the colder parts of the temperate zone, and nearly to the polar basin, is not a native of the *Eastern* coast of North America. It has not been sent to me by any of my correspondents from any part of the Atlantic coast, except from Florida, at the mouth of the Mexican Gulf. There I have myself gathered it. On the west coast it appears to be abundant, and extends as far north as Sitcha. There is nothing to distinguish Californian specimens from those found in Europe, in Ceylon, in Australia, at the Cape of Good Hope, or at Cape Horn, at all which places it is common.

V. CHLORODESMIS. *Bail. and Harv.*

Frond pencil-form, stipitate or sub-sessile, flaccid, without calcareous incrustation, wholly composed of cylindrical, dichotomous, unicellular filaments filled with dense, vivid-green endochrome. *Stipes*, when present, spongy, formed of interwoven threads.

The genus *Chlorodesmis* was founded by the late lamented Professor Bailey and myself on an alga brought by Captain Wilkes from the Feejee Islands, and which I have since collected abundantly on all the coral reefs which I had the opportunity of visiting in the tropical Pacific, where it forms a very striking object on the extreme outer edge of the reef. This original species—*C. comosa*, Bail. and Harv.—has a distinct, and often elongate, spongy stipes, and a brushlike habit, not unlike that of a *Penicillus* ; and few algologists will question its claim to generic distinction. I am not quite sure that I do well in associating the following species in the same genus ; but I know not where else to place it, unless indeed in *Vaucheria*. The specimens, however, appear to be scarcely mature ; there is a resemblance in the colour and substance, and the habitat is not dissimilar ; and I am willing to think that more advanced specimens might exhibit more of the spongy stipe which forms the most tangible character of this genus. The fruit has not been observed.

1. Chlorodesmis ? *Vaucheriæformis ;* stipes obsolete ; fronds subsessile, comoso penicillate, fastigiate, dark-green, composed of innumerable, slender, dichotomous, exceedingly lubricous and subgelatinous, unicellular, cylindrical filaments ; apices equal, level-topped, obtuse. (Tab. XL. C.)

Hab. On stones, at Brown's Wharf, Key West, *W.H.H.* (v. v.)

Stipes obsolete, consisting in a bulbous mass of interlaced, branching fibres, which throw up the erect and free filaments of which the frond is composed. These filaments form dense pencil-like tufts, about an inch high, and perfectly fastigiate. They are exceedingly slender, cylindrical, of equal diameter throughout, dichotomous, obtuse, gelatinoso-membranaceous, soft, and very lubricous, and filled with a dense, deep-green endochrome. Each filament is strictly unicellular, without articulation or constriction.

Plate XL. C. *Fig.* 1. Chlorodesmis *Vaucheriæformis ;* the *natural* size. *Fig.* 2. Portion of one of the branching unicellular filaments. *Fig.* 3 and 4, small portions of the same ; the latter figures *magnified.*

VI. VAUCHERIA. *D.C.*

Fronds densely cæspitose, and somewhat interwoven ; each consisting of a single, irregularly branched, unicellular cylindrical filament. *Cell-wall* very thin and delicate. *Endochrome* granular. *Sporangia* lateral, on the sides of the branches. *Antheridia* cylindrical, hooked, accompanying the sporangia.

The greater number of species of this genus occur in freshwater ponds, ditches, and streams, and probably several may yet be found in North America. I have received from Mr. H. W. Ravenel of South Carolina a specimen of a *Vaucheria* apparently allied to *V. dichotoma*, but not in a state to be recognised. It was found floating in limestone-waters. Dried specimens of this genus are rarely of any use, as the specific character is generally lost in drying.

VII. BRYOPSIS. *Lamour.*

Root fibrous. *Fronds* tufted, each consisting of a single, erect, branching, unicellular, cylindrical filament ; branches and ramuli either imbricated or pinnate. *Cell-wall* firmly membranaceous, glistening. *Endochrome* granular and viscid, at length converted into *zoospores*, which escape through apertures formed in the cell-wall.

This genus consists of several littoral Algæ of small size, but among the most elegant of marine plants. They occur in tufts, seldom more than two to four inches in height, and grow either on the rocky margins of clear tide-pools, or epiphytically on other Algæ. The frond is affixed to the rock by a slightly developed fibrous radicle, or simply by a disc, and consists of a single cylindrical elongated branching cell, filled with dense, starchy endochrome of a deep green colour, and destitute of any septum or interruption of the cavity throughout the whole length of the tube. The ramification is very generally on a pinnate type ; a primary undivided filament emits lateral virgate branches, also quite simple, and these are generally naked in the lower half of their length, and furnished with lateral, distichous or imbricated ramuli in the upper half. In some species, as in *B. Balbisiana*, there are either no ramuli or very few ; in others, as in *B. myura*, the ramuli are exceedingly numerous and densely set. Very many species have been named and described, with more or less care, by authors ; but many rest on very uncertain characters, and I fear that several must be regarded as mere varieties of *B. plumosa*, the original and most widely dispersed species. All are remarkable for a glassy lustre, when dry. They retain their colour, if carefully dried, and adhere closely to paper.

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1. BRYOPSIS *plumosa*, Lamour. ; frond setaceous, decompoundly much branched ; the ultimate branches filiform, virgate, naked in their lower half, and more or less plumoso-pectinate above ; ramuli simple. *Ag. Sp. Alg.* 1. *p.* 448. *Harv. Phyc. Brit. tab.* 3. *Kütz. Syst. Alg. p.* 493. *Ulva plumosa*, *E. Bot. t.* 2375.—Var. *β. densa ;* branches excessively crowded, the ultimate divisions pinnate near the apex, the pinnæ sometimes secund.—Var. *γ secunda ;* tufts matted ; fronds irregularly much branched ; branches flexuous, many of them naked, others set in the upper half with falcato-reflexed, secund (occasionally bilateral) ramuli. (Tab. XLV. A.) Var. *δ* ; *ramulosa ;* branches nearly naked, with a few scattered, secund ramuli. *Bryopsis ramulosa. Mont. Hist. Cuba, p.* 16. *Tab.* 3. *fig.* 2. (TAB. XLV. A.)

HAB. Between tide marks in rock pools. Various localities near New York, common. Charleston, South Carolina, and Key West. Vars. *β*, *γ*, and *δ*, intermixed with the ordinary form at Key West and Sand Key, *W.H.H.* (v. v.)

Root small, scutate, accompanied by lateral, entangled fibres, and sometimes matted.

Fronds 3–6 inches high, setaceous, much branched ; normally in a decompound pinnate manner, but very irregularly so. In what we may call typical or normal specimens, the outline of the frond is somewhat pyramidal, the lowest branches being very long and patent, the upper gradually shorter and more erect. In such specimens the branches are sometimes simply, sometimes doubly pinnate ; in either case the lower half of the branch or branchlet is bare, the upper plumose, with simple ramuli inserted in nearly distichous order. To describe every variety of ramification different from this, and commonly occurring in this species, would be an endless and useless task ; and worse than useless to found new species on such variations. I have endeavoured above to indicate the principal varieties which I have observed among American specimens. The var. γ *secunda* looks very like a distinct species, and had I seen none but carefully selected specimens, possibly I should have so regarded it ; but though many specimens may be found strictly conforming to the character assigned, having all their ramuli secund and recurved, others occur, growing intermixed with them, in which the ordinary ramulification is followed. At Key West I collected some specimens which I cannot distinguish from *B. ramulosa*, Mont., and which seem to pass through var. γ and other intermediate forms, into ordinary *B. plumosa.* Having received from Dr. Montagne himself an authenticated specimen of his plant, I can speak with more confidence.

Bryopsis plumosa, under one or other of its many forms, is found in most parts of the world, at least within the temperate and tropical zones. In Europe it occurs as far north as the Faroe Islands (lat. 65°). In the Southern Ocean it extends to Cape Horn, and the Falkland Islands, and to New Zealand. The *B. Rosæ* of the Southern Hemisphere seems to be merely a luxuriant form, and not a distinct species.

Plate XLV. A. *Fig.* 1. Bryopsis *plumosa*, var. γ *secunda ;* the *natural* size. *Fig.* 2 and 3, secund and bilateral plumules from the same ; *magnified.* Fig. 4. *B. plumosa*, var. δ *ramulosa ;* the natural size. *Fig.* 5, imperfectly pinnulate branch from the same, *magnified. Fig.* 6, apex of a branchlet, more highly magnified.

2. Bryopsis *hypnoides*, Lamour. ; frond setaceous, decompoundly much branched ; branches spreading to all sides ; ultimate branches filiform, naked below, beset above with scattered or crowded, irregularly inserted, very slender, byssoid, pinnated ramuli. *Grev. Alg. Brit. p.* 180. *Harv Phyc. Brit. tab.* 119. *Wyatt, Alg. Danm. No.* 81. *Harv. Man. p.* 146. (quere Lam. *Jour. Bot.* 1809. *p.* 135 ?) *B. cupressoides*, *Lam. fide I. Ag.*

Hab. Key West, *W.H.H.*, *Dr. Blodgett*, *Professor Tuomey.* (v. v.)

Tufts dense, 4-6 inches high. *Fronds* setaceous, much branched, the branches issuing from all sides of a common stem or central filament, long and virgate, either quite simple, or bearing a second set of similar quadrifarious branches. These branches, as in *B. plumosa*, though sometimes ramulose nearly to the base, are generally naked in their lower half, and beset with ramuli only above. The ramuli are exceedingly slender, many times more so than the part of the branch from which they spring, and are generally furnished with opposite or scattered, slender pinnules. The colour is a pale yellow green ; the substance exceedingly soft and tender.

The figure given in Phyc. Brit., taken from West of Ireland specimens, does not very well represent the Key West plant, which, however, closely resembles specimens from the South Coast of England and coast of Normandy, except that they are rather more luxuriant. This plant is generally of a much paler colour and still softer substance than *B. plumosa*, and is distinguished from the varieties of that plant by its *ramuli* being compound (pinnate), as well as greatly more slender than those of *B. plumosa.*

ORDER II.—DASYCLADEÆ.

Dasycladeæ and Polyphyseæ, Kütz. Phyc. Gen. p. 311–312. *Valonieæ, in part. Kütz. Sp. Alg. p.* 507. *Part of Siphoneæ, Auct. alior.*

DIAGNOSIS. Green, marine Algæ, naked, or coated with carbonate of lime, having a unicellular simple or branched axis, which is whorled, either throughout its whole length, or near the summit, with articulated ramelli. *Spores* spherical, developed in proper fruit-cells.

NATURAL CHARACTER. *Root* formed of tubular, elongated, branching fibres more or less matted together. *Frond* either simple or branched, essentially consisting of an axis and of ramelli. The *axis* is in all cases a continuous tube, without articulation or septum, running throughout the frond, containing endochrome in a young stage, but very frequently found empty in the mature plant ; and is apparently formed by the evolution of a single cell. Its walls are thick, tough, and readily seen, when a cross section is examined under the microscope, to be composed of successive concentric layers of cellulose. At regular intervals, either throughout the whole length of the axis, or in its upper half only, the tube is pierced by a circle of holes, and from these holes there issue whorled, articulated, confervoid ramelli, which appear to discharge the functions of leaves, and are sometimes deciduous, sometimes persistent. In the less complex genera, *Polyphysa* and *Acetabularia*, the ramelli are extremely delicate and fugacious, and are found only on young plants, or during the process of evolution ; their position being indicated on plants from which they have fallen, by the circle of holes in which they had been inserted. In *Dasycladus* the ramelli are permanent, and thickly clothe every part of the stem, in whorls sometimes very closely placed, sometimes sub-distant ; but there is no connection among the ramelli or between the whorls. In *Neomeris* the structure of the stem and ramelli is very similar to that of *Dasycladus*, with this difference, that the apices of the ramelli cohere to form an investing membrane or epidermis which completely encases the frond and conceals its filamentous structure. In *Cymopolia*, again, we have a still further advance in structure ; for, not to speak of its calcareous shells, every node of which the branching frond is composed may be compared to the whole frond of a *Dasycladus* or a *Neomeris*. Like them, it is a tubular axis whorled with ramelli ; but these latter are so closely placed together that the whorled character is not obvious, and the branch has the mammillated look of a *Codium*, if its calcareous shell be removed ; or of a piece of honeycomb, if viewed with the shell still remaining.

The *spores* are of large size, and are always formed within proper fruit-cells or sporangia, and, so far as I am aware, are destitute of vibratile cilia, and appear to be formed on a much more perfect type than ordinary zoospores. They have a tough, hyaline, membranous coat, and enclose a mass of dense, dark green or brown endochrome. In *Polyphysa* and *Acetabularia* the sporangia spring directly from the axial tube ; in *Dasycladus*, *Neomeris*, and *Cymopolia* they are found on the ramelli, and are either special cells, developed in the axils of the ordinary cells (as in *Dasycladus)*, or are formed by metamorphose of a division of the ramellus, as in *Cymopolia*.

All the plants of this order, with the exception of *Dasycladus*, secrete carbonate of lime, but in very different proportions. In *Polyphysa* and *Acetabularia* the calcareous matter exists as a thin varnish to the surface of the stem ; but in *Cymopolia* it forms as complete a shelly envelope as it does in one of the calcareous polypes, and indeed a dead frond in this genus might readily be mistaken for the husk of a zoophyte : its honeycombed pores closely resembling polype-cells.

All the species are natives of the warmer parts of the sea. *Dasycladus* and *Acetabularia* have representative species in the Mediterranean ; and the latter is found also in the tropical Pacific. *Neomeris*, which may probably yet be detected on the Floridan Keys, has species in the West Indies and Pacific Ocean. *Cymopolia* is found in the Carribean Sea, and also at the Canary Islands. *Polyphysa* was discovered by Dr. R. Brown at King George's Sound, and has recently been found at Port Lincoln, Australia, by Mr. Wilhelmi ; and at Swan River, by Mr. George Clifton.

I am very unwilling to multiply families, especially among plants of such low organization as the Chlorospermatous Algæ, and yet I have been in a manner compelled to remove from the *Siphonaceæ* both the little group now described, and the following one *(Valoniaceæ);* from the impossibility of devising any diagnostic character which would include the whole. The true *Siphonaceæ* are typically known by being wholly formed of long, tubular branching cells. In the *Dasycladeæ* the axis only is of this character ; the rest of the frond consists, as in *Conferva*, of strings of short cylindrical cells ; and the *spores* are of a higher type than in *Siphonaceæ*. In *Valoniaceæ* tubular branching cells are found, if at all, only in the root, or in a spongy caudex, while the principal part of the frond is formed of confervoid filaments. They approach *Dasycladeæ* through *Chamædoris*, and possibly Kützing may be correct in associating them, as he has done in his latest arrangement, with this group ; but, ignorant as we are of their proper fructification, I have not ventured to adopt this course. The habit of the true *Valoniaceæ* is dissimilar, and in none of them do we find the ramelliferous internodes which characterise the present family.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

I. CYMOPOLIA. *Frond* with a calcareous, branching, articulated shell; the internodes honeycombed; apices emitting pencilled ramelli.

II. DASYCLADUS. *Frond* soft, unbranched, set throughout with closely placed whorls of trichotomous, horizontal ramelli.

III. ACETABULARIA. *Frond* with a filiform, incrusted stipes, terminating in a peltate disc formed of radiating fruit-cells *(sporangia.)*

I. CYMOPOLIA. *Lamour.*

Frond filiform, dichotomous; its outer crust (or shell) calcareous, thick, distinctly articulate, the articulations everywhere pierced with pores, and the younger nodes fringed with byssoid, multifid fibrillæ. *Inner frond* (enclosed in the crustaceous shell) a membranous, continuous branching hollow tube, nodoso-constricted and moniliform, but not septate; the *nodes* when young fibrilliferous, at length bare; the *inter-nodes* whorled with several rows of short, horizontal, 3–4-fid, club-shaped ramelli, which protrude through the pores of the outer crust. *Sporongia* globose, borne on the club-shaped ramelli.

The frond in this genus consists of two distinct and separately organised systems—one mineral, and which wholly disappears when the plant is put into muriatic acid; the other vegetable, of the same texture, substance, and very similar organization to the frond of the following genus *(Dasycladus)*; but still more nearly akin to another genus, *Neomeris*, not yet recorded from our shores, but which very probably exists on the Florida reefs, as one of its species is found in the West Indies. For sake of greater clearness, I have, in the above diagnosis, first described the outer crust, or frond, as it appears when lifted from the sea; and then given the characteristics of the vegetable axis which is brought to light when the calcareous envelope has been removed by acid. When the plant is alive, and seen under water, its green colour, and the rich pencils of delicate, bright green byssoid fibres that crown all the growing branches and their divisions, at once suggest its vegetable nature. But when seen dry and dead on the shore, where all these fibres and the green colour disappear, the resemblance to a porous zoophyte is so great, that it is no wonder that this Alga should, until quite recently, have had a place in the animal kingdom. The pores of the crust may easily pass for polype cells, and the enclosed tube has, when dry, an almost horny consistence.

Two species, *C. barbata* and *C. rosarium* are usually kept up, and Kützing has added a third, *C. bibarbata*, but it seems to me that the differences indicated have reference more to the age and state of individual specimens, than to difference of species. The fringing or non-fringing of the apices with fibrillæ surely depends on the state of the specimen. The fibrills are homologues of leaves, and, like leaves, are deciduous when they have performed their functions. I had abundant opportunities of studying the species at Key West, and see no ground for believing that there is more than one as yet known to botanists.

1. CYMOPOLIA *barbata*, Lamour. *Cor. Flex. p.* 293, *and C. rosarium, l. c. p.* 294. *Kütz., Sp. Alg. p.* 511. *Corallina barbata, Lin. Syst. Nat. Ed.* 12, *p.* 1305. *Ellis and Sol. Zoop. p.* 112. *Ellis, Cor. p.* 54, *t.* 25, *f. C. C. rosarium, Ellis and Sol. Zoop. p.* 111, *t.* 21, *fig. h. Sloane, Nat. Hist. Jamaica, t.* 20, *fig.* 3. *Cymopolia bibarbata, Kütz. Phyc. Gen. t.* 40, *f.* 2. *Kütz. Sp. Alg. p.* 510. (TAB. XLI. A.)

HAB. Near low-water mark, under the bridge at Key West. *W. H. H.* (v. v.)

Fronds tufted, at first simple, till they attain to one or two inches in height, then becoming branched, at first by the development of simple alternate branches. These afterwards fork at their extremities, and throw out lateral branches ; and by continual repetitions of this process of division the frond at length becomes much branched in a di-trichotomous but irregular order. The tendency to become dichotomous is greater in the older specimens ; the branches in all are fastigiate. Every part of the frond, except the young tips of the branches, is invested with a thick calcareous, brittle crust, pierced with innumerable horizontal canals, opening at the surface by pores, arranged in transverse rings, which are so closely placed together that the surface appears as if honeycombed. In these canals of the crust the ramelli of the enclosed vegetable lie hid, the points only of their divisions protruding through the pores, and this only in the younger parts, which then have a green colour. The calcareous crust is regularly articulated at short intervals ; the internodes in the main stem and branches are about twice as long as broad, those in the young parts of the frond spheroidal and bead-like. The *nodes* are much contracted throughout, and thus each branch looks like a string of beads. In the older parts the nodes are bare ; but in the younger, toward the ends of the growing branches, they emit whorls of extremely delicate, byssoid, di-tri-chotomous or multifid, membranaceous fibrills ; and whorls of similar fibrills terminate the young branch itself. The branches in the developing plant are thus penicillate or barbed at the extremity. When a piece of a frond is macerated in acid, so as to remove the calcareous crust, the true frond becomes visible. This we must now describe. It consists of a continuous, tubular axis or filament, seemingly formed of a single, cylindrical, branching cell, which runs through every part of the calcareous covering, and whose growing apices, clothed with byssoid fibres, protrude at the ends of the branches. This filament is nodose, annularly constricted at short intervals, corresponding to the articulations of the crust ; but there are no internal septa. The wall is very thick and tough, and is evidently seen, under the microscope, to be formed of concentric layers, deposited one within another, as in the cell-wall of the *Caulerpœ.* When a transverse section of a branch is examined, the ring of cell-wall appears as if divided into numerous cells, corresponding in number to the ramelli that issue from it ; the apparent septa of these supposed cells being placed opposite the insertion of the ramelli. This would suggest a structure not very different from what I have just described ; namely, that the axial tube was not a single cell, but a tube formed by the lateral cohesion of a number of small, cylindrical, longitudinal cells, placed in a circle ; a structure not very different from what occurs in *Batrachospermum.* After repeated examinations and dissections I am disposed to think that the appearance of cell-division in the wall is deceptive, and that what look like septa are prolongations inwards, through the wall, of the bases of the ramelli. The internodes of the axial filament are beset with very closely placed whorls of horizontal *ramelli*, each composed of a primary, and 3 or 4 secondary, clavate cells ; the primary cell issuing from the substance of the wall of the axial tube, and forming the basal portion of the ramellus ; the secondary cells springing from its apex. The primary cell is obconical ; the secondary more clavate, and inflated at the point. *Fructification* takes place by the transformation of one of the secondary or terminal cells of the ramellus, which is changed into a spherical *sporangium*, filled (at first) with dense, dark green granular matter, surrounded by a pellucid margin, and raised on a short stalk. Whether it eventually contains *spores* or only *zoospores*, I have not determined ; analogy with *Dasycladus* would lead us to the former inference. The *colour* of the frond, when growing, is a pleasant, and rather a full, yellow green ; when dry, the calcareous crust fades to a dirty white, and the tufts of byssoid apical fibrills become brown or black, staining the paper to which they adhere.

Ellis's figures, quoted above, are both characteristic ; and so also is that in Sloane's Jamaica, though rude and without analysis. Lamouroux strangely misquotes, under his *C. rosarium*, Sloane, Tab. 20, fig. 4, which is a very fair representation, not of a *Cymopolia*, but of *Amphiroa fragilissima.*

Plate XLI. A. *Fig* 1. Cymopholia *barbata ;* the *natural* size. *Fig.* 2. Apex of a branch, crowned with its pencil of byssoid fibres. *Fig.* 3. Transverse section of a branch, from which the calcareous shell has been removed. *Fig.* 4. Small portion of the same, showing a *sporangium* formed from one of the peripheric ramelli. *Fig.* 5. Portion of a longitudinal section of a branch, to show the insertion of the horizontal ramelli, and the holes on the inner face of the cell wall. *Fig.* 6. Byssoid fibres from the apical pencil. *Fig.* 7. Tips of the same ; the latter figures more or less highly *magnified.*

II. DASYCLADUS. *Ag.*

Frond destitute of calcareous crust, soft, and flaccid, cylindrical or club-shaped, unbranched, composed of a tubular, unicellular filiform axis, beset throughout with closely placed whorls of trichotomous, horizontal, articulate ramelli. *Sporangia* globose, affixed to the nodes of the ramelli, and containing, at maturity, very numerous spherical spores.

Small, densely tufted, erect plants, with almost spongy fronds, so densely are the ramelli frequently inserted. Their substance is very soft and flaccid, but tough, and the colour a full dark green. The membrane composing the frond is every where hyaline, and becomes glassy when dry ; the colouring matter is viscid and granular as in *Bryopsis*. The genus was founded by Agardh on *D. clavæformis*, a common Alga in the Mediterranean ; and Meneghini has described a second species from the Adriatic. I now venture to add a third, which I was formerly disposed to consider as identical with *D. clavæformis*.

1. Dasycladus *occidentalis ;* whorls sub-distant ; apices of the ramelli very obtuse. (Tab. XLI. B.)

Hab. On rocks between tide marks, on the Florida Keys. Key West, *Dr. Wurdemann*, *W. H. H.* Key Biscayne, *Prof. Tuomey.* (v. v.)

Root discoid, throwing out a few clasping fibres. *Fronds* mostly densely tufted, sometimes solitary, 1–2 inches high, clavate, from a line to nearly half-an-inch in diameter (including ramelli) erect, straight or curved, destitute of calcareous incrustation; consisting of a filiform, unbranched, unicellular axis, whorled throughout with densely inserted polychotomous ramelli. The axial filament varies in diameter from the thickness of a human hair to twice the diameter of hog's bristle ; it is cylindrical, with a continuous cavity filled with endochrome, and seems to be developed from a single cell. Its wall is very thick, tough, and composed of several distinct layers of cellulose, concentrically deposited. The filament is marked externally, at short intervals, varying in distance in different specimens, with transverse rings or *nodes*, which give an appearance of joints (but there are no internal septa) ; and immediately above each node from six to twelve horizontal ramelli are inserted in a whorl, and in denuded specimens their places are indicated by a whorl of disc-like scars surmounting the node. The ramelli vary much in length and in density. In some specimens the internodes are so short that the frond seems continuously clothed, like the spongy frond of a *Codium*, from base to apex ; the axis being completely concealed by the ramelli. In others the internodes are as much as a line in length, and the whorls appear sub-distant, like those of a *Myriophyllum*. Sometimes the ramelli are scarcely a line long ; in other specimens they are 2–3 lines or more. In all cases they are tri-dichotomous, twice or thrice compounded and articulated ; being formed of two or three series of nearly cylindrical cells, four to six times longer than broad, filled with dark green slimy endochrome. The terminal cells are very obtuse. *Fructification* is formed at the axils of the ramelli, where two or three supplementary cells are developed and become spherical *sporangia*, by absorbing all the endochrome of the cells from which they spring, and finally that of the whole frond. When ripe, these sporangia are membranous bags, stuffed with innumerable spherical spores. *Colour*, a deep grass-green. *Substance*, soft and somewhat gelatinous.

This species closely resembles, in habit and structure, *D. clavæformis* of the Mediterranean ; but the ramelli, even in the densest specimens, are much more distantly placed than in that plant, and the apices (or terminal cells) of all the American individuals I have examined are perfectly blunt ; not mucronulate, as they are in *D. clavæformis*. If this distinction prove constant, the species will be sufficiently characterised.

PLATE XLI. B. *Fig.* 1. DASYCLADUS *occidentalis ;* the normal form. *Fig.* 2. An attenuated and depauperated variety ; both figures the *natural* size. *Fig.* 3. Transverse section of the frond, showing a whorl of trichotomous ramelli. *Fig.* 4. Portion of a fertile ramellus with *sporangia*. *Fig.* 5. A *sporangium*. *Fig.* 6. *Spores* from the same ; all the latter figures *magnified*.

III. ACETABULARIA. *Lamour.*

Root scutate. *Frond* stipitate, umbrella-shaped, thinly incrusted with calcareous matter. *Stipes* tubular, unicellular, cylindrical, when young emitting whorls of byssoid fibrills at and below the summit ; when mature, crowned with a peltate disc, formed of numerous radiating cuneiform cells. Cells of the disc at first containing granular endochrome, which is afterwards changed into spherical spores.

The two species which are included in this genus are among the most elegant and singular of the Algæ, resembling delicate fungi of the genus *Agaricus*, more nearly than any marine production. This is, however, descriptive only of the fully grown plant, for in the young state, the peltate umbrella which crowns the stipes is not found. In the youngest specimens which I have examined (represented at fig. 2 in our plate) the upper part of the stipe is beset at sub-distant intervals with whorls of extremely slender byssoid fibrills, above the last of which a young disc is commencing to be formed. In older plants these fibrills drop away, and their position is indicated by an annular row of holes, the tube being also swollen at each whorl, so as to appear jointed. There are no septa, however, and the tube is continuous, at least to the base of the young disc. When the disc is further advanced, a dense pencil of fibres springs from its centre, on its upper surface, or from what may be called its *umbo*, and which is really the growing point of the frond. I regard the disc as being properly a whorl of *sporangia*, united by their edges ; each radiating cell constituting a sporangium. The discs, after they have developed spores, are deciduous ; and new ones are successively formed, one above the other, as the stipe lengthens.

1. ACETABULARIA *crenulata*, Lamour. ; margin of the peltate disc minutely crenulate ; the cells apiculate (when young). *Lam. Pol. Flex. p.* 6, *Tab.* 8, *fig.* 1. *Kütz.*, *Sp. Alg. p.* 510. (TAB. XLII. A.)

HAB. Rocks and corals, within tide marks, on the Florida reefs. Key West, *W.H.H.*, *Prof. Tuomey* (v. v.)

Root minute, discoid. *Fronds* scattered or tufted, two or three inches high, consisting of a slender, setaceous stipes, thinly coated with carbonate of lime, and bearing at its summit a peltate disc or cup, radiated like an agaric, and formed of clavato-cylindrical cells cohering by their edges, and filled with green endochrome. The stipes, when deprived of its lime by maceration in acid, forms a membranous, cylindrical tube, destitute of markings, slightly enlarged upwards, having near its summit one, two, three, or more (according to age) annular swellings, from which issue whorls of very delicate, polychotomous, byssoid ramelli, and terminating in the first formed disc, from whose centre a pencil of similar byssoid fibres is produced. In further growth, the stipes proceeds through the first disc upwards for a distance of 1–2 lines, where another annulus emits a second whorl of filaments, above which a second disc is formed ; and thus, by successive apical growths new discs succeed each other, the older falling off as the younger are formed. In old specimens, therefore, you find the upper part of the stipe furnished with 4–5 or more annuli, marked with scars of the fallen ramelli and discs. In full grown specimens, the peltate disc, or circle of sporongia, is nearly half-an-inch in diameter. At first the matter contained in its cells is fluid and homogeneous. Eventually nuclei are formed in it, and the contents of each cell is converted into numerous globose spores, the whole endochrome being consumed in the process. The cell-wall of the stipe is thick and concentrically striate.

This species very closely resembles *A. Mediterranea*, from which it is distinguished by the minutely crenulate margin of the disc. In *A. Mediterranea* the margin is quite entire.

Plate XLII. A. *Fig.* 1. ACETABULARIA *crenulata ;* the *natural* size. *Fig.* 2. Apex of a young frond, before the development of the peltate disc. *Fig.* 3. A young disc, within which is a pencil of byssoid fibres. *Fig.* 4. A mature disc. *Fig.* 5. Apex of one of the radiant cells, from a young disc in which they are mucronate. *Fig.* 6. One of the radiant cells of a mature disc, converted into a *sporangium*, and full of *spores*. *Fig.* 7. *Spores* from the same : all the latter figures *magnified*.

ORDER III.—VALONIACEÆ.

Valonieæ, in part, Kütz. Sp. Alg. p. 507. *Anadyomeneæ, Dictyospherieæ, and part of Codieæ, Kütz. l. c. Siphoneæ, in part, Auct. alior.*

DIAGNOSIS. Green marine Algæ, naked or encrusted with carbonate of lime, with fibrous roots. *Frond* polymorphous, formed of large vesicated cells filled with watery endochrome; either consisting of a single cell, or of several united into filaments, or into net-works or membranous leaf-like expansions.

NATURAL CHARACTER. *Root* in most cases well developed, and consisting of a plexus of tough fibres, forming a mat, and either penetrating the sand or grasping firmly to the rock or stones on which the plant grows. *Frond* very variable in form, and in complexity of structure. In *Valonia* the whole frond, in some species, consists of a single vesicated cell, which is often of large size, upwards of an inch in length, and three-quarters of an inch in diameter, filled with a thin, watery endochrome. In other species of that genus, several such cells are strung together so as to form confervoid branching filaments. In *Dictyosphæria*, a number of large globose cells cohere together in a single stratum, and thus form a tessellated or honey-combed membrane. In *Anadyomene*, the membranous expansion is formed in a different manner, namely, by the lateral cohesion and anastomosis of a branching filament; and in *Microdictyon*, a network is formed in a similar way, the difference from *Anadyomene* being, that the branches of the generating filament stand apart, leaving open spaces between their anastomosing ramuli. A further advance in structure occurs in *Penicillus*, where the frond has a dendroid habit; the trunk of the treelike body being composed of branching, unicellular filaments like those of a *Codium*, and the head of confervoid, articulated filaments like those of *Valonia*. This spongy caudex, or trunk, appears to me to be merely an exaggeration of the rooting processes, common to most plants of the family. A more definite stipes, or true stem, is found in *Chamædoris*, *Apjohnia*, and *Struvea*, the most highly organised genera of the Order, and those which connect it with the *Dasycladeæ*. In these the stipe is monosiphonous, and is developed nearly to its full size before any part of the capitulum makes its appearance. In the early stage these plants are not to be known from the simple *Valoniæ*, and like them consist of a single cell rising from a branching root.

In this description of the fronds of the Order I omit the curious plant which will be found described below under the name *Blodgettia*, because it is not quite certain whether it be properly a member of this series; or possibly the type of a separate family.

The fructification of none of these plants is satisfactorily known.

All are natives of tropical and sub-tropical latitudes. The Penicilli or *Merman's Shaving Brushes* are characteristic of coral reefs, and are found in the Caribbean Sea, and on the shores of Australia and of the Indian archipelago. *Anadyomene* is common to the Mediterranean Sea, the Gulf of Mexico and the shores of Brazil. *Dictyosphœria* is tropical and Australian. *Valonia* is found in most western oceans, and ought to occur on the Floridan Keys, though not yet found there. *Microdictyon* is generally a deep water production, lying at the bottom in 5–10 fathoms; but it sometimes occurs at low water mark. Species of it, all very similar to each other, have been found in the tropics of both hemispheres and in the Mediterranean; and one is very abundant in Port Jackson, Australia. *Struvea* is confined to the West coast of Australia, and *Apjohnia* to the Southern coast. *Chamœdoris* is Caribbean; and *Acrocladus*, Næg., a closely allied form, is found in the Mediterranean.

TABLE OF THE NORTH AMERICAN GENERA.

* *Dendroid; stipitate, crowned with tufted filaments.*

I. Chamædoris. *Stipes* monosiphonous, annulated; head very dense.

II. Penicillus. *Stipes* formed of innumerable interwoven filaments, spongy; head brush-like.

** *Confervoid; densely tufted.*

III. Blodgettia. *Frond* filamentous, articulated, branching, densely tufted.

*** *Membranous, leaf-like.*

IV. Anadyomene. *Membrane* erect, flabellately veined; veins articulated, confervoid, radiating from the base toward the margin.

V. Dictyosphæria. *Membrane* amorphous, wholly formed of spherical cells lying in a single stratum.

I. CHAMÆDORIS, Mont.

Root much branched. *Frond* stipitate, dendroid. *Stipes* at first clavate, then cylindrical; tubular, unicellular, horny-membranous, annularly constricted and corrugated, at length crowned with a dense fascicle of confervoid, much branched, articulate ramelli. *Fruit* unknown.

Young and full grown specimens of the little Alga which constitutes the present genus are so unlike that they might readily pass for different entities. The frond originates in a dense mass of branching, horny-membranous, intricate, rooting fibres, from which spring erect unicellular branches, or fronds. These are at first quite simple and naked; but afterwards develope from their summit two or three very closely placed whorls of much branched ramelli, which form a dense, fasciculate capitulum. The frond is then mature and resembles a little tree; or perhaps, more justly, a little mop. The genus was founded by Montagne in 1842, by a separation from *Penicillus*.

1. CHAMÆDORIS *annulata*, Mont. *An. Sc. Nat. Ser.* 2, *vol.* 18, *p.* 261. *Kütz. Sp. Alg. p.* 509. *Nesœa annulata*, *Lamour. Pol. Flex. p.* 256. *Corallina peniculum*, *Ell. and Sol. Zoop. p.* 127, *tab.* 7, *fig.* 5–8 *and tab.* 25, *fig.* 1. (TAB. XLII. B.)

HAB. Key West, rare. *W. H. H.*, *Dr. Blodgett.* (v. v.)

Root composed of many branching and clasping, tufted fibres, which issue from the base and lower part of the stipes, and at length form a dense mat. *Fronds* tufted, 2–3 inches high, nearly a line in diameter, tubular, simple, membranaceous or somewhat horny, destitute of calcareous incrustation except in old age, when they are thinly coated toward the base; cylindrical, annularly constricted at short intervals as if jointed, the internodes most apparent on old specimens, when the annular constrictions are deeper. In the young state the frond consists merely of such an annulated tube, formed of a single cell. When this has attained the height of two or three inches, it ceases to grow longer; a septum is formed just below the summit, and a new cell begins there to develope. This second cell is very short, and again divides, once or twice, vertically; so that the original tubular cell (now to be called the *stipe)* is crowned with two or three minute cells, placed one above the other (TAB. XLII. *fig.* 3), the terminal one being attenuated and pointed. These cells remain short and rudimentary, but from their nodes dense whorls of *ramelli* begin to grow *(fig.* 4), which finally constitute a dense, mop-like capitulum. When fully grown the capitulum is an inch or more in diameter, globose, very dense, composed of innumerable, crowded and interwoven, much branched, irregularly dichotomous, articulated filaments. The articulations are cylindrical, constricted at the nodes and many times longer than broad; but variable in length. *Colour*, a bright, grass-green. *Substance*, membranaceous, rather rigid and tough, not adhering to paper in drying. Thin slices of the tube, when examined under the microscope, show concentric lines of growth, as in *Dasycladus*, &c.

This plant is rare at Key West, and none of my specimens are fully grown. It is a native of the West Indian Islands.

PLATE XLII. B. *Fig.* 1. CHAMÆDORIS *annulata*, the *natural* size. *Fig.* 2. A young, unicellular frond, previous to the formation of the capitulum. *Fig.* 3. Apex of a frond in a more advanced stage, showing the newly formed axial cells of the future capitulum. *Fig.* 4. Apex of a still more advanced young frond, with the capitulum beginning to be formed. *Fig.* 5. Portion of the capitular filament; the latter figures more or less *magnified.*

II. PENICILLUS. *Lamarck.*

Root fibrous, much branched, matted. *Frond* stipitate, dendroid. *Stipes* erect, cylindrical or compressed, incrusted, wholly composed of numerous longitudinal, unicellular branching filaments woven together into a compact spongy mass; and crowned with a dense pencil of confervoid, articulate ramelli, whose branches are either free, or cohere together in fan-shaped laminæ, and are invested with a porous pellicle of carbonate of lime.

If Mer-men have beards and shave them, the Algæ included in this genus may serve as shaving brushes. The *root* is much branched and its fibres matted together, and generally penetrates deeply into the sand in which the plant grows. The stipe is more or less coated with carbonate of lime, and composed of a multitude of closely placed and densely interwoven longitudinal, unicellular filaments, which send off laterally, throughout their length, short, fastigiate, corymbose ramelli, that unite together to form a periphery. Thus far we have a structure closely agreeing with that of a *Codium.* But from the apex of this compact, spongy stipe there springs a dense tuft or capitulum, composed of dichotomous, articulated, free filaments; and the whole frond bears a striking resemblance to a shaving brush. The habit is similar to that of *Chamædoris*, from which the spongy, multicellular stipe distinguishes it; and to *Chlorodesmis*, which differs in having a capitulum formed of unicellular filaments.

The species naturally arrange themselves in two groups, or sub-genera, which Kützing has separated; a separation which is hardly needed, where the species are so few in number and so closely related in structure.

Sect. 1. HALIGRAPHIUM, Endl. (*Corallocephalus*, Kütz.); branches of the capitulum free.

1. PENICILLUS *dumetosus*, Dne.; stipes short, thick, somewhat compressed, velvetty; filaments of the capitulum loosely spreading, ultra-setaceous, flaccid, deep-green; their joints cylindrical, many times as long as broad, equal, obtuse, strongly constricted at the nodes. *Dne. Cor. p.* 97. *Nesæa dumetosa*, *Lamour. Polyp. p.* 259. *pl.* 8, *fig.* 3, *a. B.* *Corallocephalus dumetosus*, *Kütz. Sp. Alg. p.* 506. (Tab. XLIII. A.)

HAB. Key West and Sand Key, *W.H.H.* Soldier's Key, *Prof. Tuomey.* (v. v.)

Root, a dense mass of fibres deeply sinking in the sand. *Stipes*, 1–3 inches long, half-inch to nearly an inch in thickness, sometimes rather hollow in the centre, more or less compressed, erect, coated with a velvetty scurf, and partially incrusted with calcareous matter; nearly destitute of lime when young, much incrusted with it in old age. This stipes is composed of innumerable, densely packed, longitudinal, unicellular fibres which closely adhere by lateral branching processes, and are interlaced together. The outer strata of these fibres emit, to form the periphery of the stipe, innumerable short, lateral, horizontal, multifid, fastigiate ramelli, whose apices, lying close together, give the velvetty appearance to the surface. As long as these longitudinal filaments cohere into a stipe they are unicellular; but when they become free at the apex of the stipe, they are articulated, or pluricellular; and a capitulum of confervoid filaments completes the frond. According to the age of the specimen, the filaments of the capitulum are more or less developed; in young specimens they are less than an inch long; in older and full-grown ones they vary from 3 to 6 inches. They are densely, but not intricately tufted, thicker than hog's bristle, dichotomous, radiating to all sides, equal and obtuse; their articulations are cylindrical, and many times longer than broad. The colour is a full, deep green, and they are very thinly incrusted with lime; the crust pierced with minute pores. The primordial utricle separates readily from the cell-wall, and is firmly membranous.

Plate XLIII. A. *Fig.* 1, 2, 3. Penicillus *dumetosus*, of different ages: the *natural* sizes. *Fig.* 4. Portion of one of the dichotomous filaments of the capitulum. *Fig.* 5. Small portions of the same, after the calcareous coating has been removed, showing a pitted surface; the latter figures more or less *highly magnified.*

2. Penicillus *capitatus*, Lamk.; stipes long or short, cylindrical or clavate, terete, incrusted, smooth; filaments of the globose capitulum densely crowded, fastigiate, capillary, rigid, pale green, their joints cylindrical, many times as long as broad, obtuse, constricted at the nodes. *Dne. Cor. p.* 97. *Nesœa Penicillus, Lamour. Pol. flex. p.* 258. *Corallina Penicillus, Ell. and Sol. p.* 126, *tab.* 25, *fig.* 4, 5. *Corallocephalus Penicillus, Kütz. Sp. Alg. p.* 505. (Tab. XLIII. B.)

Hab. Key West, *W. H. H.*, *Prof. Tuomey.* (v. v.)

Root very large, two inches long or more, deeply descending, very fibrous and densely matted. *Stipes* from one to four or five inches long, a quarter to a third of an inch in diameter, mostly cylindrical and equal throughout, occasionally compressed and widened upwards, thickly incrusted with calcareous matter, and having a smooth and sometimes a polished surface. *Capitulum* very dense, mostly globose, sometimes oblong and rarely somewhat diffuse, fastigiate, one or two inches in diameter, composed of innumerable, curved, densely packed and often entangled, capillary filaments which are encrusted with calcareous matter to an extent that makes them rigid. The structure is similar to that of the preceding species; and the calcareous incrustation is similarly dotted or pitted. The length of the articulations varies much; usually they are many times as long as broad; but now and then a short, globose articulus is interposed between the two long ones. *Colour*, a pale green.

PLATE XLIII. B. *Figs.* 1, 2, 3. PENICILLUS *capitatus*, different varieties; the *natural* size. *Fig.* 4. Portion of a dichotomous filament from the capitulum. *Fig.* 5. Small portion of the same, after the lime has been removed; the latter figures more or less highly *magnified.*

Sect. 2. HALIPSYGMA, Endl. (*Rhipocephalus*, Kütz.); branches of the capitulum cohering in flabelliform laminæ.

3. PENICILLUS *Phœnix*, Lamk.; stipes elongate, terete, incrusted, smooth; capitulum ovoid or oblong, its filaments incrusted, very slender, dichotomous, cohering by their edges into many distinct, flat, cuneate, level-topped, spreading laminæ. *Dne. Cor. p.* 98. *Lamk. An. Mus.* 20, *p.* 299. *Corallina Phœnix*, *Ell. and Sol. p.* 126, *t.* 25, *fig.* 2–3. *Nesœa Phœnix*, *Lamour*, *l. c. p.* 256. *Rhipocephalus Phœnix*, *Kütz. Sp. Alg. p.* 506. (TAB. XLIII. C.)

HAB. Key West, *W. H. H.* Dredged in 3½ fathoms off Soldier's Key, *Prof. Tuomey.* (v. v.)

Root somewhat fusiform, dense, descending. *Stipes* cylindrical, 1–3 inches long, a quarter inch in diameter, thickly incrusted with calcareous matter, the surface smooth, composed as in the rest of the genus of many slender longitudinal branching and ramelliferous threads. The filaments of the capitulum are thickly incrusted with calcareous matter, and disposed in many flat, cuneate, flabelliform laminæ; their ramifications lying close together, and cohering laterally by means of the incrustation. On removing the carbonate of lime the cohesion of the filaments is destroyed. The articulations are many times longer than broad, cylindrical, and much constricted at the nodes.

PLATE XLIII. C. *Fig.* 1. PENICILLUS *Phœnix*, the *natural* size. *Fig.* 2. Portion of one of the fanlike laminæ of the capitulum. *Fig.* 3. Cells from the same, after the removal of the lime; the latter figures more or less *magnified.*

III. BLODGETTIA, *Harv.* *(n. gen.)*

Frond cæspitose, branching, confervoid, articulate. *Articulations* unicellular, filled with grumous, viscid endochrome; the cell-wall formed of separable membranes, the outer of which are hyaline and homogeneous, the innermost traversed by parallel, longitudinal, anastomosing veinlets. *Spores* seriated in moniliform strings, and developed from the veinlets of the inner cell-wall (!)

The highly curious little Alga on which the present genus is founded so closely resembles a *Cladophora* that it will readily pass for one, unless it be very closely examined under a powerful microscope. Indeed so great is the resemblance to a branched *Conferva* that I formerly distributed it to my friends with the manuscript name of *Cladophora cæspitosa*, under which it was my intention to have described it in the present work ; nor did I discover my error until I commenced making sketches for the plate now given. I was then first struck by the peculiar opacity of the dissepiments ; and afterwards by what looked like a compound cellular structure in the walls of the cells. On applying a higher power, other characters came out which induced me to dissect one of the articulations, when I discovered the curious structure of the inner membrane or primordial utricle ; in which (as far as I can make out) the spores are developed. To see the structure, as above described, the readiest mode is to proceed as follows. Cut off a portion of one of the long cells which terminate the branches ; place it on the table of a dissecting microscope, moisten it, and you may readily express the viscid endochrome, which generally contains, besides the usual starch and chlorophyll grains, a number of pyramidal crystals ; but these are probably adventitious. When the endochrome has been pressed out, the structure of the inner membrane of the cell-wall may be partially seen ; but to see it clearly, the outer coats must be removed. This may readily be done, either by tearing, with a pair of dissecting needles, or by making a longitudinal section through the cell, when the different coats easily separate, on the section being *teased* in a drop of water. The outer coat, or coats (for there are *two* or more, though the secondary ones sometimes elude detection, owing to their extreme tenuity) are quite transparent and structureless, as is usually the case in the walls of cellular tissue. But the inner coat offers a peculiarity of structure which I have not noticed in any other Algæ, nor have heard of its occurrence in the cells of any other plant. At first sight the membrane seems to be composed of numerous minute, elongated fusiform cellules, not unlike the wood-cells of phanerogamous plants, but totally unlike any algæ-cells known to me. Careful examination has however convinced me that the appearance of cellular structure is deceptive ; and that the membrane itself is homogenous, but traversed by slender filaments or nerves, which anastomose together, forming areolæ which look like cells. These filaments give off *free* ramuli whose apices swell into spores ; and (probably) by repeated cell division produce the strings of roundish *spores*, which are so conspicuous in most of the areolæ. The appearance of the whole membrane with its spores is as if a number of the *asci* of a lichen were placed side by side ; the true structure, however, I need hardly say, is widely different.

The generic name is bestowed as a grateful tribute to the memory of the late Dr. Blodgett of Key West, who had zealously collected and studied the Algæ of the reefs where this plant grows, and to whom I am indebted for many specimens of the rarest Algæ of the Florida Keys.

1. BLODGETTIA *confervoides*, Harv. (TAB. XLV. C.)

HAB. At Key West, on rocks near low-water mark. *Dr. Wurdeman*, *W. H. H.*, *Prof. Tuomey*. (v. v.)

Fronds filamentous, densely tufted ; the tufts spreading extensively, from an inch to an inch and half in height, very dense, pulvinate and fastigiate. *Filaments* rigid, not collapsing when removed from the water, about as thick as hog's bristle, sparingly branched, decumbent at base, then ascending, and the tips erect. The main divisions and primary branches are very patent, either arching backwards or quite recurved. They are destitute of branches along their lower or outer side, and more or less furnished with unilateral ramification on the upper ; generally with a long excurrent point destitute of ramuli. Often the filament has but a single series of simple, secund ramuli ; but in luxuriant specimens there is a second series of similar secund ramuli. *Articulations* variable in length, dark coloured, with opaque dissepiments, and not collapsing when dry, contracted at the nodes, three to six times as long as broad ; the terminal cell always very much longer than the rest, and frequently 10–12 times as long as its diameter. *Apices* very blunt. The articulations are filled with dense, viscid endochrome full of large green granules, and frequently containing also prismatical crystals. The membranous cell-wall is divisible into three or more separate membranes, one concentrically placed within the other. The outer are hyaline without obvious structure ; but the inner one is reticulated with very slender nervelike fibres, which run longitudinally through the membrane parallel to each other, and are connected by oblique crossbars ; so that the surface is divided into narrow, pointed areolæ. The *spores* are seriated in moniliform strings, four or more in each string, and attached to short free veinlets which issue from the veins of the inner cell-wall. The *colour* when recent is a very dark green ; when dry it becomes more olivaceous. The substance is very firm, and the plant imperfectly adheres to paper in drying.

PLATE XLV. C. *Fig.* 1. BLODGETTIA *confervoides ;* the *natural* size. *Fig.* 2. Pectinated branch. *Fig.* 3. Apex of the long terminal cell of the branch, the lower portion represented with the outer cell-coats exfoliated. *Fig.* 4. Portion of the membrane of the innermost cell-coat traversed by slender fibres, bearing strings of *spores (?)*. *Fig.* 5. One of the moniliform strings, apart. *Fig.* 6. Some of the crystals found in the cells. All the latter figures more or less highly magnified.

IV. ANADYOMENE, *Lamour.*

Root fibrous. *Frond* stipitate, membranaceous, leaf-like, flabellately veined ; the veins confervoid, radiating from the base to the margin, pedately multifid, excessively branched, and everywhere closely anastomosing. *Fructification* unknown.

The frond in this genus is thin and membranous, and at first view resembles that of an *Ulva*, except that it is traversed everywhere by branching veins. When more closely examined it is easily perceived that the membrane is wholly formed by the anastomosis and lateral cohesion of the branches and ramuli of a much branched, articulated, confervoid filament, composed of large, oblong cylindrical cells ; as more fully detailed in the subjoined description. As Professor J. Agardh remarks (Alg. Medit. p. 24), it is nearly related to *Valonia*, from which it differs chiefly in the lateral cohesion of the branches of the generating filaments, and to which it bears the same relation that *Codium* does to *Vaucheria*. It is still more nearly related to *Microdictyon*, where the fronds form an open network.

1. ANADYOMENE *flabellata*, Lamour. ; frond flattish or undulate, the veins multipartite. *Lamour. Pol. Flex. p.* 365, *tab.* 14, *fig.* 3. *Bory*, *Fl. Mor. t.* 41, *fig.* 5, *Kütz. Sp. Alg. p.* 511. *A. stellata*, *Ag. Sp. Alg.* 1, *p.* 400. (TAB. XLIV. A.)

HAB. Key West, on tidal rocks, common. *Dr. Wurdeman*, *W.H.H.*, *Prof. Tuomey.* (v. v.)

Root consisting of a mat of branching, articulate, confervoid filaments, emitting erect branches which develope into flat, flabelliform, membranous fronds. *Fronds* tufted, 1–4 inches long and as much in width, rigidly membranaceous, shortly stipitate ; the stipes uni- or pluri-cellular ; lamina at first flabelliform and entire, afterwards undulate and more or less deeply lobed at the margin ; wholly composed of radiating, multifid, branching, confervoid filaments, whose distichous branches closely cohere throughout, and whose ramuli as constantly anastomose and coalesce. In other words, the membrane is composed of longitudinally seriated, cylindrical cells, several series radiating from the base toward the circumference in a flabellate manner, and dividing and subdividing digitately throughout the whole length of the series ; each cell emitting from its summit 5–7 or more similar cells, which in their turn put forth another series, and so on. In this way the frond increases in length. It is widened by the gradual evolution of other cells formed along the sides of contiguous parallel cells in a pinnate order. At first these lateral or transverse cells are very minute and placed opposite each other. They gradually lengthen, anastomose and coalesce, and at length form a reticulated space of a narrow wedge-form between each pair of tubular, longitudinal cells. The cuneate space looks like a membrane, but is really constituted of closely placed, transverse bars, leaving narrow slits between them, as may be readily seen by examining a dried specimen when the substance shrinks. In a moist state, by the swelling of the cells, the slits close up, and the frond appears as if continuously membranous. The tubular, longitudinally seriated cells, or those that form the veins and nerves of the frond, seem to continue to lengthen during the whole growth of the lamina ; they are short in young plants, longer in others, and in old plants are many times longer than their diameter. The cell-wall in these cells is thick and tough, and when viewed under a moderately high magnifying power it appears to be transversely striate. The primordial sac readily separates from the outer cell-wall.

This plant was first noticed in the Mediterranean Sea, where it grows in the fissures of littoral rocks in many places. It occurs also in Brazil, from whence I possess a specimen ; and is found generally throughout the West Indian Islands. Our Key West specimens are rarely more than two inches high and about three in breadth. The largest specimen I possess was given me by the late Mr. Menzies, as having been dredged in twenty fathoms in the Gulf of Mexico. This specimen measures six inches across, and its venation offers some peculiarities ; which perhaps may lead to its specific separation. In our Key West plants the seriated cells of the principal veins stand apart from each other, or are in single file, leaving wedgeshaped spaces between. In Mr. Menzies' specimen the principal veins are partly unicellular, partly formed of several parallel, closely placed cells, without interspaces. The structure is easily seen, but difficult to describe in intelligible language. Should subsequent observations establish this plant as a species, it may be called *A. Menziesii.*

Plate XLIV. A. *Fig.* 1. Anadyomene *flabellata*, full grown ; and *Fig.* 2, a young plant ; the *natural* size. *Fig.* 3 represents *Fig.* 2, *magnified*, to show the structure of the frond.

V. DICTYOSPHÆRIA. *Dne.*

Root consisting of a few grasping processes. *Frond*, a decumbent, amorphous membrane composed of a single series of vesicated, sub-globose, tough-coated cells, filled with green, fluid endochrome. *Fructification* unknown.

The plant for which this genus was defined by Decaisne was formerly referred to *Valonia*, to which no doubt it is closely allied, but from which it differs by the greater lateral coherence of the cells which compose the frond, and also by the structure of these cells. It is of common occurrence throughout the tropics of both hemispheres. On the coast of Australia a second species is equally common, differing from *D. favulosa* in the frond being never vesicated, and in the component cells being very much smaller, the surface flatter, and the frond having a silky lustre. This I have elsewhere described under the name *D. sericea.*

1. Dictyosphæria *favulosa*, *Dne.*; frond at first globose and hollow, afterwards irregularly torn, expanded ; the vesicated cells globoso-hexagonal, convex, and very prominent. *Dne. An. Sc. Nat. Ser.* 2. *vol.* 17, *p.* 328. *Kütz. Sp. Alg. p.* 512. *Valonia favulosa*, *Ag. Sp. Alg.* 1. *p.* 432. (Tab. XLIV. B).

Hab. Key West, W.H.H., *Prof. Tuomey.* (No. 103). (v. v.)

Fronds at first globose, like tubers, heaped together, hollow and empty or filled with sea-water, attached to the rock and to each other by a few short, rooting processes ; at length irregularly torn, and then forming expanded, cartilaginous, or skinlike coarsely reticulated membranes. The membrane is wholly composed of a single layer of large, globose, or by mutual compression hexagonal cells, which closely cohere by their sides, leaving the convex ends of the cell free, and these form the surface of the membrane, which when dry resembles a piece of fish skin, or a miniature honeycomb. When the cells have been separated, each is seen to be marked at the line of junction by a double row of circular discs. In full grown cells the primordial utricle is easily separable from the outer cell-wall, and contains a green, granular endochrome ; from which, by cell-division, four new cells are formed, and thus the frond extends by repeated quadrisection of its component cells. The cell-wall is very tough and semifibrous in texture, more like an animal than a vegetable membrane ; and I have seen hairlike processes issue from it internally, analogous perhaps to the fibrous processes of the membrane of Caulerpa. I cannot say whether this be a constant character. It was observed in specimens from the Pacific brought home in spirit, and cannot be readily ascertained from dried specimens.

Plate XLIV. B. *Fig.* 1. Dictyosphæria *favulosa*, the *natural* size. *Fig.* 2. Portion of the surface, showing the division of the cells. *Fig.* 3. One of the cells of which the frond is composed, removed ; the latter figures *magnified.*

Order IV.—ULVACEÆ.

Grev. Alg. Brit. p. 168. *Hook. Br. Fl.* 2, *p.* 309. *Harv. Man. p.* 211. *J. Ag. Alg. Medit. p.* 14. *Endl. 3rd Suppl. p.* 18. *Ulvaceæ et Enteromorpheæ, Kütz. Spec. Alg. pp.* 471–475.

Diagnosis. Green or purple, marine or fresh water Algæ, composed of small, polygonal or quadrate cells, forming expanded membranes or membranous sacs or tubes ; rarely arranged in filaments. *Fructification*, zoospores formed in the cells of the frond.

Natural character. *Root* a small disc, or point of attachment. *Frond* formed of small, often very minute, roundish, quadrate or polygonal cellules cohering together into thin, filmy membranes, of no very definite form, and either expanded into broad leaves, contracted into narrow ribbons, or forming tubes which are either simple or branched. In those of lowest organization, such as *Tetraspora*, the frond is of a nature so loosely gelatinous that it can only by courtesy be called a membrane, and the cells which give it consistency are widely separated by transparent jelly. In *Prasiola* the cells are closer, with narrower hyaline interspaces, and the gelatine has a firmer consistence, more like that of ordinary cellulose ; and in *Ulva* there is perfect cohesion between thin-walled cells, and the membrane formed by them is firm, and often rigid and tough. Perhaps in all cases the cells multiply by a fissiparous division into four, the old cell dividing longitudinally and transversely. This is very obvious wherever the cells stand sufficiently apart, as in *Tetraspora* and *Prasiola*, and in the more transparent *Enteromorphæ;* but is less evident in the ordinary marine *Ulvæ*. Most of the *Ulvaceæ* have the brilliant, grass-green common to the Chlorosperms; but in the genera *Porphyra* and *Bangia* the frond assumes a more or less pure dark-purple hue, and hence some authors have removed these genera to the Rhodosperms. But I cannot think such removal natural or desirable ; for there is really no difference between *Ulva* and *Porphyra* in structure or fructification, and the occurrence of a purple colour, or even of a purer red, is by no means limited among *Chlorosperms* to these plants. We frequently find purple colours in Batrachospermeæ, especially in *Thorea ;* they occur also in Oscillatoriaceæ and in Palmellaceæ ; and in the latter, and also in the spores of *Œdogonia* a pure carmine or scarlet is often seen.

The fructification of the Ulvaceæ consists in zoospores, which are formed indifferently in all or in any of the cells of the frond, and are furnished with two or four cilia. Their development and germination are beautifully figured by Thuret in his valuable memoir on the zoospores of Algæ, in *An. Sc. Nat. Ser.* 3, *vol.* 14.

Ulvaceæ are universally dispersed either in salt or fresh waters throughout the world, and several are found on damp soil, or in half inundated places. All the genera and most of the species are cosmopolitan. Their specific characters are difficult to fix, and authors differ very much in their opinions respecting them. Kützing describes a multitude of species, which other writers find it difficult to separate, even as varieties. The form of the frond, in the foliaceous species, is assuredly a most uncertain character; and the comparative size and branching of the tube, in the tubular, equally variable.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* Porphyreæ : *frond purple.*

I. PORPHYRA. *Frond* leaf-like, purple.

II. BANGIA. *Frond* filiform, purple.

** Ulveæ : *frond green.*

III. ENTEROMORPHA. *Frond* membranous, tubular, simple or branched.

IV. ULVA. *Frond* membranaceous, leaf-like.

V. TETRASPORA. *Frond* gelatinous, expanded.

I. PORPHYRA. *Ag.*

Frond membranaceous, flat and leaf-like, purple. *Fructification*, dark purple granules (spores) arranged in fours, dispersed over the whole frond.

The species of this genus are difficult to determine, and I am induced, in this place, to unite the *P. vulgaris* and *P. laciniata* of authors, which I have elsewhere *(Phyc. Brit.)* figured and described as distinct. They appear to me to run one into another ; and if we contend for two species, with equal justice might we make half-a-dozen. Both are indifferently used in England in the preparation of " *marine sauce*," or laver, which is often brought to table as an accompaniment to roast meat. Kützing describes sixteen species, several of which are probably reduceable to the following :—

I. PORPHYRA *vulgaris*, Ag. ; frond polymorphous, either undivided or cleft into several broad segments ; sometimes peltate, fixed by a middle point. *P. purpurea, and P. laciniata, Ag. Sp. Alg. p.* 190—191. *P. vulgaris, Ag. Aufz. p.* 18. *Harv. Phyc. Brit. t.* 211. *P. laciniata, Harv. Phyc. Brit. t.* 92. *Wyatt. Alg. Danm. No.* 32. *P. linearis, Grev. P. amethystea, Kütz.*

HAB. Rocks between tide marks. On the eastern shores from Charleston, South Carolina, to the Arctic Regions. Western Coast, from California to Russian America (v. v.).

Very variable in form in different localities and at different stages of growth. In an early state it is either oblong or linear-lanceolate, with an evident though minute stipes, and then it constitutes the *P. linearis* of Greville, which is found truest to its type in the beginning of winter, in situations near high-water mark, where its vegetation is less vigorous. Later in the season the form usually called *P. vulgaris*, as figured in *Phyc. Brit.* t. 211, will be found in the same locality, and also throughout the whole space between tide marks. In this the frond is ovate or ovato-lanceolate, or broadly lanceolate, much waved at the margin, and without obvious stipe, several inches long and 2–3 inches wide. *P. laciniata*, Ag., which merely differs in having a deeply lobed or divided lamina, grows mixed with the simple variety *(P. vulgaris) ;* and specimens may easily be found which are intermediate in character. The state called *P. umbilicalis* grows on exposed rocks, generally near low water mark, and looks more like a different species than any of the other varieties. In it the frond is always short, usually of a very dull colour, fixed by a point removed from the margin of the lamina, and therefore somewhat peltate, with the upper side depressed or umbilicate in the centre. This variety is rarely more than two or three inches in length. Other varieties attain to 8 or 10 inches or more.

The colour varies with the age and condition of the fronds. Often it is olivaceous green, with little or no trace of purple ; but generally it is of a fine dark purple, especially when in fructification, the colour being wholly derived from the fructifying cells. The colour also generally becomes more intense and more purple after steeping in fresh water, and in the process of drying; and the dried plant has a very glossy surface, like satin. Sometimes it adheres to paper and sometimes not; and it always shrinks considerably in drying.

II. BANGIA. *Lyngb.*

Frond thread-shaped, tubular, composed of numerous radiating cellules, disposed in transverse rows, and enclosed within a hyaline continuous sheath. *Spores* purple, one formed in each cell of the frond.

This genus was founded by Lyngbye on the *Conf. fusco-purpurea* of Dillwyn, and several other Algæ, both marine and of fresh water, which are more or less nearly allied to it. Some of these have been properly removed. The genus still contains some anomalous species, but the three following appear to me to be con-generic. The genus was first placed by Greville in Ulvaceæ. This position has been questioned, and I was formerly disposed to concur with those who refer it to the neighbourhood of *Lyngbya* in Oscillatorieæ; but a careful examination, especially of *B. vermicularis*, has now convinced me that *Bangia* cannot be far removed from *Porphyra*, to which it bears the same relation that *Enteromorpha* bears to *Ulva*.

1. Bangia *fuscopurpurea*, Lyngb.; filaments elongated, simple, decumbent, nearly straight, capillary, here and there constricted, forming a brownish-purple, glossy stratum; granules several in each transverse band, dark purple. *Lyngb. Hyd. Dan. p.* 83, *t.* 24. *Grev. Alg. Brit., p.* 177. *Wyatt, Alg. Danm., No.* 167. *Harv. Phyc. Brit., t.* 96. *Kütz. Sp. Alg. p.* 360. *B. atropurpurea, Ag. Syst. p.* 76. *Alg. Eur. t.* 25. *Conferva fuscopurpurea, Dillw. t.* 92. *E. Bot. t.* 2055, and *C. atropurpurea, Dillw. t.* 103. *E. Bot. t.* 2085.

Hab. On rocks and wood-work between tide marks. Newfoundland, Herb. *Montagne.* Narragansett Pier, *Prof. Bailey.* Little Compton, *Mr. Olney.* Providence, *M. Charles Giraud.* Lynn, Mass. *Mrs. Estes.* (v. v.).

This is attached to rocks and stones, or to woodwork, and occurs in stratified patches of indefinite extent, of a dark purple colour. The filaments are 2-3 inches long, and float freely in the water, lying down in a fleece when left by the retreating tide. They vary greatly in diameter according to age, and the miscroscopic characters are equally varied in young and old specimens. In the young state the filament is formed of a series of very short cells, much shorter than the diameter of the filament ; each containing an undivided mass of dark purple endochrome, and at this age the whole structure is very similar to that of *Hormotrichum.* When further advanced, the endochrome divides longitudinally into many quadrate portions, round each of which a cell membrane grows, and they become so many cells arranged in a radiant manner round a central point, and appear, when viewed from the side, as transverse rows of beadlike granules tessellating the filaments. Eventually, from repeated cell division, the arrangement in transverse lines becomes difficult to observe, and the filament looks like a confused mass of tissue. The number of transverse granules seen in each row depends on age. The figure in *Phyc. Brit.* represents an old state of the plant when the granules have multiplied. The colour under the microscope is a beautiful amethystine purple.

I have only received this plant from the above-named American localities, but it is probably to be found along the rocky shores of all the northern States. In the British Islands it grows indifferently in the sea or in fresh water ; in the latter case it often occurs on the walls and gates of canal locks, and it may be expected to occur in similar situations in America. The specimen from Newfoundland is in a very advanced stage ; the filaments being of large diameter, irregularly constricted, and their granules very numerous in each band, and of minute size. The specimen from Lynn, on the contrary, is very young, with the transverse rows just beginning to be formed.

2. BANGIA *vermicularis*, Harv.; root scutate ; filaments basifixed, twisted, setaceous at the base, gradually widening upwards and at last claviform, much incrassated toward the end, undulating, flaccid, with a wide, hyaline, firm investing tube ; transverse bands closely placed ; granules dark-purple, vertically flattened, few in each whorl toward the base, very crowded and numerous toward the upper portion of the filament. (TAB. XLIX. A.)

HAB. Golden Gate, California, *A. D. Frye* (v. s. in Herb. T. C. D.)

Filaments fixed at the base by a scutate root, and probably freely floating in the water ; perhaps tufted, but the specimens received have been pulled asunder. Each filament is about two inches long ; at its origin it is of the diameter of human hair ; it becomes gradually thicker upwards, until, near the apex, in old filaments, it is at least twice as thick as hog's bristle. The form is therefore linear-clavate, though the club be very slender in proportion to its length. When dried the threads look like sinuous worms, tapering from a thickened apex to a very slender base. A cross section shows a central cavity surrounded by a variable number of radiating, cuneiform, dark-purple endochromes. Toward the base of the filament there are but four of these in a plane ; a little higher up there are eight, and in the upper portions they are not only indefinitely numerous in the whorl, but they form dichotomous radiating strings extending horizontally from the central tube to the circumference. They do not cohere in regular moniliform filaments, but there seems a tendency to do so. It is difficult, in this part of the frond, to see the exact cellular structure, owing to the great transparency of the cell-walls, and the facility with which the endochromes are thrown out of their cavities when cross-sections are moistened.

This is a very distinct species, remarkable for the great diameter of its worm-like filaments, and their clavate form. Notwithstanding its somewhat greater complexity of structure, I think there can be no doubt of its near affinity with *B. fuscopurpurea.*

PLATE XLIX. A. *Fig.* 1. BANGIA *vermicularis*, the *natural* size. *Fig.* 2. A frond *magnified. Fig.* 3. Base ; 4. middle portion ; and 5, apex of the same. *Fig.* 6, 7, 8. Transverse sections at different heights. *Fig.* 9 and 10. Radiating endochrome-cells, all highly *magnified.*

3. BANGIA *ciliaris*, Carm. ; filaments very minute, (forming a rosy down on the fronds of other Algæ) basifixed, straight ; granules either in a single series, or two or three in each transverse row. *Harv. Phyc. Brit. tab.* 322. *Chauv. Rech. p.* 37.

HAB. Parasitic on *Chondria atropurpurea*, at Charleston, S. C., *W.H.H.* (v. v.)

This forms a very short, bright, rose-red downy pile on the fronds of the *Chondria.* Each filament is scarcely the tenth of an inch in length, and consists either of a single row of cells shorter than their diameter ; or of a double or triple series of such cells. Possibly it may be only the very young state of *B. fuscopurpurea* ; but the habitat is different, and the colour much brighter.

III. ENTEROMORPHA, *Link.*

Frond tubular, membranaceous, green, reticulated. *Fructification*, granules, commonly in fours, contained in the cells of the frond.

The tubular frond distinguishes this genus from Ulva. The tube varies greatly in width, in different or even in the same species. Sometimes it is of no greater diameter than that of human hair ; and sometimes it is one or two inches across, forming an inflated bag. The species are widely dispersed, extremely variable in ramification and general appearance, and some of them are among the commonest of all littoral algæ. The green stringlike weeds that infest the bottoms of boats and vessels lying in harbour are generally species of this genus, and mostly *E. compressa*, which is found in all parts of the ocean from the Arctic and Antarctic basins to the Equator.

1. ENTEROMORPHA *intestinalis*, Link ; fronds perfectly simple, elongated, becoming inflated, obtuse, tapering extremely to the base. *Link, Hor. Phys. Ber. p.* 5. *Grev. Alg. Brit. p.* 179. *Harv. Phyc. Brit. t.* 154. *Wyatt, Alg. Danm. No.* 80. *E. Bot. Sup. p.* 2756. *Kütz. Sp. Alg. p.* 478. *Ulva intestinalis, Linn.*

HAB. Whalefish Islands, Davis's Straits, *Dr. Lyall.* Boston Bay, *Dr. Gray.* Providence, Rhode Island, *Mr. Olney.* New York Bay, *Mr. Walters, &c.* Beesley's Point, *Mr. Ashmead.* Sullivan's Island, *Mr. Ravenel.* (v. v.)

Very variable in the length and breadth of the frond. Old specimens are often much inflated and bag-like ; the frond being 1–2 inches in diameter. Others, often from the same locality, are not more than quarter of an inch in breadth.

2. ENTEROMORPHA *compressa*, Grev. ; fronds elongated, branched, cylindrical or subcompressed ; the branches simple or nearly so, long, obtuse, much attenuated at the base. *Grev. Alg. Brit. p.* 180 *t.* 18. *Harv. Phyc. Brit. tab.* 335. *Wyatt, Alg. Danm. No.* 168. *Kütz. Sp. Alg. p.* 480.

HAB. Sea shores, extremely common. (v. v.)

Under one or other of its many forms this species is found on all parts of the American coast extending also up the estuaries of tidal rivers. Our most northern specimens were collected in Lat. 75° 42′ by *Dr. Sutherland.*

3. ENTEROMORPHA *clathrata*, Grev. ; frond tubular, tesselated, cylindrical, slender, very much branched ; branches erect or spreading, sometimes squarrose, more or less beset with slender tapering subulate ramuli. *Grev. Alg. Brit. p.* 181. *E. clathrata, erecta* et *ramulosa, Hook. Harv. Phyc. Brit. t.* 340, *t.* 43, *and t.* 245. *Wyatt, Alg. Danm. Nos.* 34, 166, *and* 208. *E. clathrata, ramulosa, paradoxa, &c. Kütz. Sp. Alg. p.* 479.

HAB. Rock pools, &c. Rhode Island, *Mr. Olney.* Staten Island, New York, *Professor Bailey.* Red Hook, &c., *Messrs. Hooper and Calverley.* Boston Bay, *Captain Pike.* Beesley's Point, *Mr. Ashmead.* (v. v.)

Very variable in appearance, but generally more slender and filiform than *E. compressa*, and also more cylindrical. It is usually densely tufted, capillary, or setaceous, soft to the touch and very much branched ; the branches either erecto-patent or patent ; sometimes horizontal or squarrose, repeatedly decompound, and their ultimate divisions furnished with slender ramuli that taper to a fine point, and are not constricted at base. These ramuli are sometimes very numerous, sometimes few, and either short and spine-like or elongated and filiform. When short, horizontally spreading, numerous and spinelike, the plant becomes *E. ramulosa* of authors. I have seen the varieties *erecta*, *ramulosa* and *clathrata* from the American coast. The cells of which the walls of the frond are composed are larger and more quadrate than those of *E. compressa;* the surface therefore looks tessellated.

4. Enteromorpha *Hopkirkii*, McCalla; frond excessively slender and byssoid, flaccid, very much branched; branches feathery, decompound, erect, attenuated, set with minute subulate ramuli; cellules large, hyaline, each containing one or two minute grains of endochrome; the ramuli formed of a single series of such cells. *Harv. Phyc. Brit. tab.* 263.

Hab. In rock pools between tide marks. Greenport, *Mr. Hooper.* (v. s.)

Tufts very soft, 3-4 inches long. *Fronds* very slender and much branched. The frond of this species is composed of much larger and more hyaline cells than in the preceding, and the endochrome is of very minute size in proportion to the cells in which it is lodged. This species occurs also on the shores of England and Ireland; but is not so common as others of the genus, and appears to be sufficiently characterised by its cellular structure. The ramuli are articulated, like the branches of a *Cladophora.*

IV. ULVA. *L.*

Frond membranaceous, flat, and leaflike, green. *Fructification*; green granules (spores) often arranged in fours, dispersed over the whole frond.

Under this generic name I still retain the species of the modern genera *Prasiola*, *Ulva*, and *Phycoseris;* the first of which differs from the second in having its cellules arranged in a most obviously tessellated pattern; and the last, from either of the preceding, by its membrane consisting of two layers of cells instead of a single layer. The species of the section *Prasiola* are of minute size, and are found in damp places, on the soil, on old walls and on decaying timber and thatch, &c.; and no doubt several (such as *P. crispa*, *P. calophylla*, &c.) occur in America, but I have not received any American specimens. Kützing describes a *P. mexicana*, Lieb. from Mexico, in words which would apply equally to the *P. crispa* of Europe.

Sect. 1. Phycoseris; membrane formed of a double layer of cellules.

1. Ulva (Phycoseris) *fasciata*, Delile; frond stipitate, cartilagineo-membranaceous, rigid, cleft into several strapshaped segments, which are undulate at the margin, and irregularly toothed or sinuate. *Del. Egypt*, *p.* 153, *t.* 58, *f.* 5. *Mont. Alg. Alger*, *p.* 151, *t.* 14, *fig.* 1–2. *Phycoseris fasciata*, *Kütz. Sp. Alg. p.* 477. *Ulva divisa*, *Suhr!*

Hab. California, *Dr. Coulter.* Shores of the Gulf of Mexico, *Dr. Schott.* (v. v.)

More rigid than *U. latissima*, and divided into many long narrow segments, half an inch to an inch wide, and 6–8 inches long or more, preserving a nearly equal breadth throughout, and either simple or forking. Sometimes the laciniation is almost pinnate, having an undivided leading segment with lateral and often opposite lesser segments. Sometimes the division extends nearly to the base, and the form is then palmate. The margin is mostly toothed, or cut, and frequently undulate. The colour is a full grass green, and the substance rigid. It does not adhere to paper in drying.

I possess authentically named specimens from Montagne and Von Suhr.

2. Ulva (Phycoseris) *Linza*, Linn.; frond linear-lanceolate, acute, crisped at the margin, composed of two membranes closely applied. *Linn. Sp. Pl. p.* 1633. *Ag. Sp. Alg.* 1, *p.* 413. *Harv. Phyc. Brit. t.* 39. *Wyatt, Alg. Danm. No.* 164. *Phycoseris Linza and P. lanceolata, Kütz. Sp. Alg. p.* 475, *(and probably others.)*

Hab. Rocky shores of British America, and of the north-eastern States. Halifax, *W.H.H.* Boston Bay, *Captain Pike.* New York Bay, *Messrs. Calverley, Hooper*, &c. (v. v.)

Root a small disc. *Frond* 6–12 inches long or more, from half inch to one or two inches in width, linear-lanceolate, tapering to the base, and either blunt or attenuated at the apex, much waved and curled at the margin; formed of two distinct, separable membranes, closely applied and cohering together. *Colour*, a full, brilliant grass green, becoming pale in age. *Substance*, rather soft and thin. It adheres to paper in drying.

Agardh's *U. Bertolonii* appears to me to be a form of this species, which is also nearly allied to *Enteromorpha intestinalis*, with which, if we omit the inflated frond, there is much similarity in form and structure. It is not so common as the following species, but is nevertheless widely dispersed.

3. Ulva (Phycoseris) *latissima*, Linn.; frond polymorphous, very broad, ovate or oblong, simple or lobed, undulate, bright green. *Lin. Fl. Suec. p.* 433. *Ag. Sp. Alg.* 1, *p.* 407. *Harv. Phyc. Brit. tab.* 171. *Wyatt, Alg. Danm. No.* 33. *Phycoseris gigantea and others, Kütz. Sp. Alg. p.* 476.

Hab. Common on the American coast. (v. v.)

Fronds from six inches to two feet in length, from three to twelve inches in breadth, tufted or scattered; very variable in shape, sinuated and wavy or flat, often plaited. *Substance*, thin and soft, very smooth and glossy, like fine green silk. *Colour*, a brilliant green, when growing near high water mark; darker, and often glaucous when obtained from deep water, and sometimes turning brownish in the herbarium.

Specimens are often found pierced with holes, the result either of age or of the attacks of worms. Such individuals constitute the *Phycoseris myriotrema* of Kützing.

Sect. 2. ULVA. Membrane formed of a single layer of cellules.

4. ULVA *lactuca*, Linn. ; " frond at first obovate, saccate, inflated, at length cleft down to the base ; the segments plane, unequal, laciniated, semi-transparent," *Grev. Lin. Sp. Pl. p.* 1632. *Ag. Sp. Alg.* 1, *p.* 409. *Grev. Crypt. Scot. t.* 313. *Harv. Phyc. Brit. t.* 243. *Kütz. Sp. Alg. p.* 474.

HAB. Boston Bay, *Miss E. H. Brewer.* Indianola, Texas, *Dr. Schott.* (v. v.)

Much thinner and more delicate in substance, and of a paler colour than *U. latissima ;* and clearly characterised, on dissection, by its simpler membrane. It is more transparent, and the cells are more regularly grouped in fours, more distant, with hyaline interspaces. When young it forms a bag, like a very short and broad *Enteromorpha.* It closely adheres to paper in drying.

5. ULVA *bullosa*, Roth. ; frond very delicate, gelatinoso-membranaceous, at first saccate, afterwards bursting, and opening out into a broad, wavy or torn floating membrane. *Roth, Cat. Bot.* 3, *p.* 329. *Ag. Sp. Alg.* 1, *p.* 414. *Harv. Man. Ed.* 1, *p.* 171. *Hass. Br. Fr. Wat. Alg. p.* 297, *t.* 78, *fig.* 13. *Tetraspora bullosa, Kütz. Sp. Alg. p.* 226.

HAB. In fresh-water ponds and ditches. Whalefish Islands, Davis's Straits, *Dr. Lyall.* (v. v.)

Probably as common in stagnant pools in America as it is in Europe, but I have as yet only seen specimens brought from the Arctic Regions by Dr. Lyall. When young it is attached, and somewhat tubular, like large specimens of *Ent. intestinalis ;* but it afterwards bursts open, and then generally floats on the surface, being buoyed up by bubbles of oxygen, which it disengages.

By Kützing this species is referred to *Tetraspora*, from which it scarcely differs by any definite character.

V. TETRASPORA. *Link.*

Frond gelatinoso-membranaceous, tubular, inflated or flat, green. *Fructification*, green granules (spores) arranged in fours, dispersed throughout the hyaline cells of the frond. *(In fresh water.)*

This genus scarcely differs from *Ulva* on the one side and *Palmella* on the other. The frond is more gelatinous that in *Ulva*; and more membranous than in *Palmella*. The whole of the endochrome is converted into spores, which are arranged in squares and more distantly placed than in *Ulva*.

1. Tetraspora *lacunosa*, Chauv.; frond at first tubular, then flat, or irregularly lobed, membranaceo-gelatinous, pale-green, everywhere pierced with roundish holes of various sizes. *Chauv. Alg. Norm. Breb. Alg. Fal. p.* 11, *t.* 1. *Kütz. Sp. Alg. p.* 227. *T. Godeyi*, *De Breb. Kütz. Tab. Phyc. t.* 30, *f.* 3. *T. perforata*, *Bailey*, *M.S.*

Hab. In fresh-water streams. Abundant near Westpoint, *Prof. Bailey*. Providence, Rhode Island, *Mr. Olney*. (v. s. in Herb. T.C.D.)

Frond at first funnel-shaped, afterwards splitting open, and then flat, expanding upwards and irregularly lobed, everywhere pierced with roundish holes of various sizes, large and small intermixed. These holes increase in size and numbers with age, and thus at last the frond becomes an open network. The substance is very gelatinous, but rather firmer than in some other species of the genus. The colour is a pale green; and the hyaline gelatinous membrane is filled with roundish granules set in fours.

Kützing's figure of *T. Godeyi* answers well to our plant. I have not seen any authentic specimens of *T. lacunosa*, which is referred by Kützing to his *T. lubrica*, *var. β.*, but the description given of it applies to the American plant. When carefully dried, it forms a very pretty object for the Herbarium.

Order V.—BATRACHOSPERMEÆ.

Batrachospermeæ, *Ag. Syst. p.* 23, *(partly) Harv. Man. Ed.* 1, *p.* 119. *Berk. Crypt. Bot. p.* 136, *Dne. class, p.* 33 *(partly.) Kütz. Sp. Alg. p.* 535. *Lemanieæ*, *Ag. Sp. Alg.* 2, *p.* 1. *Harv. Man. Ed.* 1, *p.* 118, *Dne. Class, p.* 31. *Kütz. Sp. Alg. p.* 527 *(partly.)*

Diagnosis. Blackish-green, olivaceous or purplish fresh water Algæ, with filiform, branching, inarticulate fronds, composed of small cells; naked, or whorled with moniliform ramelli. *Fructification;* moniliform strings of naked spores, either forming external tufts, or concealed within a tubular frond.

Natural Character. *Root* merely a point of attachment or little disc, by which the frond is firmly fixed to the substances (usually rocks and stones in rapid rivers and streams) on which it grows. The plants referred to this Order naturally group themselves into two suborders, distinguished from each other by the habit of the frond, but closely related in structure and fructification, and as it seems to me inseparably connected by the genus *Tuomeya*, which unites in itself the characters of the seemingly so dissimilar genera *Batrachospermum* and *Lemanea*. In the first suborder *(Batrachospermeœ veræ)* the branching filiform frond consists of a solid axis, invested with a gelatinous coating, and composed of vertical, confervoid filaments, strongly glued together. This axis is either, as in *Batrachospermum*, whorled at short intervals with moniliform ramelli, formed of globose cellules strung together; or else, as in *Thorea*, it is uniformly clothed with a villous stratum of byssoid ramelli, formed of cylindrical cellules. The fructification, so far as known in this suborder, consists of globular, very dense tufts of spore-threads, similar in structure to the ramelli, but of more minute size, and far more densely packed together. I question whether they be properly *spores*, probably they are rather highly developed or compound gemmæ. In the second suborder, *Lemanieœ*, the frond is denuded of confervoid ramelli, and consists altogether of a compound, filiform axis, composed of minute cells. In *Lemanea* the frond is hollow and tubular, the walls of the tube being laxly constructed within; and moniliform strings of spores, similar to those of *Batrachospermum*, are attached to the surface of the tube. This structure is almost the exact reverse of that of *Batrachospermeœ*, where the central axis is most solid, and clothed *externally* with moniliform filaments. In *Tuomeya* the frond has at first the external characters of a *Lemanea*, but is furnished with an *axis* having the structure of a *Batrachospermum*, as if a *Batrachospermum* were developed within the tube of a *Lemanea*; and when fully developed the surface is uniformly coated with minute filaments, as in *Thorea*.

Authors differ much in their views of the proper limits of this Order. Decaisne unites with it *Liagora* and *Dichotomaria (Galaxaura)* both of which are undoubtedly Rhodosperms; and *Myriocladia*, which is a Melanosperm. Kützing separates *Batrachospermum* as the type of an Order of which it is the only genus; while he refers *Galaxaura*, *Actinotrichia* and *Lemanea* to his Lemanieæ; and places *Thorea* with his Chætophorideæ. My own views more nearly correspond with those of Mr. Berkeley, who brings *Batrachospermum*, *Thorea*, and *Lemanea* together into one Order. These genera are exclusively fluviatile or lacustrine, so far as I am aware. The *marine* variety "*purpurascens*," Roth, of *Batr. moniliforme* is founded on a figure of Dillenius *(Hist. Musc. t.* 7. *fig.* 40*)* which certainly looks very like a *Batrachospermum*, but the original specimen preserved in the Dillenian Herbarium belongs, according to Turner, to *Ceramium diaphanum*. The marine "*Thorea Americana*" of Kütz. is assuredly not a congener with *T. ramosissima*, the type of the genus; but properly referred by Bory, who first described it, to *Chordaria*.

Like most fresh water Algæ, several of the species are widely distributed. *Batrachospermum moniliforme* is found throughout Europe in various parts of Asia, in Tasmania and New Zealand, and in extra-tropical South America; and *B. vagum* and *atrum*, of which as yet I have seen no North American specimens, have nearly as extensive a range. *Lemanea torulosa* occurs in Europe. *Tuomeya fluviatilis* has only as yet been found in North America, but occurs in distant localities (New York and Alabama) and may probably be found to have a much larger area of distribution.

TABLE OF THE NORTH AMERICAN GENERA.

Sub-Order I. BATRACHOSPERMEÆ ; *Frond* filamentous, gelatinous, externally clothed with minute articulated ramelli.

I. BATRACHOSPERMUM. *Frond* nodose, ramelli whorled.

Sub-Order II. LEMANIEÆ. *Frond* cartilaginous, solid or hollow, with a cellular peripheric stratum.

II. TUOMEYA. *Frond* solid, with a filiform, nodoso-articulate axis.

III. LEMANEA. *Frond* hollow.

I. BATRACHOSPERMUM. *Roth.*

Root discoid. *Frond* filamentous, gelatinous, branched, consisting of an articulated longitudinally striated *axis* beset with closely placed whorls of moniliform, free ramelli. *Fructification*, globose clusters of seriated spores, attached to the ramelli. *In fresh water.*

Widely dispersed plants inhabiting clear fresh-water streams and wells in most parts of the world ; rarely found in stagnant waters. Several species have been described, but the characters of many are unsatisfactory. All are exceedingly gelatinous, every part of the frond being invested with a clear, rather firm mucus, and when removed from the water the collapsed branches have the colour and general aspect and feel of *frog-spawn;* whence the generic name. Kützing, in Plate 8 of his Phycologia Generalis, has given figures to illustrate the early development and gradual formation of the frond. At first the young plant consists merely of a string of moniliform cells. Soon there is a distinction into an axis and ramelli, the axis consisting of a series of long, pellucid cylindrical cells, placed one above the other ; and the ramelli being more coloured, formed of roundish cellules, and placed at the nodes of the axial filament, round which they gradually form a whorl. At first these ramelli are simple ; afterwards they are repeatedly dichotomous. The *axis* in the young plant consists merely of a string of naked cells ; in the full-grown frond it is invested with a sheath or outer coat formed of slender filaments which issue from the bases of the whorled ramelli, growing downwards like roots, adherent to the axis and continued to the next node. These give the longitudinally striate appearance to the axial filament; and in old fronds they constitute the axis itself, which then becomes tubular, from the absorption or rupture of the primordial tube.

1. BATRACHOSPERMUM *moniliforme*, Roth. ; frond irregularly much branched, very

gelatinous; whorls of ramelli globose, distinct, the branches resembling strings of beads. *Kütz. Sp. Alg.* 1, *p.* 535. *Harv. Man. Ed.* 1, *p.* 119. *Hass. Brit. Fr. Wat. Alg. p.* 108. *Conferva gelatinosa*, *Dillw. Conf. t.* 32. *E. Bot. t.* 689.

Hab. On stones, &c. in running streams and wells of fresh water. New York, *Prof. Bailey*, *Mr. Calverley*. Virginia, *Mr. Jackson*. Alabama, *Prof. Tuomey*. South Carolina, *Mr. H. W. Ravenel*. Michigan, *Dr. A. Gray*. (v. v.)

Fronds densely tufted, gelatinous, capillary, irregularly much branched, decompound, the branches tapering to their extremity, beset with short tapering ramelli, which are very patent and once or twice divided. All the branches and ramuli are moniliform, and are composed of a filiform cylindrical axis; set at short intervals with very dense, globose whorls of multipartite, dichotomous ramelli. The axis is formed of an articulated monosiphonous filament, externally coated with a sheath of closely-placed, cohering, longitudinal, parallel, articulated, very slender filaments, derived from the bases of the whorled ramelli, and developed along the internodes from above downwards. The *ramelli* are excessively branched, and composed of short cells much constricted at the points of union; the lower ones are somewhat pyriform, the upper lanceolate. The masses of fructification are very dense, appearing to the naked eye like black grains among the ramelli. When examined, by squeezing between two glasses on the table of the microscope, they are seen to consist of exceedingly densely packed, minute, dichotomous ramelli, radiating from a common centre. These ramelli scarcely differ in structure from those of the ordinary whorls, and can scarcely be regarded as composed of true *spores;* but seem to be rather of the nature of gemmæ. The general *colour* of this species varies much: commonly it is a dark slate colour, sometimes it is olive-green, and often becomes purple after having been dried.

B. moniliforme is found in most parts of the world. It is very common in fresh-water streams in Europe; and we have received it from Van Diemen's Land, New Zealand, and Cape Horn.

II. TUOMEYA. *Harv.* (Nov. Gen.)

Frond cartilaginous, continuous, solid, at first transversely banded, afterwards annularly constricted; composed of a longitudinal axis, and two strata of peripheric cells. *Axis* columnar, consisting of several longitudinal, cohering filaments, beset with closely placed whorls of moniliform ramelli, whose branches anastomose horizontally and vertically into a cellular peripheric membrane, which is coated externally with moniliform filaments, gradually developed. *Fructification* (probably in the superficial filaments.) *In fresh water.*

Tuomeya *fluviatilis*, Harv.

HAB. On stones, in rivers and streams. River in Alabama, *Prof. Tuomey.* Near Fredericksburg, Virginia, *Prof. Bailey.* (v. s. in Herb. T.C.D.)

Fronds tufted, an inch or two in height, scarcely as thick as hog's bristle, much and irregularly branched, bushy; the branches alternate or secund, scattered or crowded, twice or thrice divided, and set with scattered, patent ramuli, which are slightly constricted at the insertions, and taper to an obtuse point. When young the branches and ramuli are perfectly cylindrical, and when examined under a low power of the microscope show a surface composed of minute, dotlike cells, placed close together, and marked at short intervals with dark coloured transverse bands. These bands disappear under a higher magnifying power. They are indications of the *nodes* of the axis of the frond, seen through the peripheric stratum. In old, fully developed specimens the branches and ramuli are annularly constricted at short intervals, the nodes becoming swollen, while the internodes remain unchanged. When a young branch is bruised between two pieces of glass the axis may be readily extracted. It consists of several parallel, longitudinal, jointed threads combined together at closely placed *nodes*, from which issue horizontal dichotomous filaments composed of roundish or angular cells. These excurrent filaments spread both horizontally and vertically, and their branches anastomose into a cellular mass or fleshy membrane which forms the inner peripheric stratum. In young plants a portion of the frond, between the axis and periphery, is hollow, but in older ones the cavity is quite filled up with cells. The external surface of the cellular periphery is clothed with a coat of moniliform filaments gradually developed, and forms what is above called the *second* peripheric stratum. These are found only in fully grown specimens; they consist of much smaller cells than those of the inner stratum; they are more strongly coloured, and I consider them to be connected with fructification. The *colour* is a dark olive. The substance is brittle and rigid when dry; and the plant scarcely adheres to paper.

I formerly received specimens of this curious little plant from my late friend Prof. Bailey, under the name "*Lemanea fluviatilis*;" but, as may be gathered from the above description, it is very different from *Lemanea* in structure and much more nearly related to *Batrachospermum.* The external habit, substance, and colour are however those of a *Lemanea*, and without microscopic examination it might pass for one. The structure is difficult to see and also to describe in words. What I have called the inner peripheric stratum is externally as solid as the walls of a *Lemanea;* the outer periphery consists in a continuous clothing of the external surface of the frond with minute, fastigiate, horizontal ramelli, not unlike those of which the globose fructifications of a *Batrachospermum* are made up. In young specimens only can the mode of evolution of the frond be observed; old specimens become completely blocked up with cellular tissue, and seem to be solid in every part when a transverse slice is examined; their axis may, however, be seen by employing a compressing glass.

The generic name is bestowed in memory of the late Prof. Tuomey of Tuscalosa, Alabama, so often mentioned as a valuable contributor to these pages. I have not ventured to make a drawing from the dried specimens which alone I have yet seen.

III. LEMANEA, *Bory.*

Frond cartilaginous, continuous, tubular, branched, its periphery composed of two strata of cells, the *inner* stratum formed of roundish, empty, vesicated cells ; the *outer*, of minute, closely cohering, angular, coloured cellules. *Fruit*, tufts of seriated spores, attached to the inner surface of the tubular frond. *(In fresh water streams and rivers.)*

The species referred to this genus are found in fresh water streams and rivers, attached to stones by a discoid root. They are very dissimilar in appearance from other fresh water algæ, being of a remarkably firm fucoid substance, opake and closely cellular. In many respects, however, they approach *Batrachospermum*, near which genus I have long considered to be their true systemic position, an opinion which must be considered as confirmed by the discovery of *Tuomeya*, a genus of intermediate structure. Kützing associates *Lemanea* with *Galaxaura* and *Actinotrichia*, two genera that appear to me to belong to HELMINTHOCLADIEÆ, among the Rhodospermatous groups. Thwaites has given in the 20th vol. of Linn. Trans. a short account of the early development of the frond in *L. fluviatilis*. The spores at first vegetate into confervoid, slender jointed filaments, with long joints containing a spirally arranged endochrome. These constitute a sort of pro-thallus, or pseudo-colytedonous condition of the plant. After a time thick branchlets, the germs of the permanent frond, spring from the cells of the confervoid filament ; they are at first wholly dependent on the cell from which they rise, but soon acquire rootlets at their base, and rapidly elongating grow into the cellular, opake, cartilaginous fronds characteristic of the genus. Kützing, *Phyc. Gen. t.* 19, also illustrates the early development, and gives elaborate sections of the cellular structure of the mature frond.

1. LEMANEA *torulosa*, Ag.; frond tufted, subsimple or divided near the base, robust, nodoso-constricted at short intervals, or moniliform, tapering from the base to the apex. *Ag. Sp. Alg.* 2, *p.* 6. *Act. Holm.* 1814. *tab.* 2, *fig.* 1. *Kütz. Sp. Alg. p.* 528. *L. variegata*, *Ag.? l. c. p.* 7.

HAB. On rocks and stones in rivers and streams. Kentucky, *Dr. Short.* (v. s.)

Root discoid. *Stems* many from the same base, 4--8 inches long or more, twice or thrice as thick as hog's bristle, rising from a very slender, capillary base, and gradually increasing in diameter upwards for about an inch, thence maintaining an equal diameter for ¾ of their length, and again tapering off at the extremity ; either quite simple or divided shortly above the base into numerous simple branches. The frond is regularly constricted and swollen at intervals of from one to two lines, so as to be nodose in the younger, and moniliform in the more advanced state, the distances between the swellings as well as their intensity varying in different specimens. The walls of the tubular frond are thick, composed of two layers of cells, the outer layer consisting of very minute and closely crowded radiant, coloured cellules, whose apices unite to form the exterior coating of the frond, the inner of three or four rows of large, colourless, oblong, irregularly anastomosing cells. The tube is traversed and crossed by a few slender, cylindrical, long jointed filaments issuing from the inner peripheric cells. *Globose* masses of *fructification* are attached to the inner face of the tubular frond, either at the nodes or between them, without any apparent order. They consist (as in *Batrachospermum*) of very densely crowded, moniliform, subsimple strings of cellules radiating from a central point. The general *colour* is olivaceous when recent, and very opake; it becomes a livid purplish in drying. *Substance* firmly cartilaginous or subcoriaceous. It does not adhere to paper in drying.

Agardh describes a *L. variegata*, "filis moniliformibus variegatis," as sent to him by Muhlenberg, from North America. By the description given it seems merely to differ from the common *L. torulosa* in being variegated with alternate bands of dark and pale, a character most probably dependant on the state of the specimens. I am indebted to Dr. Short of Kentucky, for fine specimens of the ordinary form. *L. fluviatilis*, which is the commonest European species, has not been sent to me from America.

ORDER VI. CONFERVACEÆ.

Confervecæ, J. Ag. Alg. Medit. p. 12. *Harv. Man. Ed.* 1 *and Ed.* 2, *p.* 196. *Lindl. Veg. Kingd. p.* 18. *Confervoideæ, Endl. 3d Supp. p.* 14. *Confervaceæ, Berk. Crypt. Bot. p.* 131. *Confervaceæ and Chætophoroideæ,* (*partly*) *Dne. class, p.* 31, *Kutz. Sp. Alg. pp.* 363-531.

DIAGNOSIS. Green, marine or fresh water Algæ, composed of articulated threads or filaments, and of cylindrical cells usually longer than their diameter. *Endochrome* diffused, or filling the cavity of the cell. *Zoospores* minute, indefinitely numerous in each cell.

NATURAL CHARACTER. *Root* rarely more than a mere point of attachment, and often perishing on the evolution of the frond, which then floats on the surface of the water. *Frond* in all cases filamentous, composed of strings of truncated, more or less cylindrical cells, placed end to end, and usually longer than their diameter. These cells are never branched, like those of the *Siphonaceæ*, and are usually much shorter in proportion to their diameter than in that order; but as compared with those of most of the filamentous Algæ they are long, varying however extremely in different species. The endochrome generally fills the cavity or primordial utricle of the cell, but varies greatly in density. In some cases it is thin and watery, and in others very dense, granular, and subopaque. It is sometimes arranged in transverse bands. In most cases the cell wall is membranaceous, soft, but of firm texture; but in *Draparnaldia* and *Chætophora*, the filaments are invested with gelatine, and in the latter genus numerous filaments are enclosed within a common gelatinous envelope, and thus formed into somewhat compound fronds. In the great bulk of the Order no fructification other than minute *zoospores* has been observed. These are formed out of the colouring matter of the cells, are furnished with vibratile cilia, and when they escape from the cell in which they have been organised, enjoy for a time active powers of locomotion. At length fixing themselves to some object they change their form, becoming cylindrical; and then, dividing repeatedly, are changed into articulated filaments similar to those of the parent plant. In the *Confervæ* the frond lengthens in two ways; either by the repeated bisection of all the cells of the frond, as is usually the case in the unbranched species; or by the evolution of new cells, constantly at the apex of the terminal cell, as is common in the branching species. In these latter the cell, after having once formed one or more new cells out of its apex by a cutting off of the summit from the basal portion, remains unchanged, without further growth or cell division. If but one new cell be formed at the apex, the filament will be simple; but in the branched species two or more cells are formed, the central one continuing the frond, while the lateral ones, which spring just below the summit of the old cell, grow out into branches.

The Confervaceæ are almost universally dispersed in water of every character found on the surface of the globe. Many are marine, but perhaps the largest number, at least of individuals, if not of species, are found in fresh water. The marine species usually grow within tidal limits, but several of the Cladophoræ occur in the Laminarian zone, and some even at a greater depth. The fresh water species are found in lakes and ponds, in rivers, streams, and wells, and in thermal springs or in mineral waters. A large number of genera and species have been described; but I fear the proper number of both genera and species has been much exaggerated, and that multitudes must be erased from the list whenever the Order shall be carefully revised. The fresh water species have as yet scarcely been attended to in America. I have received very few of these, and most of them in a state unfit for examination. Indeed, dried specimens of such obscure algæ are of little value for determining species. A few of the more remarkable are here described; being all those that I can clearly make out from the specimens received. It is, however, often a difficult task either to refer one of these species to its supposed type, or to devise specific characters that shall not be illusory for what appear to be new forms. The characters usually insisted on, namely, the length of the cells as compared with their diameter, the absolute diameter of the cell, and the degree of ramification of the filament, are all subject to much variation. There appear to be no definite limits to any of these characters in any species. We are forced therefore, in describing them, to be content with rude approximations. Figures are of little use, for in many of the species, such as *Chadophora glomerata*, scarcely two specimens are in all respects similar.

TABLE OF THE NORTH AMERICAN GENERA.

Sub-order 1. CHÆTOPHOREÆ. *Frond* invested with gelatine.

I. CHÆTOPHORA. Numerous filaments combined into a gelatinous frond of definite form.

II. DRAPARNALDIA. Filaments separate, fasciculately ramulose.

Sub-order 2. CONFERVEÆ. Frond destitute of a gelatinous coating.

III. CLADOPHORA. Filaments tufted, erect, branched.

IV. CHÆTOMORPHA. Filaments unbranched, membranaceous, with a thin cell-wall.

V. HORMOTRICHUM. Filaments unbranched, gelatino-membranaceous, with a thick cell-wall; nodes constricted.

VI. RHIZOCLONIUM. Filaments decumbent, spuriously branched, the branches few and rootlike.

I. CHÆTOPHORA. *Ag.*

Frond gelatinous, polymorphous, of definite form; the gelatine tranversed by many filaments aggregated together and issuing from a common base. *Filaments* articulated, branched; articulations of the branches nearly hyaline, those of the ramuli filled with green endochrome. *Sporangia* globose, attached to the ramuli. *Zoospores* formed in the articulations. *(In fresh water.)*

The species form gelatinous masses, of definite or sub-indefinite form, attached to sticks, water-plants, or stones, in stagnant or running water. The gelatine is colourless, tolerably firm and tenacious, and when a portion is placed under the microscope is seen to be traversed in every part with slender, articulated, branching filaments, variously arranged. The filaments are dimorphous, that is, their main divisions are formed of differently shaped cells from those that compose the ramuli. The latter alone contain much endochrome. *Fructification* has, as yet, been seen only in very few species. In some stage of growth the terminal cell of the ramuli is tipped with a very long, hyaline bristle, whence the generic name, from *χαιτη*, a *bristle*, and *φορεω*, to *bear*. The two following species have been sent me from America; both are common European plants. Probably several others occur in American waters.

1. CHÆTOPHORA *endiviæfolia*, Ag.; frond elongate, irregularly much branched; branches linear, scattered, or fasciculate, very patent, dichotomous or pinnate, or secundly ramulose; longitudinal filaments parallel, hyaline, or transversely banded,

emitting at short intervals tufts of multifid bright-green ramuli. *Ag. Syst. Alg. p.* 28. *Lyngb. Hyd. Dan. t.* 65, *fig. C. Kutz. Sp. Alg. p.* 532. *Hass. Brit. Fr. W. Alg. p.* 125, *t.* 9, *fig.* 1–2.

HAB. On sticks and stones, in running streams and ponds. Near West Point, *Prof. Bailey.* Cumberland, Rhode Island, *Mr. Olney.* South Carolina, *Mr. Ravenel.* (v. v.)

Frond gelatinous, varying greatly in size and in ramification; the younger specimens thicker, with fewer branches; the older attenuated and compound. The American specimens before me are 1–3 inches long, and from 1–2 inches in the expansion of the branches. Their fronds are not more than half a line in diameter, linear, filiform, and excessively branched, the branches very much crowded on a prolonged axis, from which they issue without order and are directed to all sides. They are sub-dichotomous, and more or less densely set with divaricated, simple or forked ramuli. When a portion of a branch is examined with a magnifier, it is seen to be composed of several parallel, longitudinal, articulated filaments, lying apart from each other, being separated by a gelatinous matrix; their cells are 4–6 times as long as broad, hyaline or marked with a central transverse band of granules, and they emit, at short intervals, horizontally spreading, multifid, coloured ramuli. The branching of the ramuli is irregular, and between fasciculate and pinnate, the ramification being sometimes densely crowded, sometimes distant. The cells of these ramuli are filled with green endochrome; they are 2–3 times as long as broad, and the terminal cells, which are short, are either simple or carry at their summit a long bristle-shaped acumination. *Substance* gelatinous. The plant closely adheres to paper in drying.

This species occurs in fresh-water ponds and streams in all parts of Europe, and its many minor varieties have received several names. All agree in microscopic structure. The ramification of the gelatinous matrix alone is variable, and that is a character of very little moment. Professor Bailey's specimens are labelled "Batrachospermum Americanum, Schweinitz;" a synonym referred by Agardh to his *Draparnaldia opposita*, which is quite different from the Alga now described.

2. CHÆTOPHORA *pisiformis*, Ag.; frond globose, carnoso-gelatinous, formed of numerous erect, radiating, sub-parallel filaments emitting to the circumference dichotomo-multifid patent branches. *Ag. Syst. p.* 27. *Hass. Brit. Fr. Wat. Alg. p.* 128, *t.* 9, *fig.* 5–6. *Kutz. Sp. Alg. p.* 532.

HAB. On sticks, in fresh-water ponds and ditches. Dr. Witt's Meadow, New York, *Prof. Bailey.* (v. v.)

Frond the size of a pea, or less, globose, several occurring together on the same stick, gelatinous, but rather firm, bright green. When bruised between two glasses, and examined under the microscope, the gelatinous matrix which forms the globe is seen to be everywhere filled with much branched filaments which rise from the base and radiate towards all parts of the circumference, sending forth multifid coloured branches vertically and laterally. The articulations of the filaments are once, twice or thrice as long as their diameter in different parts, contracted at the dissepiments, and filled with bright green endochrome. In a young state the apices of the ramuli are prolonged into setæ, or needleshaped, colourless acuminated cells, but these are deciduous in this and other species of the genus. *Colour*, a bright green.

Possibly this species is only a small state of *C. elegans*.

II. DRAPARNALDIA, *Bory*.

Filaments separate, gelatinous, articulated, dimorphous ; the articulations of the stem and branches hyaline, transversely banded ; those of the ramuli filled with green endochrome. *Zoospores* formed in the articulations. *(In fresh water.)*

Very beautiful, and extremely gelatinous, bright green, filamentous, much branched Algæ, found in clear wells and gentle streams. The structure of the filaments is similar to that of the filaments of the *Chætophoræ ;* and this genus merely differs from the preceding in its filaments being separate one from another, and not combined by means of gelatine into a compound frond. It therefore bears the same relation to *Chætophora* that *Vaucheria* does to *Codium.* The name was bestowed by Bory de S. Vincent in honour of *M. Draparnaud,* a French naturalist.

1. Draparnaldia *opposita*, Ag.; frond vaguely much branched ; joints of the main filament as long as broad, or shorter ; pencils of ramuli mostly opposite, densely set, lanceolate-acuminate in outline, plumose, bi-tripinnate, the apices much attenuated. *Ag. Syst. p.* 59. *Kütz. Sp. Alg.* 357. *Lyngb. Hyd. Dan. tab.* 65, *fig. A. Batrachospermum Americanum*, *Schweinitz.*

Hab. In clear streams. New York, *Professor Bailey.* New Jersey, *Mr. Jackson.* (v. s.)

Frond 2-3 inches long, gelatinous, capillary, irregularly much branched; the branches patent, lateral, more or less divided, and set with lesser ramuli. Main filaments with short articulations, as long as their breadth or shorter, transversely banded. At every two or three nodes and sometimes at every node a pair of opposite penicillato-multifid ramuli are thrown off. These are bright green, ovato-lanceolate in outline, much acuminated and twice or thrice pinnate, their pinnules somewhat constricted at the nodes, and tapering at the apex into long, needle-like, hyaline points. Their cells are commonly nucleated and filled with endochrome.

Whether this be permanently distinguishable from *D. glomerata* is doubtful. It has externally the aspect of that species, but its microscopic characters are nearer those of *D. plumosa.*

2. DRAPARNALDIA *glomerata*, Ag.; frond vaguely much branched; articulations of the main stems once or twice as long as broad, swollen in the middle; pencils of ramuli alternate or scattered, often distant, ovate in outline, fasciculato-multifid. *Ag. Syst. p.* 58. *Kütz. Sp. Alg. p.* 356. *Lyngb. Hyd. Dan. t.* 64. *Hass. Brit. Fr. W. Alg. p.* 120, *tab.* 13, *f.* 1. *Conferva mutabilis*, *Dillw. Conf. t.* 12. *E. Bot. t.* 1746.

HAB. In clear streams. New York, *Professor Bailey.* Rhode Island, *Mr. Olney.* (v. v.)

Very similar to the last species, but less densely plumose, with scattered fascicles of ramuli.

3. DRAPARNALDIA *plumosa*, Ag.; frond very slender, elongate, much branched; joints of the main filaments once or twice as long as broad; pencils of ramuli opposite or whorled, plumose, much attenuated, pinnate or bi-pinnate, the apices of the pinnules acicular. *Ag. Syst. p.* 58. *Kütz. Sp. Alg. p.* 357. *Hass. Brit. Fr. W. Alg. p.* 121. *tab.* 12, *f.* 1.

HAB. In streams. West Point, *Professor Bailey.* (v. v.)

More slender than *D. glomerata*, and much more branched, forming dense, gelatinous tufts, 3-6 inches long, often much drawn out in running water. In the American specimens the articulations of the stem and branches are about twice as long as broad, slightly constricted at the nodes, and swollen in the middle. Several seriated cells of this length follow each other, and then occur two or three short, nearly globular cells consecutively, which shorter cells emit the opposite or ternary penicillate ramuli. This alternation of longer and shorter cells occurs throughout the branch, the shorter ones always producing the ramuli. The ramuli are pinnate or bi-pinnate, but much less compound than in *D. opposita* or *D. glomerata.*

The synonymy of this species is confused. The American plant differs slightly from the European specimens with which I have compared it, but I am not disposed to think it specifically different. Indeed the three forms now described as species are so similar in all essential respects, that it may well be questioned whether they should be kept separate.

III. CLADOPHORA. *Kütz.*

Filaments (not gelatinous) tufted, articulated, uniform, branched. *Articulations* filled with green, granular endochrome, which is changed at maturity into *zoospores.* *(Marine or in fresh water.)*

An immense genus, in which, for the present, are placed almost all the branching species of a *green* colour formerly referred to the genus *Conferva*. The species are extremely difficult to define, and have been unreasonably multiplied ; but are so much diversified that it is difficult to avoid giving different names to the many forms met with, if they are to be described at all. Kützing admits 210 species, and probably nearly 100 more have been described by other authors. A wholesale reduction will probably be eventually made. I have referred most of the American forms, approximately or absolutely, to European types ; in some cases perhaps incorrectly. But unless better specific characters than those at present in use shall be discovered, it is almost impossible to find words to characterise, as distinct, nearly allied forms. When, therefore, I meet with an American specimen reasonably like a European, I here place them under the same head, or specific name. Several doubtful specimens I have been unable satisfactorily to identify, and hold them over for future examination, should better materials be sent to me.

Sect. 1.—*Species found in the sea.*

* CÆSPITOSÆ. Filaments short, rigid, densely interwoven into cushion-like tufts.

1. CLADOPHORA *repens*, J. Ag. ; filaments short, emitting root-like processes, densely interwoven into globose or expanded mats, capillary, rather rigid, sparingly and very irregularly branched ; branches erect, subsimple, filiform, naked or having a few secund ramuli ; articulations cylindrical, many (10–20) times as long as their diameter. *J. Ag. Alg. Medit. p.* 13. *Harv. Phyc. Brit. t.* 236. *Kütz. Sp. Alg. p.* 416.

HAB. On rocks, &c. in the sea. Key West, *W. H. H.* (v. v.)

Tufts very dense, an inch or two in breadth and about half an inch high, cushion-like, composed of innumerable, interwoven, capillary filaments. The filaments are at first decumbent, and connected by rootlike fibres which form the substratum of the mat ; the branches are erect, simple or branched, with or without secondary ramuli. The articulations vary greatly in length in specimens from different localities.

This species is a native of the Mediterranean, and also of the British Channel Islands. Except in the length of the articulations, which also vary much in the same filament, the European and American specimens nearly coincide.

2. CLADOPHORA *membranacea*, Ag. ; filaments short, creeping, densely interwoven into globose or expanded mats, somewhat fastigiate, thick, almost setaceous, flaccid, membranaceous, sparingly and irregularly branched ; articulations many times longer than broad. *Ag. Syst. p.* 120. *Kütz. Sp. Alg. p.* 415.

HAB. On rocks and the smaller Algæ. Key West, *W.H.H.*, *Professor Tuomey.* (v. v.)

Matted tufts an inch or more in diameter, sometimes widely spreading. *Filaments* scarcely an inch long, rising from creeping fibres, sparingly branched, flaccid, the branches very irregular, few or many, either undivided or once or twice compounded, naked, or having a few secund ramuli toward the ends. *Articulations*, especially the lower ones, very many times longer than broad, their membrane thin and membranous. *Colour* a very pale green, with watery endochrome.

This has the densely matted habit of the preceding species, but the filaments of which the mats are composed are much more robust, and less rigid, of a paler green, &c. Kützing well observes that it has the aspect of a *Valonia*.

** Rupestres; rigid, dark-green, tufted; the cell-wall thick.

3. Cladophora *rupestris*, L.; filaments capillary, rigid, dark-green, straight, tufted, bushy; branches erect, crowded, densely clothed with appressed, opposite or tufted, subulate ramuli; articulations three or four times as long as broad. *Linn. Sp. Pl. p.* 1637. *Dillw. Conf. t.* 23. *E. Bot. t* 1699. *Harv. Phyc. Brit. t.* 130. *Kütz. Sp. Alg. p.* 396. *Wyatt*, *Alg. Danm. No.* 95.

Hab. Rocky shores, near low water mark. Fiskernaes, near Cape Farewell, Greenland, *Dr. Sutherland.* Halifax, *W. H. H.* (v. v.)

Root a largish disc. *Filaments* densely tufted, 2-6-8 inches long (in my American specimens scarcely two inches), capillary, rigid, very dark-green, much branched; the branches straight and very erect, repeatedly divided, the divisions either alternate or opposite. Penultimate branches often nearly naked, filiform, elongated, very erect and straight; in luxuriant specimens set throughout with opposite or fascicled or scattered subulate ramuli, whose terminal cell is sometimes acute, sometimes obtuse. The process of cell division is well illustrated in this species, and may be observed even in dried specimens, so perfectly does the endochrome recover its form. The cells of the middle portion of the branches divide as well as those of the younger ramuli, and consequently consecutive cells are found of various lengths.

Two specimens of what I take to be a much denuded and battered state of this species were collected by Dr. Sutherland, in the Arctic expedition under Captain Inglefield, in the above mentioned locality, and have been sent to me by Professor Dickie of Belfast. They are faded to a dull green. The substance and ramification, so far as branches remain unbroken, are those of *C. rupestris;* but in one specimen the articulations are very short, being only as long as their diameter, or scarcely longer. This peculiarity at first seems sufficiently characteristic of a distinct species, but a little further examination shows that the character is deceptive, resulting merely from the ordinary process of cell-division being in this specimen carried to an excess. On the other specimen are cells of the common length mixed with these short or halved cells; and intermediate stages occur which quite explain the unusual character of the first specimen.

4. CLADOPHORA *cartilaginea*,* Rupt.; tufts............... ? filaments robust, setaceous elongate, firm, somewhat rigid, rather sparingly branched; branches very erect, scattered, long and virgate, undivided, straight, set with a few scattered, erecto-patent, filiform branchlets, which are either naked or bear one or two minute ramuli ; articulations in the older parts much shorter than their diameter ; in the younger (towards the ends of the branches) as long, or twice as long as broad. *Rup. Alg. Ochotzk*, *p.* 211, (403.)

HAB. Unalaschka, *Dr. Ruprecht.* (v. s. in Herb. T.C.D.)

My only specimen is a fragment, but it seems to belong to a well characterised species of large size. The portion before me is about four inches long, with a few lateral virgate branches, set at very acute angles, quite simple, straight and three inches long, furnished with several scattered, simple, erect ramuli, each of them from half an inch to an inch in length, obtuse, nearly as thick as the stem from which they spring. These are mostly naked, but in a few cases they bear a minute ramulus near the tip. The apices are not attenuated. The diameter of the filament is equal to that of hogs' bristle. The substance is firm and cartilaginous, and the colour a pale-green. Through the greater part of the filament the articulations are much shorter than their diameter ; but towards the apices they are longer, and the few terminal joints are twice as long as broad, or more.

*** ARCTÆ. Filaments soft, forming dense, spongy, fastigiate tufts of a pale, but vivid green.

5. CLADOPHORA *arcta*, Dillw. ; tufts dense, more or less matted at the base, starry, fastigiate, soft, brilliant and glossy green ; filaments capillary, much branched ; branches straight, crowded, very erect ; ramuli opposite or scattered, erect or appressed ; articulations in the lower part of the frond about twice as long as broad, in the upper (younger) branches many times longer than the diameter ; apices obtuse. *Dillw. Conf. Supp. p.* 67, *t. E. E. Bot. t.* 2098. *Harv. Phyc. Brit. t.* 135. *C. arcta*, *vaucheriæformis*, *and centralis*, *Auct. C. scopæformis*, *Rup.*

HAB. Coasts, from the Arctic Regions to New York Bay, on rocks near low water mark. Whalefish Islands, Davis's Straits, *Dr. Lyall.* Prince Edward's Island, *Dr. Jeans.* Penobscot Bay, *Dr. Young.* Boston Harbour, *Mr. G. B. Emerson.* New York Bay, *Messrs. Walters*, *&c.*, *W. H. H.* (v. v.)

* Besides this species Dr. Ruprecht notices the following from Russian America :—*C. adhærens*, Rup. from the Arctic Sea, allied to *C. arcta* (if it be different) ; *C. Chamissonis*, Rup. from Unalaschka ; *C. Mertensii*, R. from Sitcha ; *C. viminea*, Rup. from Sitcha and Unalaschka ; *C. scopæformis*, and *C. coalita*, from Northern California. Of these Dr. Ruprecht has sent me fragments of *C. Chamissonis*, *C. viminea*, and *C. coalita;* but as he has not, that I am aware of, assigned full specific diagnoses to any of the above species, I am unwilling to describe the few that I possess, from the very imperfect materials at my command, lest I might add to the confusion already sufficiently confounded in this genus. I collect the above names from Dr. Ruprecht's *Alg. Ochotsk.*, as already quoted.

This species varies much in minor characters, but may generally be known by its lubricous substance, brilliant colour, fastigiate tufts, and straight, much branched filaments which radiate to every side from a common base, in a star-like manner. In the young plant the tufts are less dense, the filaments nearly free from each other to the very base; but as the plant advances in age, root-like processes are developed along the lower part of the filaments, while the tufts become matted together, sometimes into a compact spongy frond. In very old specimens this condensation takes place throughout the whole length of the filament, except in the very youngest ramuli. The tufts are from two to four inches in height, hemispherical, or variously divided into two or more hemispherical or flabelliform lobes, and are generally level-topped. They are composed of many parallel, much branched, capillary filaments, of nearly equal diameter from base to apex; the branches all very straight and erect, repeatedly but most irregularly divided, and set with lateral, erect, straight ramuli, which are nearly as robust as the branches from which they spring, and very obtuse. Toward the base of the filaments the articulations are once or twice as long as broad; a little farther up they are three to four times; and in the young branches and ramuli six to eight or twelve times as long as broad. In the state or variety called *C. centralis* they are uniformly short throughout except in the very young tips. The endochrome is dense and granular, and recovers its form on being moistened after having been dried. The colour in general is well preserved in drying, in which state the tufts retain much of their gloss, and closely adhere to paper.

Authors have made several species out of what we regard as simply *C. arcta* in different stages. Thus *C. vaucheriæformis* is the young, half-developed form; *C. arcta*, Auct. the middle stage; and *C. centralis* the old plant, where the matting together of the threads has been carried to an extreme point. Other species of Kützing's section *Spongomorpha* might probably be added to these synonyms A fragment of *C. scopæformis*, Rup. from Russian America, sent to me by Dr. Ruprecht himself seems to belong to one of the spongy forms of this species. *C. arcta* is perennial; and specimens collected in the same locality at different seasons will be found to put on, successively, all the characters attributed to the three principal forms indicated above.

6. Cladophora *lanosa*, Roth.; tufts dense, globose, small, fastigiate, yellow-green; filaments slender, irregularly much branched; branches straight and virgate, erect, patent; ramuli few, scattered, erect, straight; axils acute; articulations in the lower part twice, in the upper six to eight times as long as broad. *Roth. Cat. Bot.* 3, *p.* 291, *t.* 9. *E. Bot. t.* 2099. *Lyngb. Hyd. Dan. t.* 56. *Kütz. Sp. Alg. p.* 420. *Harv. Phyc. Brit. t.* 6. *Wyatt, Alg. Danm.* 194.

Hab. On the smaller Algæ, and on Zostera; generally epiphytic. Boston Bay, *Mr. G. B. Emerson.* (v. v.)

Tufts rarely more than an inch in diameter, globose, dense, formed of many filaments radiating from a common base. These filaments are at first separate, but at length by means of rooting processes issuing along their sides, they become somewhat interwoven below. They are fastigiate and very irregularly divided, but mostly straight, with erect branches and ramuli. The lower articulations are short; the upper, and especially the terminal ones, are very long. The endochrome generally recovers its form after having been dried, at least in the younger portions of the frond, if it have not been discharged, as often happens, by the rupture of the membrane, when the frond is immersed in fresh water. This plant adheres closely to paper.

A much smaller species than *C. arcta*, to which, as well as to *C. uncialis*, it is nearly allied.

7. Cladophora *uncialis*, Fl. Dan.; tufts short, vivid-green, very dense, spongy, globose, simple or somewhat lobed, fastigiate, composed of numerous filaments matted together by lateral rootlets; filaments flexuous, sparingly branched, interwoven; branches and ramuli distant, patent, curved, alternate or secund; articulations of uniform length, about twice as long as broad. *Fl. Dan. t.* 771, *fig.* 1. *Lyngb. Hyd. Dan. t.* 56. *Ag. Syst. p.* 111. *Wyatt, Alg. Danm.* 146. *Harv. Phyc. Brit. t.* 207. *Kütz. Sp. Alg. p.* 420.

Hab. On rocks near low water mark. Prince Edward's Island, *Dr. Jeans.* Halifax, *W. H. H.* Nahant, *Mrs. Mudge.* (v. v.)

Tufts about an inch in height and diameter, very dense and spongy, either somewhat globose, or cleft into numerous spongy divisions, fastigiate. *Filaments* very numerous from a common base, densely matted and interwoven by root-like processes developed along the sides, flexuous, more or less compound. Branches very irregularly disposed, generally distant, secund or alternate, once or twice again divided, and having a few patent, curved, simple ramuli. *Colour*, when growing, a vivid-green; instantly discharged in fresh water, and in drying the specimen fades to a pale yellow-green, especially toward the centre of the tuft. The endochrome recovers its form and fills the cell, on moistening after having been dried. The articulations in all parts of the filaments are of nearly uniform length, twice or thrice as long as their diameter. *Substance* soft but not gelatinous.

Very nearly related to *C. lanosa*, but the place of growth is different, and the filaments are more flexuous, the branches more patent, and the rooting processes more numerous.

**** Graciles. Filaments loosely tufted, feathery, very slender, pale or bright-green.

8. Cladophora *glaucescens*, Griff.; filaments loosely tufted, pale or glaucous green, very slender, flexuous, excessively branched; branches erecto-patent, flexuous, repeatedly sub-divided, the penultimate ones pectinated with closely set, elongate, straight, slender, many celled, erect or sub-erect ramuli; axils acute; articulations constricted at the nodes, nearly uniformly thrice as long as broad, those of the main branches a little the longest. *Wyatt, Alg. Danm. No.* 195. *Harv. Phyc. Brit. t.* 196. *Kütz. Sp.*

Alg. p. 403. *Var. β. pectinella;* small, very slender, all the divisions of the ramification secund, the penultimate ramifications closely pectinated with short ramuli and recurved.

HAB. On rocks and stones, between tide marks and in rock pools. Halifax, *W. H. H.* Lynn and Nahant, *Mrs. Mudge.* Portsmouth, N. H., *Dr. Durkee.* New York Bay, *Messrs. Hooper, Calverley, Walters, and Pike.* Beesley's Point, Rhode Island, *Mr. Ashmead.* Var. *β.* Charleston, S. C., *Prof. L. Gibbes, W. H. H.* (v. v.)

Filaments very slender, 3–5 inches long, forming tufts of greater or less density, but not usually entangled or interwoven, excessively branched, the main divisions and principal branches flexuous, sometimes very much so, closely beset with lesser branches which divide either alternately or secundly, the tendency to secund ramification increasing as the frond extends. The penultimate branchlets are generally closely pectinated with secund, erect, straight, simple ramuli composed of several cells; and occasionally the ramuli are fascicled, three or four springing from the same cell. Though always very slender, the diameter varies. The articulations, on the whole, are pretty uniform; those of the ramuli are most constricted at the nodes, and also a little the shortest. In drying the endochrome is dissipated from the centre of the cell, and collapsed at the two ends, so that the filaments, in dried specimens, have a variegated appearance under a pocket lens. On remoistening, it never perfectly recovers its form.

My Halifax specimens are identical with those published by Mrs. Wyatt, and on which the species was originally founded. Those from other localities vary in some degree, being either coarser or more slender, and more or less branched; but on the British coasts similar varieties occur.

9. CLADOPHORA *flexuosa*, Griff.; filaments very slender, pale green, tufted, flexuous, sparingly and distantly branched; branches elongate, sub-simple, of unequal length, flexuous, sometimes nearly naked, sometimes ramuliferous; the ultimate ramuli secund or alternate, short or long, curved; articulations of the branches 3–4 times, of the ramuli twice as long as broad. *Griff. in Wyatt, Alg. Danm. No.* 227. *Harv. Phyc. Brit. t.* 353.

HAB. Rock pools between tide marks, &c. Hingham, Massachusetts, *Miss Brewer.* Boston, *Dr. Durkee.* Jackson Ferry and Hell Gate, New York, *Messrs. Walters and Pike.* (v. s.)

Very nearly related to *C. glaucescens*, if really specifically distinct. It is chiefly known by its less compound habit, the length and nakedness of the principal branches, and their flexuosity. The diameter of the filament is nearly as in *C. glaucescens:* the articula ions are rather longer. Some of the specimens are nearly destitute of ramuli, and scarcely two of those before us agree in all respects.

10. CLADOPHORA *Morrisiæ;* tufts elongate, dense, somewhat interwoven, dark green;

filaments very slender, much and irregularly branched, the penultimate branches very long, filiform, flexuous, simple, set with alternate or secund, short, erecto-patent ramuli, some of which are simple and spine-like, others pectinated on their upper side ; articulations filled with dense endochrome, in the branches 2–3 times, in the ramuli about twice as long as broad, cylindrical, not contracted at the nodes. (TAB. XLV. B.)

HAB. Elsinborough, Delaware, *Miss E. C. Morris.* (v. s. in Herb. T.C.D.)

Tufts dense, 6–8 inches in length. *Filaments* inextricably bundled together, very slender, much branched, the ramification of the principal divisions not determinable from dried specimens. The penultimate branches which float out from the somewhat rope-like tufts are generally simple for an inch or two in length, or the longer ones are furnished with similar simple branches ; and all are beset with short, erecto-patent ramuli. Some of the ramuli are simple, of 3–4 cells ; others emit similar ramuli on their upper side. The membrane of the cell-wall is very thick and tough, and the endochrome peculiarly firm, recovering its form well on being moistened after having been dried. The nodes are not contracted, and the internodes or articulations rarely exceed thrice their diameter in length, and often do not reach that dimension. The colour is a full dark-green, somewhat olivaceous when dried. Specimens adhere closely to paper.

I have as yet only received this plant from Miss Morris. It differs in several respects from any that I now remember.

PLATE XLV. B. CLADOPHORA *Morrisiæ ; Fig.* 1, the *natural* size. *Fig.* 3, portion of a branch : and *Fig.* 2, a ramulus of the same; *magnified.*

1. CLADOPHORA *refracta*, Roth. ; filaments very slender, rather densely tufted, bright green, membranaceous (not lubricous), excessively branched ; secondary branches spreading on all sides, repeatedly divided and very patent, densely set with short, often opposite, recurved or squarrose branchlets, which are pectinate on the inner face with patent, simple or forked ramuli ; articulations of the branches 2–4 times of the ramuli about twice as long as broad. *Roth. Cat.* 2, *p.* 193. *Alg. Syst. p.* 114. *Wyatt, Alg. Danm. No.* 228. *Harv. Phyc. Brit. t.* 24. *Kütz. Sp. Alg. p.* 398.

HAB. On rocky coasts, in tide pools, &c. Rhode Island, *Mr. Olney*, *Mr. G. Hunt.* Boston Bay, *Dr. A. Gray.* Portsmouth, N. H., *Dr. Durkee.* New York, *Messrs. Calverley, Walters, and Pike.* Newport, R. I., *Professor Bailey.* Seaconot, *Mr. Congdon.* Charleston, S. C., *Professor Gibbes.* (v. v.)

Tufts 2–3 inches long, feathery, rather diffuse, the main filaments sometimes interlaced in rope-like bundles. *Filaments* more slender than human hair, rather rigid, tough, excessively branched, all the divisions patent or divaricate. The penultimate ramuli are especially reflexed or refracted, and often opposite ; their ultimate divisions are either simple or forked. The colour is a brilliant green, but it does not well preserve in drying, in which state the specimen is without gloss and generally pale. The endochrome is generally dissipated in drying, and does not, in ordinary cases, recover its form when the frond is remoistened ; sometimes, however, the endochrome remains.

A beautiful species, and tolerably easily known. The American specimens are very similar to our West of Ireland plant, but more robust than those from the South Coast of England.

12. CLADOPHORA *albida*, Huds.; filaments exceedingly slender, flaccid, but not gelatinous, pale green, forming dense, silky or somewhat spongy, soft, intricate tufts, very much branched ; branches zigzag, their divisions very patent, the lesser branches very frequently opposite, and nearly horizontal ; ramuli alternate, opposite or secund, patent or divaricating ; articulations 3-5 times as long as broad. *Huds. Fl. Angl. p.* 595. *E. Bot. t.* 2327. *Wyatt, Alg. Danm. No.* 96. *Harv. Phyc. Brit. t.* 275.

HAB. On rocks and algæ, between tide marks. Staten Island, *Dr. Torrey.* Beesley's Point, *Mr. Ashmead* (64, 65, 66). New York Bay, *Messrs. Calverley, Walters, &c.* (v. v.)

Tufts 6-8 inches long, very dense and soft, and somewhat intricate or woven together, occasionally feathering and opening out freely. *Filaments* excessively slender and very much branched, and so interwoven that it is impossible to trace the branching. In the American specimens the main branches are very flexuous, angularly bent from side to side, and very much divided, all the divisions squarrose or divaricating. The penultimate branches, which are nearly horizontally patent, are generally opposite, but three or more sometimes issue from the same point ; the ultimate ramuli are scattered, either alternate or secund. The nodes are somewhat contracted ; the cell-wall thin, and the endochrome pale and watery. When dry the whole plant frequently becomes a dull greenish white. It does not strongly adhere to paper.

13. CLADOPHORA *Rudolphiana*, Ag.; filaments very long, exceedingly slender, flexuous, sub-gelatinous, much branched, bright yellow-green, inextricable ; branches di-trichotomous or irregular ; ultimate ramuli pectinate, secund, very long, and much attenuated ; articulations of the main branches many times longer than broad, here and there swollen, their granular endochrome somewhat spiral ; those of the ramuli 6-10 times as long as broad. *Ag. Bot. Zeit.* 10, *p.* 636. *Harv. Phyc. Brit. t.* 86. *Kütz. Sp. Alg. p.* 404.

HAB. Jackson Ferry, N.Y., *Mr. Walters.* (v. v.)

A specimen sent by *Mr. Walters* agrees pretty well with the Irish specimens figured in Phyc. Brit. The filaments are 4-5 inches long, soft, and somewhat gelatinous, closely adhering to paper, intricately interbranched, very flexuous, zigzag, and much branched. The branches are patent, sometimes opposite, mostly alternate or scattered, and repeatedly divided ; the ramuli slender, few and subdistant. The articulations of the branches are very many times longer than broad; those of the ramuli 5–6 times their breadth. The endochrome is generally dissipated in drying. When dry the specimen retains a brilliant green and has a silky gloss.

14. CLADOPHORA *gracilis*, Griff.; filaments very long, capillary, flexuous, silky, much branched, bright yellow-green ; main branches entangled, sparingly divided, angularly bent ; ultimate ramuli pectinate, secund, much attenuated, straight, and very long ; articulations 3–5 times as long as broad. *Griff. in Wyatt, Alg. Danm. No.* 97. *Harv. Phyc. Brit. t.* 18. *Kütz. Sp. Alg. p.* 403.

HAB. Growing on *Zostera*, and the various Algæ, in the Laminarian zone. Nahant, *Mrs. Mudge.* Beesley's Point, Rhode Island, *Mr. Ashmead* (67.) Seaconot, Rhode Island, *Mr. Olney.* (v. v.)

Filaments more or less densely tufted, 4–12 inches long, (about 4 inches in the American specimens), capillary, soft and silky, much branched ; the main branches rather more robust and bent in a zigzag manner, sometimes very flexuous, and frequently more strongly coloured than the rest of the plant, set throughout with lateral, decompound branches all whose divisions are patent ; and the ultimate branchlets pectinated with long, simple, secund ramuli. *Colour* a yellow-green. *Substance* soft and silky, but not gelatinous. *Articulations* 3–5 times as long as broad. It does not strongly adhere to paper in drying.

Mrs. Mudge's specimens are small, but in other respects very similar to English ones. Those from Mr. Olney and Mr. Ashmead are less true to the type.

15. CLADOPHORA *brachyclados*, Mont. ; filaments very slender, tufted, sparingly branched ; branches long and virgate, set with distant, alternate, erecto-patent branchlets, which are pectinated along their upper sides with very short, erect, or incurved ramuli, of 1 or 2 cells; articulations of the branches 5–6 times as long as broad. *Mont. Cuba, p.* 13, *t.* 4. *Sylloge Pl. Crypt. p.* 456. *C. Montagneana, Kütz. Tab. Phyc. vol.* 4, *p.* 9, *t.* 41, *fig.* 2.

HAB. Mouth of Rio Bravo, on the sea-beach, *Dr. Schott.* (v. s. in Herb. T.C.D.)

The specimen received from *Dr. Schott* is a very imperfect one, but its filaments, when examined under the microscope, show so many characters in common with those of Montagne's *C. brachyclados* from Cuba, with an authentic specimen of which I have compared them, that I am unwilling to separate forms so similar. The short, mostly single-celled ramuli are characteristic.

16. CLADOPHORA *luteola;* filaments very pale yellow-green, tufted, excessively slender,

and much branched, not matted together ; main and lesser branches remarkably flexuous, the angles rounded, and the filaments arcuate; branching irregular, frequently trichotomous, the lesser ramuli secund or opposite, and their ultimate divisions pectinate, somewhat corymbose and crowded toward the apices ; articulations cylindrical, hyaline, 6–8 times as long as broad.

HAB. Growing on littoral corals, at Key West, *W. H. H.* (v. v.)

Filaments 2–3 inches long, rather loosely tufted, excessively slender, and soft, but not in the least gelatinous, very much branched, remarkably bent ; the filaments arcuate between each ramification. The branching is irregular. In the principal and also in the lesser divisions it is frequently trichotomous, three branches springing from a node; but the branches are almost as often alternate or sub-dichotomous. In the medial portion of the frond the forkings are sub-distant ; they become more frequent upwards, and the branches generally end in closely set, but scarcely fasciculate pectinated ramuli, which are either opposite, alternate, or secund. The ultimate ramuli are erect and incurved. *Articulations* seldom less than six times as long as broad, sometimes more, with a very pale, watery endochrome, which is dissipated in drying. Notwithstanding its tenuity this plant does not adhere closely to paper.

***** LÆTEVIRENTES. *Filaments* loosely tufted, robust, and somewhat firm or rigid, vivid-green.

17. CLADOPHORA *lætevirens*, Dillw. ; filaments much branched, bushy, forming tufts of a transparent, yellow-green colour (faded and without gloss when dry) ; branches erecto-patent, crowded, repeatedly divided, flexuous, the lesser divisions often opposite ; ultimate ramuli secund, blunt, of few articulations ; articulations of the branches six times, of the ramuli thrice as long as broad. *Dillw. Conf. t.* 48. *E. Bot. t.* 1854. *Harv. Phyc. Brit. t.* 190. *Wyatt, Alg. Danm. No.* 143. *Kütz. Sp. Alg. p.* 400. *Conf. glomerata var. marina, Roth. Cat. Bot.* 3, *p.* 237.

HAB. In rock pools between tide marks. New York Bay, *Messrs. Hooper & Walters.* Boston, *Dr. Durkee.* California, *Dr. Coulter.* (v. v.)

Tufts feathery. *Filaments* 3–6 inches long or more, capillary, much branched, main filaments flexuous or angularly bent, set with alternate or scattered, occasionally opposite, repeatedly decompound patent branches, which are densely set with lesser branches and ramuli, all of which are patent and often recurved. Lesser and penultimate branches mostly secund, sometimes opposite or fasciculate, their ultimate divisions pectinated with short closely set ramuli on the upper side. Articulations of the main branches 4--6 or 8 times, of the ramuli 3--4 times as long as broad. *Colour*, a full grass green. *Substance,* not very soft. It adheres, but not strongly, to paper in drying.

18. CLADOPHORA *diffusa (?)*; filaments capillary, elongate, loosely tufted, somewhat rigid, full green, flexuous, much branched; branches distant, irregularly subdivided, nearly naked, or furnished toward the ends with a few short secund ramuli; articulations 3–4 times as long as broad. *Harv. Phyc. Brit. t.* 130 (?) &c.

HAB. New York Sound, *Messrs. Walters, Pike, &c.* California, *Mr. A. D. Frye.* (v. s.)

Tufts loose. *Filaments* 6-12 inches long or more, generally so rigid as not to collapse when removed from the water, capillary or somewhat more robust, much and irregularly branched. Branches distant, often an inch or more apart, erecto-patent, naked in the lower portion or very sparingly ramulose, and sometimes naked throughout and little subdivided. Generally, however, the upper divisions are more repeatedly and more closely branched, and their branches furnished with a few short, secund, pectinate ramuli. On some specimens these are very few and confined to the apices; on others they are more abundant.

Recognised chiefly by its naked and distant branches, nearly destitute of ramuli. The more ramulose specimens seem gradually to glide off into *C. lætevirens.* I quote the figure in *Phyc. Brit.* with a mark of doubt, and refrain from quoting other authorities, because I am not quite sure of the specific identity of the American and European specimens.

SECT. 2. Species found in brackish water, or in fresh-water ponds and streams.

19. CLADOPHORA *fracta*, Fl. Dan.; tufts irregular, entangled, often detached and then forming floating strata, dull green; filaments rather rigid, distantly branched, the lesser branches somewhat dichotomous, spreading, with very wide axils; the ramuli few, alternate or secund; articulations 3--6 times as long as broad, at first cylindrical, then elliptical, with contracted nodes. *Fl. Dan. t.* 946. *Dillw. Conf. t.* 14. *E. Bot. t.* 2338. *Lyngb. Hyd. Dan. t.* 52. *Harv. Phyc. Brit. t.* 294. *Kütz. Sp. Alg. p.* 410.

HAB. In salt water ditches and ponds, also in brackish or fresh water. Rhode Island, and in the Hudson, at West Point, *Prof. Bailey.* Beesley's Point, *Mr. Ashmead.* Near New York, *Mr. Walters.* (v. v.)

This is at first tufted and attached to sticks or stones, but afterwards occurs floating, and then forms strata of considerable extent. *Filaments* capillary, several inches long, loosely tufted or bundled together, much but distantly branched, the branches widely spreading at very obtuse angles, and again and again dividing, all the minor divisions being equally patent, and the angles equally wide. The lesser branches sometimes bear a few secund ramuli, and are sometimes quite naked. *Colour*, at first a grass green, but gradually becoming darker. *Substance*, membranaceous and rather rigid, seldom quite adhering to paper in drying, and readily detached.

To this species I am disposed to refer a specimen which was provisionally named *C. prasina*, formerly received from Professor Bailey, who found it abundantly in the Hudson at West Point, where it is thrown ashore after storms. I have also received a fresh-water specimen collected by Dr. Bigelow when engaged on Lieutenant Whipple's expedition to the Pacific.

20. CLADOPHORA *glomerata*, Linn.; filaments tufted, bushy, somewhat rigid, much branched, bright grass-green; branches crowded, irregular, erecto-patent, repeatedly divided; ultimate ramuli secund, subfasciculate; articulations 4--8 times as long as broad. *Dillw. Conf. t.* 13. *E. Bot. t.* 2192. *Harv. Man. Ed.* 1, *p.* 134.

HAB. In streams, lakes, and rivers. Probably common.

I have received North American specimens from Milton, Saratoga County, N.Y., and from Lake Erie; also from the Mexican Boundary Surveying Expedition.

IV. CHÆTOMORPHA, *Kütz.* (May, 1845.)

Filaments (not gelatinous), membranaceous or cartilaginous, unbranched, attached, or floating, articulated; formed of a string of oblong cells, the basal cell longer than the rest. *Articulations* filled with granular endochrome. *(Marine.)*

The genus, as here adopted from Kützing, is intended to include most of the marine species of the older *Conferva*, which have unbranched filaments and articulations usually longer than their diameter. It differs from *Cladophora* solely in being branchless. From *Hormotrichum* it is less easy to point out a clear distinctive character, unless we seek it in the substance of the cell-coats, and in the shortness of the cells usual in that genus. The name *Aplonema* was proposed for this group by Mr. Hassall *(Brit. Fr. W. Conf. p.* 213.) only two months subsequently to the publication of Kützing's genus, which thus establishes its priority on very narrow evidence. It forms a part of the Agardhian *Lychæte*, published in 1846; a group that includes both simple and branched species, and which is thus characterised by its author:—

LYCHÆTE, J. Ag.; "fronde sub-heterogenea, articulo infimo (in simplicibus), aut infimis ramorum (in ramosis) dissimilibus et non mutandis, superioribus omnibus continua subdivisione iterum iterumque divisis atque coniocystis externis distinguendum." *Alg. Ined. Ed.* 2, *No.* 9. *(Lychæte mirabilis).*

I prefer, with Kützing, to keep the branching and unbranched species in separate genera, as being a more obvious, if not more natural arrangement. However, the whole subject of the natural arrangement of these obscure plants is open to future discussion. The present is but a temporary settlement of the question.

1. Chætomorpha *Piquotiana*, Mont. ; filaments loosely bundled together in strata, very long, ultra-setaceous, grass-green, rigid, glossy and variagated when dry, variously twisted ; articulations 3--5 times as long as broad, contracted at the nodes. *Mont. An. Sc. Nat. 3d Ser. vol.* 11, *p.* 66. *Mont. Syll. p.* 459. *Kütz. Sp. Alg. p.* 379. *Tab. Phyc. vol.* 3, *p.* 19, *t.* 58, *f.* 2. (Tab. XLVI. C.)

Hab. In deep water ; from 5 to 6 fathoms. Coast of Labrador, *M. Lamare-Piquot!* Burnt Coat Island, Maine, *Dr. A. Young.* Halifax, *W. H. H.* Boston Bay, *Mrs. A. Gray.* Staten Island, N.Y., *Dr. Torrey.* (v. v.)

This occurs in large bundled strata, the filaments lying loosely together, but probably they are attached at an early age. *Filaments* 12--14 inches long or more, twice as thick as hog's bristle, crisp and rigid, variously curved and twisted, of a full grass-green colour, fading in drying, but retaining a glossy surface. The *endochrome*, in drying, is usually dispersed toward the ends of the cell, which gives the filament a variegated look, with alternate pale and dark bands. The cell membrane is thick and tough. The articulations are variable in length, but always much longer in proportion than those of *C. melagonium.* They are commonly four times as long as broad ; occasionally only thrice their breadth, and sometimes 5--6 times as long. The dissepiments or nodes are always much constricted and very narrow. The endochrome recovers its form when remoistened. It does not adhere to paper.

I have compared my specimens with an original one communicated by Dr. Montagne. The species is nearly related to *C. melagonium*, but of larger dimensions and with much longer articulations.

Plate XLVI. *Fig.* 1. Chætomorpha *Piquotiana*, the *natural* size. *Fig.* 2, a magnified portion.

2. Chætomorpha *melagonium*, Web. and Mohr. ; root scutate ; filaments erect, straight, elongate, very robust, ultra-setaceous, stiff and wiry, dark-green, tapering to the base, obtuse ; articulations 2–3 times as long as broad. *Ag. Syst. p.* 99. *Lyngb. Hyd. Dan. t.* 51. *Harv. Phyc. Brit. t.* 99. *A. Wyatt, Alg. Danm. No.* 221. *Kütz. Sp. Alg. p.* 379.

Hab. In rock pools near low water mark, and at a greater depth. Greenland, *Wormskiold.* Halifax, *W. H. H.* Boston Bay, *Mrs. Asa Gray.* Newbury Port, *Mr. Hooper.* Unalaschka, *Wosnessensky.* (v. v.)

Root an expanded disc. *Filaments* either scattered, or somewhat tufted, 5–12 inches long, twice as thick as hog's bristle, erect and stiff, peculiarly wiry to the feel when growing, straight or slightly curved, very blunt at the apex, and tapering to the base. *Articulations* rather longer in the American than in European specimens, but variable even in the same tuft ; once and a-half, twice, or thrice as long as broad, filled with dark-green endochrome and contracted at the dissepiments.

3 CHÆTOMORPHA *ærea*, Dillw. ; root scutate ; filaments setaceous, tufted, straight, (sometimes twisted in age) harsh and brittle, yellow-green ; articulations about as long as broad. *Dillw. Conf. t.* 80. *E. Bot. t.* 1929. *Lynb. Hyd. Dan. t.* 51. *Ag. Syst. p.* 100. *Wyatt, Alg. Danm. No.* 191. *Harv. Phyc. Brit. t.* 99. *B.* *Kütz. Sp. Alg. p.* 379.

HAB. In rock pools, between tide marks, &c. Newport, *Professor Bailey*. New York Bay, *Messrs. Hooper, Walters, &c.* (v. v.)

Filaments generally in dense tufts, 3-12 inches in length, and as thick as hog's bristle, rather harsh to the touch when fresh, but much less rigid than *C. melagonium*, and collapsing on being removed from the water, usually straight, but old specimens are sometimes crisped and contorted. The colour when growing is a beautiful yellowish green, but dried specimens are usually much faded, and dull-greenish white after long keeping in the Herbarium. The endochrome fills the cell and is of a watery consistence, and dispersed in drying. The articulations are pretty uniformly as long as broad, with contracted dissepiments.

4. CHÆTOMORPHA *Olneyi*, Harv. ; filaments tufted, setaceous, straight or curved, soft, pale-green ; articulations once and half as long as broad. (TAB. XLVI. D.)

HAB. Rhode Island, *Mr. Olney*. (v. s. in Herb. T.C.D.)

This has the habit of *C. ærea*, but is of a soft and flaccid substance, adhering closely to paper in drying. When dry it is very pale, greenish white, and without gloss. The filaments are about the same diameter as those of *C. ærea* ; the articulations are longer, and the cell-wall thicker.

PLATE XLVI. D. Fig. 1. CHÆTOMORPHA *Olneyi*, the *natural* size. Fig. 2. a portion *magnified*.

5. CHÆTOMORPHA *longiarticulata*, Harv. ; filaments capillary, curved, loosely bundled together, flaccid, soft, pale green ; articulations 4--6 times as long as broad, swollen at the nodes. (Tab. XLVI. E.) Var. *β. crassior* ; filaments more robust.

HAB. In rock pools, between tide marks. Ship Anne Point, *Mr. Hooper*. Boston Bay, *Mrs. Asa Gray*. Little Compton, *Mr. Olney*. Var. *β*, in brackish ditches at Little Compton, *Mr. Olney*.

Filaments rather more slender than human hair, 3–4 inches long, loosely bundled together, and somewhat stratified. *Articulations* filled with very pale endochrome, almost hyaline when dry, several times longer than their diameter, nodoso-incrassate at one or both ends, with contracted dissepiments. The cell-wall is very thin and membranous.

I do not know any species to which this is nearly related. It is much more robust than *C. arenosa.* The length of the joints and the swelling of the nodes distinguish it from *C. litorea.*

Plate XLVI. E. *Fig.* 1. Chætomorpha *longiarticulata;* the *natural* size. *Fig.* 2, a portion *magnified.*

6. Chætomorpha *sutoria*, Berk.; filaments setaceous, elongate, flexuous, equal, pale or dark green; articulations once and half as long as broad; interstices pellucid. *Berk. Gl. Alg. t.* 14, *f.* 3. *Harv. Phyc. Brit. t.* 150. *B. Ch. rigida*, *Kütz. Sp. Alg. p.* 377.

Hab. Floating in large masses at Stonington, Con., *Prof. Bailey.* (v. s.)

This occurs, loosely bundled together in extensive floating masses or strata. *Filaments* as thick as hog's bristle, several inches long, rigid and variously curved and twisted, pale-green, cylindrical. *Articulations* once and half as long as broad, at length bisected. *Substance* rigid. It scarcely adheres to paper in drying.

Professor Bailey's specimens chiefly differ from the British plant with which I have associated them in being of a paler colour, with less dense endochrome, and of rather softer substance.

7. Chætomorpha *litorea*, Harv.; filaments capillary, rigid, crisp, forming loose, extensive, dull-green bundles; articulations once and half as long as broad, here and there swollen in pairs and discoloured. *Harv. Phyc. Brit. t.* 333. *C. linum*, *Alg. Danm. No.* 220 (Excl. Syn.) *C. tortuosa, var. crassior*, *Rup. Alg. Och.*

Hab. Sea-shores. Sitcha, Russian America, *Wosnessensky.* (v. s.)

Filaments forming loosely interwoven, extensive, floating strata, or entangled among the branches of other Algæ, capillary, several inches in length, and of a dull green colour. The articulations are once and a-half to twice as long as broad, cylindrical, not contracted at the nodes, and mostly uniform in the same filament; but here and there a pair of longer cells occur, which are swollen towards their commissure, where the endochrome collects in a dark mass. In drying the endochrome is usually dispersed, and never recovers its form on being moistened.

This has been sent to me by Dr. Ruprecht from Sitcha, under the name *C. tortuosa, var. crassior.* The filaments, however, are fully twice as robust as in *C. tortuosa;* they are more rigid, and adhere less strongly to paper, and their endochrome is dissipated in drying. They agree pretty well with the *C. litorea* of British collections.

8. Chætomorpha *brachygona*, Harv.; filaments capillary, interwoven in strata, curved and twisted, rigid; articulations either as long as, or much shorter than their

diameter, with occasionally a pair of swollen longer cells among the short ones. (TAB. XLVI. A.)

HAB. Key West, *W. H. H.*, *Mr. Binney.* Boca di Rio Bravo, *Dr. Schott.* (v. v.)

Forming decumbent strata, covering rocks, or entangled with other Algæ. *Filaments* slender, variously curved and twisted, of a membranaceous, rather rigid substance, destitute of gloss, and not adhering to paper when drying, cylindrical. The articulations appear to be normally about as long as broad, but as they divide in the middle by transverse cell division, they are frequently found less than half their proper length. Here and there, throughout the filament, a pair of cells occur longer than the rest, and swollen, with the endochrome of each cell collected at the dissepiment: these may be connected with reproduction. The endochrome is dispersed in drying, and does not well recover its form on being moistened.

A much more robust and rigid plant than *C. tortuosa.*

PLATE XLVI. A. *Fig.* 1. CHÆTOMORPHA *brachygona*, the *natural* size. *Fig.* 2. Portion of a filament, *magnified.*

9. CHÆTOMORPHA *tortuosa*, Dillw. ; filaments very slender, somewhat rigid, densely interwoven into dark green, crisped, fleecy strata ; articulations twice or thrice as long as broad, filled with endochrome. *Dillw. Conf. t.* 46. *E. Bot. t.* 2220. *Harv. Phyc. Brit. t.* 54, *A.* *Ag. Syst. p.* 98. *Kütz. Sp. Alg. p.* 376. (TAB. XLVI. B.)

HAB. On rocks, &c. about half tide level. Halifax, *W. H. H.* Coast of Maine, *Dr. A. Young.* Massachusetts' Bay, *Mr. Pike*, *W. H. H.*, *&c.* Newbury Port, *Mr. Hooper.* Unalaschka, *Wosnessensky.* (v. v.)

Strata spreading widely over the surface of rocks, &c. like a coating of dark green wool. The filaments are very slender, about half the diameter of human hair, but they are when recent crisp and rigid, and do not collapse when removed from the water. They are densely interwoven, of a dark green colour, and not without gloss. The articulations vary in length in different specimens, but are usually twice as long as broad, sometimes more, sometimes less ; and the endochrome generally recovers its form on being remoistened after drying.

I have received from Dr. Ruprecht, under the name *C. confervicola*, a specimen from Unalashka that I cannot distinguish, under the microscope, from the ordinary *C. tortuosa* of the East coast. It grows attached to *C. melagonium*, in which it is peculiar. The " *C. tortuosa crassior*" of Dr. Ruprecht I have already alluded to under *C. litorea.*

PLATE XLVI. B. *Fig.* 1, CHÆTOMORPHA *tortuosa*, the natural size. *Fig.* 2, portion of two filaments, *magnified.*

V. HORMOTRICHUM, *Kütz.*

Filaments gelatino-membranaceous, unbranched (or with a few rootlike branches), basifixed, articulated ; formed of a string of very short cells. *Cell-wall* very thick and soft. *Nodes* constricted. *Articulations* often tumid, filled with dense, green, granular endochrome, which is finally converted into darker-coloured compact sporidia. *(Marine.)*

The plants comprised under this genus have hitherto been placed either in *Conferva* or in *Lyngbya.* They all have a peculiar habit, by which they are more readily known than by any definite character at present established. The changes that take place in the endochrome will probably afford better characters when they have been carefully ascertained and compared with what occur in *Chætomorpha.* At present we are contented to refer to this place all the soft, sub-gelatinous, marine Confervæ, which are basifixed, and have short joints—the type of these being *C. Youngana,* Dillw. ; and such *Lyngbya*-like Algæ as *Lyngb. Carmichaelii* and its allies, whose truly articulated tube distinguishes them from proper *Lyngbya.* The whole assemblage of species which are thus brought together are remarkable for the brilliant green of their endochrome, which at first fills the cells, and is afterwards contracted and condensed, and for the breadth of the soft, sub-gelatinous, glassy cell-wall. At maturity the wall of the cell opens, and the compact *sporidium* escapes. All the species are natives of littoral rocks and objects growing within tide marks. Three of the following are European.

1. HORMOTRICHUM *Younganum,* Dillw. ; filaments short or elongated, tufted, capillary, rather firm, grass-green, not remarkably gelatinous, nor glossy when dry ; articulations as long, or once and half as long as broad, or shorter than their breadth, tumid, constricted at the nodes. *Dillw. Conf. t.* 102. *Harv. Phyc. Brit. t.* 328. *Kütz. Sp. Alg. p.* 382.

HAB. On stones and wood-work, between tide marks. New York Bay, *Mr. Congdon.* Common at Fort Hamilton in spring. *W. H. H.* (v. v.)

Filaments densely tufted, 1–3 inches long, as thick as human hair, erect, straight or curved, spreading over the surface of rocks and wood-work in grass-green fleecy tufts, not lubricous or gelatinous (as compared with others of the genus), soft, but rather firm. The filaments when young are cylindrical, but soon become constricted at the dissepiments or nodes. The cells vary much in length, even in the same filament. The common length is once and half as long as broad, but they are sometimes twice as long, sometimes only as long as their diameter, and sometimes only half as long. At first they are quite filled with the granular deep-green endochrome, which, while the filament is elongating, divides in the centre, forming two new cells from each old one; but in the mature plant it gradually condenses, and retreats toward the centre of the cell, where it forms a compact, globose or oval sporidium. In drying the filaments adhere, but not strongly, to paper.

2. Hormotrichum *boreale*, Harv. ; filaments slender, forming decumbent strata of a pale yellowish-green, flaccid, slightly interwoven ; articulations as long as broad or somewhat longer, at length constricted at the nodes.

Hab. On rocks near high-water mark. Whalefish Islands, Davis's Straits, *Dr. Lyall.* (v. s. in Herb. T.C.D.)

This forms a thin, yellow-green, decumbent fleece, lying on the surface of the rock, and extending indefinitely. *Filaments* flaccid, glossy when dry, variously interwoven, about half the diameter of those of *H. Younganum*, but in other respects very similar, except that the cells are commonly shorter. *Articulations* usually quadrate ; in age contracted at the nodes.

A much more slender plant than *H. Younganum*, softer, more glossy, and spreading in patches, not tufted.

3. Hormotrichum *speciosum*, Carm. ; filaments long, thick, flaccid, straight, at length curled, the margin slightly crenate, forming bright yellow-green strata, glossy when dry ; articulations half as long as their breadth, the cell-wall very thick. *Harv. Phyc. Brit. t.* 186, *B. Wyatt, Alg. Danm. No.* 196. *(Lyngbya.)*

Hab. Mixed with the foregoing species, at Whale-fish Islands, *Dr. Lyall.*

Much more robust than the following species, to which it is allied.

4. Hormotrichum *Carmichaelii*, Harv. ; filaments scarcely capillary, closely interwoven into decumbent, crisped, full-grass-green strata, variously twisted ; articulations half as long as their diameter ; the cell-wall thick. *Harv. Phyc. Brit. t.* 186. *A. Wyatt, Alg. Danm. No.* 230. *Kütz. Sp. Alg. p.* 382.

Hab. On rocks and fuci, between tide marks. Near Boston, *Mr. Calverley.* In a "running stream" (quere, of salt, or fresh water ?) on stones, in Wellington Channel, Arctic Regions, *Dr. Lyall.* (v. v.)

Strata extensive, densely interwoven, full green, or somewhat yellowish, soft, but not gelatinous, and not glossy when dry. *Filaments* very long, thinner than human hair, variously curved and twisted. *Articulations* shorter than their diameter, generally less than half as long as their breadth ; the cell-wall thick, and the endochrome at length contracting into a lenticular sporidium.

This plant is common on the British Coasts, where it occurs between tide marks. The specimen received from Mr. Calverley is said to come "from fresh water near Boston ;" but I suspect some mistake. Whether that from the Arctic Regions be from brackish or fresh water I cannot tell ; but under the microscope there is no character by which I can distinguish its threads from British specimens of *C. Carmichaelii.* It is very luxuriant, of a bright green colour, and quite resembles the ordinary marine form. Quere, are two species confounded ? Or is there an error in the habitat ? Or does this plant inhabit both salt and fresh water, as *Bangia fuscopurpurea* is well known to do ?

5. Hormotrichum ? *Wormskioldii*, Fl. Dan. ; filaments "branched at the base" (Lyngb.) ; thence simple, erect, straight, ultra-setaceous, flaccid, bright yellow-green, moniliform ; articulations at first nearly cylindrical and rather longer than broad, then globular, and very much contracted at the nodes. *Conferva Wormskioldii. Fl. Dan. t.* 1547. *Lyngb. Hyd. Dan. p.* 158. *t.* 55. *A. Ag. Syst. p.* 121. *Hormotrichum Wormskioldii, Kütz. Sp. Alg. p.* 383. *Chætomorpha monilis, Harv. in Herb. (olim.)*

Hab. Coast of Greenland, common, *Wormskiold.* Fragments dredged in Queen's Channel, lat. 76° 29′, long. 96° 13′ W. *Dr. Lyall.* (v. s.)

Dr. Lyall's specimens, which alone I have seen, consist of a few single threads (broken branches ?) 6–8 inches long, as thick as hog's bristle or a little thicker, moniliform, with very turgid globular articulations and strongly contracted dissepiments. These fragments so strongly resemble the figure given by Lyngbye, *(t.* 55. *A.* 5.*)* that I cannot doubt the above reference ; but I do question the propriety of arranging this species under the present genus. I follow Kützing, however, who had probably seen more perfect specimens than I possess. Judging from the fragments collected by Dr. Lyall, I formerly placed it in *Chætomorpha*, near *C. melagonium*, believing that it was an undescribed species.

Lyngbye's description may be thus rendered : "Filaments densely tufted, parallelly floating, an ell or more in length, branched at the base, slender, as thick as human hair (below ?), then increasing to the thickness of hog's bristle, or sparrow's quill, simple, attenuated toward the apex. *Articulations* as long as broad, in the thicker filaments remarkably moniliform, ellipsoidal or globose, turgid ; in the more slender filaments often twice as long as broad. *Dissepiments* contracted, mostly pellucid. *Colour* green. Substance membranaceous, tender, lubricous, soft. It adheres to paper."

VI. RHIZOCLONIUM, *Kütz.*

Filaments (not gelatinous) membranaceous, uniform in diameter throughout, decumbent, simple or spuriously branched ; branches short and rootlike ; formed of a string of oblong cells. *Cell-wall* thin. *Articulations* filled with granular endochrome. *(Marine, or in fresh water, or on damp ground.)*

Confervoid Algæ, forming decumbent strata ; the filaments lying heaped together, and emitting at irregular distances rootlike branches. Kützing enumerates 28 species, among which are several which we refer to *Chætomorpha*.

1. Rhizoclonium *riparium*, Roth. ; filaments long, slender, decumbent, pale-green, forming wide strata, flaccid, entangled, angularly bent, furnished at the angles with short, rootlike processes (which sometimes, but rarely, lengthen into very patent branches, and often attach themselves to neighbouring filaments). *Conf. riparia, Roth. Cat. Bot.* 3. *p.* 216. *E. Bot. t.* 2100. *Dillw. Conf. p.* 111. *Sup. t. E. Ag. Syst. p.* 106. *Harv. Phyc. Brit. t.* 238. *Conf. obtusangula, Lyngb. Hyd. Dan. t.* 55. *B. Rhizoclonium obtusangulum, Kütz. Sp. Alg. p.* 261.

Hab. On sand covered rocks near high water mark. Greenland, *Wormskiold*, fide *Lyngbye.* (v. s.)

I have not seen American specimens of this plant.

Order VII. ZYGNEMACEÆ.

Zygnemaceæ, Kütz. Phyc. Gen. p. 274. *Sp. Alg. p.* 433. *Zygnemeæ, Endl.* 3*d Suppl. p.* 14. *Algæ Synsporeæ, Dne. Class, p.* 32. *Conjugatæ, Berk. Crypt. Bot. p.* 150. *Conjugateæ, Hass. Br. Fr. W. Alg., p.* 129.

Diagnosis. Green (freshwater) Algæ, consisting of simple, articulated, floating threads, composed of cylindrical, seriated cells. *Endochrome* usually definitely figured. *Spores* of large size, and mostly solitary, formed by the union of two endochromes or by the division of a single endochrome.

Natural Character. Freshwater, floating, *confervoid* Algæ, at first consisting of unbranched threads, formed of a number of cylindrical cells placed end to end ; afterwards often linked together in pairs by connecting processes. The endochrome in different genera puts on a variety of forms. It is rarely diffused equally through the cell as in ordinary Confervæ, but is either arranged in spiral bands, attached to the cell-walls, or divided into two star-like masses ; or it consists of larger and smaller grains subsymmetrically arranged. The cell-wall varies also much in character ; in some it is membranous, in others gelatinous, and occasionally very thick. The *fructification* consists of large and mostly solitary *spores* formed usually from the union and condensation of the contents of two cells, either consecutive cells of the same filament, or cells of different filaments. The latter mode of forming a spore is the most usual, whence we have the origin of the names "*Conjugatœ*" and "*Zygnemeœ*" applied to these Algæ, and alluding to their "yoked" character. When two filaments are about to conjugate, they float near one another, lying parallel, or nearly so in the stratum. Then, from the proximate sides of each cell of both filaments there issue short tubes, which mutually unite; the cell-wall at the point of union disappears, and the contents of both cells are mixed together. Sometimes the whole contents of one cell is discharged into the other, and the spore formed in that cell; sometimes, and equally commonly, the spore is formed in the connecting tubes. These tubes are sometimes long and barlike; and the pairs of conjugated threads resemble little ladders. Sometimes they are very short, and the filaments are angularly bent at the point of union. In most cases the spore forms a single spheroidal or angular mass; but in *Thwaitesia* it is divided into four sporules, exactly like the tetraspore of one of the *Rhodosperms.* In the genus *Œdogonium*, which Mr. Berkeley refers to this Family, the filaments do not conjugate, but the spores are formed by a division of the endochrome of a fertile cell. The cell separates into two half-cells by a transverse partition, as in ordinary cell division; the spore is then formed in one half; the other half lengthens to the size proper to the genus and again divides, forming a second spore in one of its halves; and so it may divide repeatedly until a string of six or eight consecutive spores is formed, in the centre or at the end of the thread, as in *Œ. monile*, a beautiful species from Tasmania. The spores are not always green; but (especially in Œdogonium) are often brilliantly coloured, orange or vermillion.

Several genera, containing a large number of species, are described, chiefly from the stagnant or nearly still waters of the Northern Hemisphere. But they are probably dispersed over the globe, though few have yet been brought from the tropics. Unfortunately they do not recover their characters sufficiently, after having been dried, to admit of being accurately verified from dried specimens: and consequently I am forced to omit specific descriptions of those that I have received from North America. No doubt many of the species of the genera MOUGEOTIA; ZYGNEMA *(Spirogyra)*; TYNDARIDEA; STAUROCARPUS; and ŒDOGONIUM *(Vesiculifera)* exist in American waters; but they must be examined on the spot. Mr. Ravenel has kindly sent me a few specimens of *Staurocarpus* and *Zygnema*, but I have not been able to recognize the species satisfactorily. Authors who have written on the subject appear to me to have needlessly multiplied the European species, of which Kützing enumerates 200, including 58 *Zygnemata* and as many *Œdogonia.*

Order VIII.—HYDRODICTYEÆ.

Hydrodictyeæ, *Kütz. Phyc. Gen. p.* 281. *Sp. Alg. p.* 448. *Berk. Crypt. Bot. p.* 138. *Dne. Class. p.* 31. *(in part only.)*

Diagnosis. Green (fresh-water) Algæ, composed of cylindrical cells, united by their ends into a saccate net-work, with polygonal meshes ; each side of the mesh formed of a single cell. *Endochrome* of each cell resolved at maturity into indefinitely numerous, minute *zoospores*, which arrange themselves, end to end, into a new net-work, whilst still contained within the parent cell. *Nets* viviparous.

Natural Character. The genus *Hydrodictyon* differs so remarkably in the mode of evolution of its frond from that of any other confervoid Alga that it has been found necessary to constitute it the type of a distinct family. Its essentially distinctive characters are thus well given by Messrs. Derbes and Soliere in their able memoir : "Each *zoospore* of this plant gives birth to one cell only, whose further development will consist merely in an increase of dimensions, without undergoing any multiplication. Here then, without doubt, is the most distinctive character of the genus ; for in the *Confervæ*, with which it has the greatest affinity, one zoospore gives birth to an individual, which increases in dimensions by the multiplication of its cells ; here, on the contrary, a great number of zoospores unite together to form an individual, which is composed of a limited number of cells, which number remains the same during the whole duration of the plant ; that is to say, until each of these cellules, in its turn, gives birth to a young *Hydrodictyon* complete. In other terms, a *Hydrodictyon* is an assemblage of little plants reduced to a single cell, formed by the development of a zoospore." If we trace the development, it will be obvious that this is a true explanation of the viviparous net-work.

At all stages of its growth, then, the structure of the *Hydrodictyon* is the same. Young specimens differ from old ones merely in the size of the cells of which the net is composed ; the number of the cells, their form, and that of the net are the same in young as in old nets. In all stages the *Hydrodictyon* is a bag-like or purse-shaped net, with polygonal, generally five-sided meshes, each mesh consisting of a single articulation or cylindrical cell, united by its ends to the neighbouring cells, just as the cells of a *Conferva* are united, but having no passage from cell to cell, and each cell, from first to last, carrying on an independent existence. When first emitted from the parent, the young *Hydrodictyon* is of microscopic size. It grows rapidly until each articulation becomes from a quarter to half an inch in length, and half a line in diameter. Up to this period the cells are filled with a green semi-fluid endochrome, in which grains of different sizes are formed. Gradually this green matter is resolved into an infinite number of minute zoospores, which are at first spherical, afterwards ovate, pointed at one end ; and which, while contained within the cell wall, exhibit lively movements. At length these movements gradully subside, and the zoospores arrange themselves, end to end, into polygonal, commonly pentagonal, areolæ ; and when all the zoospores contained within a single articulation have so arranged themselves, the little net is completed before its emission or birth. When all is thus ready, the parent net falls to pieces, each articulation floating separately ; and shortly afterwards, on the bursting or deliquescence of the wall of the mother cell, the little network floats independently, and commences its career of growth and development. This curious plant early attracted the notice of botanists, and has deservedly engaged the attention of physiologists. The fullest of the earlier histories is to be found in Vaucher's work on Fresh Water Confervæ ; and recent accounts are given by Areschoug in the 16th vol. of "Linnæa ;" and by Derbes and Soliere in their memoir presented to the French Academy in 1848. I have never had the opportunity of examining living specimens, though abundantly supplied with dried ones from many distant parts of the world. The only species known inhabits ponds in Europe and in America, both North and South. It is rare in England, and has not yet been found in Ireland.

HYDRODICTYON, *Roth.*

(Character the same as that of the Order.)

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1. Hydrodictyon *utriculatum*, *Roth. Fl. Germ.* 3. *part* 1, *p.* 531. *Fl. Dan. t.* 1597. *Ag. Syst. p.* 84. *Lyngb. Hyd. Dan. p.* 169. *t.* 58. *Harv. Man. Ed.* 1. *p.* 140. *Kütz. Phyc. Gen. p.* 281. *Syst. Alg. p.* 448. *Conferva reticulata*, *Linn. Dillw. Conf. t.* 97. *E. Bot. t.* 1687.

Hab. In ponds of fresh water. West Point, *Professor Bailey.* Weehawken, *Mr. Walters.* Waterholes between Van Horn's Wells and Muerte on the Mexican boundary, *Dr. Bigelow.* (v. s. in Herb. T.C.D.)

This has been sufficiently described in the remarks under the Order. The full sized nets are 6–8 or 12 inches long, and 3–4 in diameter ; their meshes from half an inch to three quarters of an inch across. In different localities and climates the size varies. No difference is appreciable between American and European specimens.

ORDER IX.—OSCILLATORIACEÆ.

Harv. Man. Ed. 1. *p.* 219. *Oscillatorieæ*, *Harv. in Mack. Fl. Hib. part* 3, *p.* 164. *Endl. 3d. Suppl. p.* 12. *Oscillatorieæ and Rivularieæ*, *Harv. Br. Fl. J. Ag. Alg. Medit. p.* 8, 10. *Oscillatoreæ*, *Lindl. Veg. Kingd. p.* 18. *Oscillarieæ*, *Leptotrichieæ*, *Lyngbyeæ*, *Scytonemeæ*, *Mastichotricheæ*, *Rivularieæ*, *Kütz. Sp. Alg. pp.* 235-344.

DIAGNOSIS. Green, (rarely olive-brown, blue, or purple) marine or fresh water Algæ, composed of simple or slightly branched filaments ; each filament having a membranous unicellular sheath, enclosing an annulated medullary chord of very short cells.

NATURAL CHARACTER. *Root* either a simple point of attachment, or, in most cases, not obvious. *Filaments* of small size, and often very minute, rarely solitary, variously aggregated together. In some microscopic forms, as in *Trichodesmium*, a number of minute filaments lie close together, cohering by their edges and parallel to each other, forming little bundles, resembling *faggots* in miniature ; and these float freely in the water, through which they move by a slow, proper motion, rising to the surface or sinking, according to the season. In others, as in *Oscillatoria*, an indefinite number of similar filaments lie loosely in a gelatinous matrix, within which they are developed, and from the edges of which they radiate ; but they have no definite or determinate arrangement in the mass. Again, in *Calothrix*, the filaments are fixed at the base, and stand erect in minute tufts, or spread in a velvetty pile over the surface of various objects. In *Lyngbya* the arrangement of the threads is similar, but they are of much greater length, more curved and flexible, resembling tufts of hair or silky wool. Lastly, in *Rivularia*, there is a compact gelatinous frond of sub-definite form, constructed of a multitude of symmetrically arranged filaments ; each one springing from a minute, spherical, bulb-like cell, by which it is attached to the neighbouring filament. These basal cells have been called " connecting cells," and also " *heterocysts*." Their peculiar function has not been clearly ascertained. Through all the genera of the Order considerable uniformity prevails in the structure of the filaments. The external coating or peripheric portion, called the *sheath*, is a tubular membrane, destitute of markings, hyaline, and apparently formed by the lengthening of a single generating cell. In many cases it is delicately membranous and thin ; in others it is thickened ; and in some (as in *Petalonema)*, the sheath consists of many foliations, one inside the other. In several of the *Rivularieæ* also, the sheath is similarly compound, and frequently plumoso-multifid at the extremity. Within the sheath is the medullary column, or endochromatic part of the filament. This always consists of a series of short, lenticular, densely coloured cells, which in the full grown filament may be readily separated. They have been described as *sporidia;* but observations on their germination are wanting. Minute *zoospores* have been observed in some. Besides the ordinary sheath which encloses each medullary column, a supplimentary sheath is found in some genera, as in *Microcoleus*, enclosing a considerable number of separately sheathed filaments. The origin of this general sheath has not been observed. It probably originates as a simple filament, whose endochrome divides and subdivides longitudinally, thus forming a number of filaments within the body of the older one, whose walls continue to enlarge, being fed by the matter of the contained filaments. This appears, at least sometimes, to be the case : in other cases probably the investing sheath is formed of exuviæ and dead filaments.

Many plants of this Order are celebrated for exhibiting peculiar movements resembling those of animals. Some have a rapid progressive and regressive movement, by which they can change their place, rising or falling in the water ; others, while remaining nearly in one place, move from side to side, describing an arc. The genus *Oscillatoria* is so named from the pendulum-like movements of its filaments. Species of this genus are to be found in most pools of stagnant water, and their peculiar movements may be easily observed. These plants occur, when fully developed, in floating, skin-like, slimy pellicles, of a deep green or blackish or blueish colour and gelatinous substance. If a small portion of the floating scum be placed in a cup of water, and allowed to remain for some hours at rest, its edges will become finely fringed with delicate, radiating threads, which extend further and further, from hour to hour ; and if the experiment be continued for a day or two, in warm weather, the whole surface of the water will be coated with a thin layer of filaments, which will spread till stopped by the dry edges of the cup. These filaments were at first contained within the gelatinous matrix, and have merely *spread* out, not *grown*, from it, by means of their peculiar movements. These movements are of three kinds :—first, there is the oscillating movement ; one end of the thread remaining nearly at rest, while the other sways from side to side, sometimes describing nearly a quarter of a circle in a single *swing.* Secondly, the tip of the filament has a minute movement, bending from side to side, like the head of a worm : and thirdly, there is an onward movement, probably the result of the two former. It is this latter which causes the filaments to radiate and spread out from the edges of the stratum. If a minute portion of a living *Oscillatoria* be placed in water, under a moderately high magnifying power, all these movements can be seen without trouble. They vary in vividness, however, in different species, some being active, and some sluggish ; and also according to the state of the weather, being most rapid in warm weather. Some of the species are furnished with minute cilia at the extremities, but these do not seem to take part in the motion.

Oscillatoriaceæ are found in all parts of the world, and under a great variety of circumstances. Not very many, with the exception of the *Lyngbyæ* and *Calothrices*, are marine ; the great proportion are found in fresh water. Several occur in hot-springs, even in the Geysers of Iceland ; and others inhabit water highly charged with mineral salts or gases. Some are found on damp soil ; others under the spray of cascades, and on the gates of canal-locks and about mill-dams. Few pieces of stagnant fresh water are free from them ; but rivers and streams are equally furnished, and broad lakes are sometimes coloured, throughout their whole extent, with minute, perhaps microscopic, species of this Order. The ocean itself, often for many hundreds of square miles, has been found discoloured by microscopic Algæ of this group, belonging to the genus *Trichodesmium;* one of which, of a red colour, is found at seasons abundantly in the Red Sea, and is supposed to have caused that name to be given to the Arabian Gulf. Others are found in the Indian Ocean, one of which is of a bright yellow-green, and sometimes deeply tinges the upper strata of the sea off the coasts of Malacca. Others have been noticed in equal abundance, but less strongly coloured, in various parts of the Pacific, and on the coasts of Australia.

The species are very difficult to determine, and have been too much multiplied by authors: little therefore can usefully be said respecting their geographic distribution. Probably, if they are ever carefully investigated, the same kinds will to a large extent be found in the most distant localities. This at least seems to be the case with some, as *Petalonema alatum*, *Lyngbya majuscula*, *L. ferruginea*, *Calothrix scopulorum*, and many others.

TABLE OF THE NORTH AMERICAN GENERA.

* *Frond filamentous, branched, olive-brown, in fresh water.*

I. PETALONEMA. *Filaments* with a flattened, longitudinally and transversely striate sheath, much broader than the endochrome.

II. SCYTONEMA. *Filaments* with a cylindrical, hyaline sheath, narrower than the endochrome.

** *Frond filamentous. Filaments separate, free, green or purple.*

III. LYNGBYA. *Filaments* very long, flexible, threadlike, bundled together.

IV. CALOTHRIX. *Filaments* short, tufted, erect.

V. OSCILLATORIA. *Filaments* rigid, needle-shaped, lying loosely in a mucous matrix, usually floating.

*** *Frond formed of numerous parallel filaments contained within a simple or branching membranous common-sheath.*

VI. MICROCOLEUS.

**** *Frond formed of numerous radiating filaments invested with firm gelatine; each filament springing from a spherical root-cell.*

VII. RIVULARIA.

I. PETALONEMA, *Berk.*

Filaments stratified, decumbent, free, simple or branched. *Tube* or sheath very wide, flattened, longitudinally and transversely striate, and crenulate at the edge ; endochrome olivaceous, annulated, here and there interrupted by a *heterocyst*. *Branches* issuing in pairs, formed by the division and protrusion of the endochrome of the original filament.

A very distinct and easily recognized genus established by Mr. Berkeley in 1833, under the name here adopted ; a name changed by Professor Kützing in 1845 to *Arthrosiphon*, for what reason I am not aware. The Alga on which it is founded was discovered many years previously, in the West of Scotland, by the late Captain Carmichael, and was first figured and described by Dr. Greville as an *Oscillatoria*. It has more recently been found in several parts of Europe, and we have now to record its occurrence in the New Continent. There are few more beautiful objects among the fresh water Algæ, and unlike many of its kindred the fronds perfectly recover their form when moistened after having been dried. When placed under the microscope the filaments present the appearance of a cylindrical central column, containing annulated, olive-coloured endochrome, and a wide winglike border at each side of the column. This border or *sheath* is obliquely striate, the striæ running in an arch from the margin toward the centre, where they become parallel, and are then continued longitudinally downwards along the medullary column, till lost in the density. The margin of the wing is closely crenulate, and in age transversely striate at the crenatures as if jointed. Such is the *apparent* structure : the *real* structure seems to be, that an annulated central filament is enclosed within a number of compressed, trumpet-mouthed gelatino-membranaceous tubular sheaths, one arising within the other, and successively developed as the growth proceeds. These sheaths, thus concentrically arranged, are indicated by the longitudinal arching striæ ; and the mouths of the younger sheaths, projecting slightly beyond those of the older, form the crenatures of the margin.

PETALONEMA *alatum*, Berk. *Gl. Br. Alg. p.* 23, *t.* 7, *fig.* 2. *Harv. Man. Ed.* 1, *p.* 168. *Hass. Fr. Wat. Alg. p.* 237. *t.* 68. *f.* 6. *Arthrosiphon Grevillii*, *Kütz. Phyc. Germ. p.* 177. *Sp. Alg. p.* 311. *Oscillatoria alata*, *Carm. Grev. Sc. Crypt. Fl. t.* 222. *Harv. in Hook. Br. Fl.* 2. *p.* 378. (TAB. XLVIII. A.)

HAB. On dripping rocks, under Biddle Stairs, Niagara Falls, abundantly, *W. H. H.* (1849). (v. v.)

This forms strata of a dark chestnut-brown colour, and of indefinite extent, on the surface of rocks or soil in places exposed to the constant drip of water. The *filaments* are decumbent, lying without order in the gelatinous matrix in which they are developed, and which forms the groundwork of the stratum. They appear to be unattached to the soil, and each filament may be about half an inch in length ; but they are commonly found broken off at the inferior end, or the lower portion decays while the upper continues to grow. They are slightly curved, in serpentlike fashion, never quite straight; at first they are simple, but now and then they emit lateral branches, which issue at considerable angles, and generally in pairs. When a filament is about to branch, a rupture takes place in the side of the sheath, and the endochrome issues in two portions, one connected with the upper, the other with the lower half of the filament; these form the nuclei or medullary portion of two new branches, and become duly invested with a membranous sheath, and gradually put on the aspect of the adult filament. The *endochrome* is granular, dark-brown, and annulated at short intervals, the transverse rings being placed very close together in the youngest portions, and less closely in the older, where they are distant from each other about twice the diameter of the column. This annulated endochrome is interrupted at certain fixed places, where an ellipsoidal cell is formed, separating the endochrome of the lower from that of the upper portions. These cells may be compared to nodes, and indicate, if I mistake not, the points where the twin branches issue. I have not, however, noticed their development into branches.

PLATE XLVIII. A. *Fig* 1. Portion of the stratum formed by PETALONEMA *alatum;* and *fig.* 2. Fronds removed from the same; the *natural* size. *Fig.* 3. Portion of two filaments *magnified.* *Fig.* 4. Apex of a filament, more highly *magnified.*

II. SCYTONEMA, *Ag.*

Filaments tufted, mostly basifixed, erect or decumbent, free, flexible, branched. *Tube* or sheath cylindrical, continuous, membranaceous, tough; endochrome olive-brown, annulated. *Branches* lateral, issuing in pairs, formed by the division and protrusion of the endochrome of the original filament.

When at Niagara Falls in the autumn of 1849, I collected on the rocks under Biddle Stairs specimens of a large decumbent *Scytonema*, which may possibly be referable to one or other of the 50 species named and described by Kützing, but whose characters appear to me to be founded, often, on insufficient data. I am unwilling to add to the synonyms by giving a new name to the American species, and I have not at hand the means of comparing it with more than a few of the recorded species. It is of large size, its filaments being nearly twice the diameter of those of the British *S. myochrous*, which it resembles in its branching. The endochrome is narrower in proportion to the sheath and distinctly annulate; the annuli rather distant. The sheath is of a deep chestnut brown colour.

Probably several other *forms*, if not species, occur in North America.

III. LYNGBYA, *Ag.*

Filaments destitute of mucous layer, free, flexible, unbranched, elongated, not oscillating. *Tube* continuous, cylindrical, membranaceous ; endochrome green or purple, densely annulated, at length separating into lenticular sporidia. *(Marine or in fresh water.)*

A genus consisting of many species, most of which are found in the sea ; several occur in estuaries of rivers and in brackish ditches, and a few are found in fresh water or in thermal springs. From *Oscillatoria* they are known by the absence of a gelatinous matrix and of oscillating movements, and by the greater flexibility of the filaments. From *Calothrix*, to which they are more nearly related, they differ chiefly in habit ; especially in the great length of the filaments, and in being rarely fasciculate. The generic name is given in honour of H. C. Lyngbye, a Danish Algologist, and author of an excellent work on the Algæ of Denmark.

1. Lyngbya *majuscula*, Harv. ; filaments thick, very long and tenacious, twisted, issuing in long, crisped bundles from a blackish green stratum. *Harv. Phyc. Brit. t.* 62. *Kütz. Sp. Alg. p.* 283. *Lyngbya crispa*, *Ag. Syst. p.* 74 *(in part.)*. *Conf. majuscula*, *Dillw.! Supp. t. A.* *L. maxima*, *Mont.* *L. Pacifica*, *Kütz. Sp. Alg. p.* 284. (Tab. XLVII. A.)

Hab. Long Island Sound, *Professor Bailey.* Peconic Bay, *Mr. Hooper.* Key West, *W. H. H. and Mr. Ashmead.* (v. v.)

Tufts often several inches in diameter, the central portion densely interwoven or stratified, the margins throwing off long bundles or fascicles of free, crisped, or variously twisted filaments, one to two inches in length, and floating freely in the water. The strata at first are attached to the bottom, but with age float to the surface and are cast ashore in large masses. The diameter of the filament is greater than in any other species, being commonly rather more than ·05 of an inch. The Key West specimens are rather less broad than usual. The sheath or tube of the filament is thick, and forms a wide, hyaline margin to the dark-coloured, closely but not strongly annulated endochrome.

The *L. maxima*, Mont. (*L. pacifica*, Kütz.) which I have gathered in great abundance on the shores of the Friendly Islands, appears to me to be merely a luxuriant state of this common species. Except in the greater diameter of the filaments, and this varies in different specimens, I see no character by which it may be distinguished. The species (as understood in England) has a peculiar external habit, and its microscopic characters —however difficult to describe—are easily remembered after having once been seen. It was first found at Bantry, South of Ireland, by the late Miss Hutchins.

Plate XLVII. A. *Fig.* 1. A tuft of *Lyngbya majuscula*, the *natural* size. *Fig.* 2. Portion of a filament, magnified.

2. LYNGBYA *ferruginea*, Ag.; filaments slender, flaccid, curved, forming a thin stratum of a verdigris green colour, which gradually changes to a pale chestnut (but resumes the green in drying). *Ag. Syst. p.* 73. *Harv. Phyc. Brit. tab.* 311. *L. æruginosa, Kütz. Sp. Alg. p.* 282. (TAB. XLVII. B.)

HAB. On muddy shores, in tide pools and floating in ditches of salt or brackish water near the sea. Haarlem River, N.Y. close to the High Bridge, *W. H. H.* Salt ditches at Hoboken and near Green Port, *Professor Bailey.* (v. v.)

Stratum thin, expanded, covering the mud to an indefinite extent, or floating on the surface of stagnant salt water, generally of an intense verdigris or blueish green colour, now and then foxy or rust colour, scarcely at all gelatinous. *Filaments* about ·001 of an inch in diameter, flaccid, slightly flexuous, rather tough, with very thin, membranous cell-walls, filled with dense closely and strongly annulated, bluish-green endochrome, occasionally with empty spaces. The striæ are very evident. In the dry state the blue-green colour is mostly preserved; and the surface is not glossy.

PLATE XLVII. B. *Fig.* 1. Portion of the stratum of LYNGBYA *ferruginea. Fig.* 2. Portion of a filament, *magnified. Fig.* 3. Section of the same, more highly *magnified.*

3. LYNGBYA *fulva*, Harv.; filaments slender, elongate, flexuous, fulvous, issuing in erect, crisped, plumose fascicles from a dark coloured stratum; cell-wall thick, forming a broad limbus to the endochrome. (TAB. XLVII. F.)

HAB. On the granite masses composing the breakwater at Stonington, Conn. *Professor Bailey.* (v. s. in Herb. T.C.D.)

Stratum attached to the rock, dull olivaceous, throwing up long fascicles of filaments, an inch or more in length, and standing upright in the water. *Filaments* about the size of those of *L. ferruginea*, but with very thick walls, which form a glassy sheath to the enclosed fulvous or ochre coloured endochrome; the hyaline border being nearly half as wide as the coloured portion. The annuli are strongly marked and very closely set.

This somewhat resembles *L. luteo-fusca*, Ag., but the walls of the tube are much thicker, as thick in proportion to the enclosed matter as are those of *L. majuscula* to the matter in its tube.

PLATE. XLVII. F. *Fig.* 1. LYNGBYA *fulva*, the natural size. *Fig.* 3. Portion of a filament, *magnified. Fig.* 2. Section of a filament, more highly *magnified.*

4. LYNGBYA *nigrescens*, Harv.; filaments very slender, flaccid, densely interwoven into a fleecy, blackish-green stratum. (TAB. XLVII. D.)

HAB. Sea shores or mud, &c. Canarsic Bay, Long Island, *Mr. Hooper.* Peconic Bay. *W. H. H.* Also on leaves of Zostera, Peconic Bay, *Mr. Hooper.*

Strata varying in extent, lying on the surface of mud, or floating, or entangled with other Algæ and attached to them, of a very dull, blackish, or somewhat violet colour, with shades of æruginous green. *Filaments* scarcely more than half the diameter of those of *L. ferruginea;* with thin, membranous cell-walls, and densely annulated, dark or dull coloured endochrome. When dry the stratum becomes brittle, and frequently breaks off from the paper in flakes.

PLATE XLVII. D. *Fig.* 1. LYNGBYA *nigrescens*, the *natural* size. *Fig.* 2. Portion of a filament, *magnified.* *Fig.* 3. Section of the same, more highly *magnified.*

5. LYNGBYA *confervoides*, Ag.; filaments very slender, flaccid, elongate, forming long, comose fasciculi, floating freely from a blackish green basal stratum; annuli not very strongly marked. *Ag. Syst. p.* 73. *Kütz. Sp. Alg. p.* 285. (TAB. XLVII. C.)

HAB. Sea-shores, Charleston, S. Carolina, *Professor Lewis R. Gibbes.* (v. s.)

Stratum dark, olivaceous, or blackish green, emitting long bundles of slender filaments, 1–2 inches long, which float freely in the water. Filaments lying parallel in the bundles, flexuous, but scarcely interwoven and often separate; with very thin, narrow, membranous tubes, and a dense, dull-green endochrome, which is much less distinctly annulated than in *L. ferruginea.* The diameter of the filament is also much less than in that species.

I have compared the above quoted species with an authentic one from Professor J. Agardh, and find little difference between them.

PLATE. XLVII. C. *Fig.* 1. LYNGBYA *confervoides*, the *natural* size. *Fig.* 2. Portion of two filaments, *magnified.* *Fig.* 3. Section, more highly *magnified.*

6. LYNGBYA *pusilla*, Harv.; stratum minute, blackish-green; filaments very slender, short, crisped, spreading in small bundles; endochrome pale, dull-green, annulate, cell-wall very thin. (TAB. XLVII. E.)

HAB. Parasitic on small Algæ, at Sullivan's Island, S.C., *W. H. H.* (v. v.)

This spreads over small Algæ in thin strata, composed of densely matted filaments, and emitting to all sides free, fascicled filaments. These latter are about quarter of an inch long, and half the diameter of those of *L. ferruginea*, with a pale endochrome. The cell-wall is extremely thin; the endochrome quite fills the tube, leaving a scarcely perceptible margin. The annuli are tolerably definite.

Possibly this may be an *Oscillatoria.*

PLATE XLVII. E. *Fig.* 1. LYNGBYA *pusilla*, the *natural* size. *Fig* 2. Portions of three filaments, *magnified.* *Fig.* 3. Section of a filament, highly *magnified.*

7. LYNGBYA *hyalina*, Harv.; filaments basifixed, erect, straight, very slender, arachnoid, gelatinoso-membranaceous, flaccid, very pale yellowish green or nearly hyaline; endochrome filling the tube, at first granular, then annulated. (TAB. XLVII. G.)

HAB. On lime encrusted rocks at Key West, *W. H. H.* (v. v.)

Forming indefinite, very soft and sub-gelatinous continuous tufts or pilose strata. *Filaments* fixed by their base to the rock, and floating freely, exceedingly slender and cobwebby, straight, glossy, cylindrical, from half an inch to an inch long, very pale æruginous or yellowish-green, often nearly colourless. The cell-wall is thin and delicate, and the endochrome quite fills the tube, leaving no perceptible margin.

I do not know any species similar to this. It is exceedingly slender and delicate.

PLATE XLVII. G. *Fig.* 1. LYNGBYA *hyalina*, the *natural* size. *Fig.* 2. Portions of three filaments, *magnified.* *Fig.* 3. Section of a filament, highly *magnified.*

8. LYNGBYA *muralis*, Ag. filaments somewhat rigid, thickish, tortuous, very long, interwoven in a bright, grass-green stratum; annuli strongly defined. *Ag. Syst. p.* 74. *Harv. Man. Ed.* 1, *p.* 160. *Conf. muralis, Dillw. tab.* 7, *E. Bot. t.* 1554. *β.* aquatica.

HAB. var. *β*, in pools of fresh water, Whalefish Islands, Davis Straits, *Dr. Lyall.* (v. s.)

The specimens are mixed with turfy soil. Except in the submerged habitat, this agrees with the ordinary form. Intermixed with threads of the usual size and structure are others cohering in pairs, as in *L. copulata*, Hass., which is obviously only a state of this widely dispersed species. I have not received specimens of the ordinary *L. muralis* from America; but no doubt it is common on damp walls, &c., as in Europe generally.

IV. CALOTHRIX, *Ag.*

Filaments destitute of a mucous layer, erect, tufted, or aggregated, fixed at the base, somewhat rigid, not oscillating. *Tube* continuous; endochrome green, densely annulated, at length separating into lenticular sporidia. *(Marine or in fresh water.)*

I retain the genus *Calothrix*, as established by Agardh, in preference to dividing it, with Kützing and others, into the groups *Leiblinia*, *Tolypothrix*, *&c.* which appear to me to be separated on very uncertain and variable characters. The whole group requires a careful study and complete remodelling; but I have neither time not sufficiently copious materials to attempt such a work. I can hardly suppose that the multitude of species and genera of these obscure plants described by Kützing are all distinct. To judge by the characters assigned by him, many appear very closely allied to each other.

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1. Calothrix *confervicola*, Ag. ; filaments short, glaucous, opake, filiform, blunt, rigid, straight or slightly curved, minutely tufted. *Ag. Syst. p.* 70. *Harv. Phyc. Brit. t.* 254. *Wyatt, Alg. Danm. No.* 229. *Leibleinia confervicola, Endl.* 3*d. Supp. p.* 221. *Leibleinia chalybea, Kütz. Sp. Alg. p.* 277. (and probably other species of *Leibleinia* of the same author). *Conferva confervicola, Dillw. Conf. t.* 8. *E. Bot. t.* 2576.

Hab. On the filiform marine Algæ. Rhode Island shores, *Professor Bailey, Mr. Olney, Mr. Hunt.* (v. v.)

Filaments about the tenth of an inch long, either forming little starry tufts along the branches of the Alga it infects, or, by the confluence of several such tufts, covering the branch with a continuous pile of dark æruginous-green threads. When seen under the microscope the filaments are simple, curved, filiform, but little attenuated upwards, and either separate from each other or variously combined by lateral cohesion into fascicles. Their cell-wall is rather thick, and the endochrome within is of a dull bluish-green, here and there interrupted and broken into separate masses, and sometimes nodoso-incrassate at short intervals. The transverse striæ are more or less distinctly seen according to the age of the specimen examined. The colour varies in different specimens, from dull to bright green ; and is sometimes olivaceous, and even yellowish or pale.

This species is a common parasite on the filiform Algæ, and found in many distant seas.

2. Calothrix *scopulorum*, Ag. ; spreading in velvetty dull-green strata of indefinite extent ; filaments flexuous, subulate, subattenuate, simple. *Ag. Sp. Alg. p.* 70. *Harv. Phyc. Brit. t.* 58, *B. Schizosiphon scopulorum, Kütz. Sp. Alg. p.* 329 *(and probably others.) Conferva scopulorum, Dillw. Conf. p.* 39, *Sup. t. A. E. Bot. t.* 2171.

Hab. Rocks near high water mark. Shores of Rhode Island, *Professor Bailey and Mr. Olney.* (v. v.)

This occurs in slimy and somewhat velvetty patches of indefinite extent, covering the surface of marine rocks. The filaments rise from a slimy debris or matrix, which is gradually accumulated. They are erect, flexuous, often very much bent, attenuated to the apices, and sometimes, but not invariably, acuminate ; and they stand in the stratum parallel to each other, crowded together, but not cohering in laminæ. The endochrome is commonly of a dark, olivaceous green, and the cell-wall thin and membranous. *Striæ* evident.

Generally dispersed throughout the temperate zones, both north and south. Its slimy patches are very treacherous to the feet of unwary trespassers who may happen to tread on them.

3. Calothrix *vivipara*, Harv.; spreading in continuous, velvetty strata; filaments thick-walled, fasciculate at base, straight or somewhat curved, viviparous above, and pseudo-branched; endochrome strongly annulated.

Hab. Seaconnot Point, *Professor Bailey* (v. s. in Herb. T.C.D.)

This appears to form a continuous stratum on rocks, like that of *C. scopulorum*, but the filaments of which it is composed are longer, 2–3 tenths of an inch long and straighter; more united at the base into fascicles, and furnished above with appositional branches which evidently rise from viviparous separations from the endochrome. Sometimes the endochrome seems to split or divide longitudinally; at other times it separates transversely, the portions growing at each end and cohering laterally. The cell-wall is wider than in *C. scopulorum.*

Certainly closely allied to *C. scopulorum* and also to *C. hypnoides*, and perhaps intermediate between them, connecting the extreme forms of each. It was sent to me by Professor Bailey as probably *C. fasciculata*, but it does not agree with the British plant so called; and not knowing what else to do with it, being unwilling to pass it by altogether, I have given it a provisional *locus* in the genus, assigning to it the trivial name *vivipara*. It may possibly be merely a viviparous state of *C. scopulorum.*

4. Calothrix *pilosa*, Harv.; strata of indefinite extent, blackish or dark brown, pilose; filaments densely interwoven at the base, then free, elongate, rigid, cylindrical, very obtuse, very flexuous, simple or slightly pseudo-branched; cell-wall very thick, fulvous or subopaque; endochrome narrow, dark green. (Tab. XLVIII. C.)

Hab. On rocks between tide marks, Key West, *W.H.H.* (v. v.)

This forms strata of indefinite extent, covering rocks in patches of a very dark blackish or brown colour, not in the least lubricous, and more pilose than velvetty. The stratum is about quarter of an inch thick; its matrix composed of the densely interwoven decumbent bases of the filaments which constitute it. These are afterwards erect, unconnected together, standing separately like the hairs on a fleece, very much curved or twisted, nearly half an inch long, rigid and not at all slimy. They are about the same diameter as *Lyngbya majuscula;* and are scarcely attenuated at the blunt apex. The cell-wall or tube is remarkably thick and opaque, evidently formed of successive deposits, indicated by faint longitudinal striæ; and is fulvous or ochraceous in colour. The endochrome seldom constitutes more than a third of the diameter of the filaments, and is of a dull dark-green, more or less annulated. When dry the whole plant is rigid and harsh, and does not adhere to paper.

This seems to be a well characterised species, different at least from any with which I am acquainted, and to be recognised by its shaggy, rigid pile of hair-like filaments, and their dark colour. Its microscopic characters are quite different from those of *C. scopulorum.* It abounds at Key West on littoral rocks.

Plate XLVIII. C. *Fig* 1. Stratified tufts of Calothrix *pilosa*, the natural size. *Fig.* 2. Portion of the filaments *magnified*. *Fig.* 3. A more highly *magnified* portion.

5. Calothrix *dura*, Harv.; strata indefinite, dull brown; filaments at first decumbent and matted together, then erect, cohering laterally in tooth-like bundles; each filament angularly bent below, at first simple, then cleft longitudinally and afterwards once or twice forked; endochrome very narrow, annulate; the cell-wall thick, lamellated and subopaque; apices acuminate. (Tab. XLVIII. D.)

Hab. On mudflats, near highwater mark. Key West, *W. H. H.* (v. v.)

Possibly this may be only a state of the preceding species, to which, at least, it is nearly allied, although it offers characters which would cause it to be referred to another genus of Kützing. The filaments are matted together at base; the mat being composed of prostrate portions of each thread, intricately interwoven. The threads, after proceeding for a time horizontally, suddenly become erect, bending nearly at right angles, and then they cohere together into stiff, tooth-like fascicles, in which they stand parallel, and are straight or but slightly curved. When a single filament is removed from the fascicle, it is seen to be simple and filiform below, but gradually increasing in diameter upwards to a certain stage, at which the endochrome separates into two columns, which are at first parallel with each other and contained in the same sheath; but they soon separate, and then each becomes invested by a separate sheath. In this way two branches are formed, which may either remain simple or may again divide once or twice in a similar manner. The cell-wall is much wider than the endochrome. The substance is rigid and tough: and the colour dull brown or fulvous.

Plate XLVIII. D. *Fig.* 1. Stratified tufts of Calothrix *dura*, the *natural* size. *Fig.* 2. Portions of the filaments *magnified*. *Fig.* 3. Apex of a filament, more highly *magnified*.

V. OSCILLATORIA. *Vauch.*

Filaments lying in a gelatinous matrix, rigid, simple, acicular, vividly oscillating. *Tube* continuous; endochrome green, densely annulated with close, parallel, transverse striæ. *(Mostly in fresh water—some marine.)*

The *Oscillatoriæ* occur in gelatinous strata or pellicles, which at first are formed at the bottom of stagnant or running water, and afterwards rise to the surface. The green scum frequently seen on the surface of putrid ditches is generally formed by one or more species of this genus. Others occur in lakes, and sometimes in such abundance as to impart a blue-green tint to the water, over very wide areas. Others, again, inhabit mineral springs and thermal waters ; and some are found on the damp surface of the soil, especially in the autumnal months. Varied as are the habitats, the general characters of the species are very uniform: and all are remarkable for an oscillating movement of the filaments, from side to side, like the motion of a pendulum. This continues with greater or less vividness, while the plant lives: but some species exhibit much more lively movements than others, and all appear to be more active in warm than in cold weather.

A considerable number of species have been described by authors, but they require to be studied in a living state, or at least with very perfect materials and an ample suite of well preserved specimens. I cannot undertake to name specifically the few scraps of American *Oscillatoriæ* which have been sent to me by various correspondents. Probably most of the European species will be met with in America ; and no doubt some others peculiar to the New Continent. It would be interesting to know whether any species be found in the Mammoth Cave of Kentucky, or in other anomalous localities.

VI. MICROCOLEUS, *Desmaz.*

(*Chthonoblastus*, Kütz.)

Filaments minute, rigid, straight, annulated, bundled, and enclosed within membranaceous simple or branching sheaths, which are either open or closed at the upper extremities.

The filaments in this genus have the structure of those of *Oscillatoria* or *Calothrix*, but are developed within membranous common sheaths, which are either simple or branched, and either lie prostrate in indefinite strata, like those of an *Oscillatoria ;* or stand erect, in toothlike tufts, like those of many *Calothrices.* In all cases the sheath is much attenuated at the base, gradually widening upwards, and terminating either in an open, trumpet-shaped upper extremity, or in a closed club-shaped one. In the lowest part of the sheath there is but a single longitudinal filament ; a little way up, two or three parallel filaments are found ; and the filaments gradually increase in number in the upper and wider portions of the common sheath. Hence it may probably be inferred that the mode of growth of the frond is by the continual longitudinal division of the filaments ; the older ones, having once split, remaining unchanged at base ; while their apices by another splitting give birth to other filaments, which multiply in the same manner. Such a mode of growth would account for the form which the full grown frond assumes. The species are found either in the sea or in fresh or brackish water, and even on damp soil. A terrestrial species is common in Europe by the borders of clayey highways and paths, and may also be found in America.

1. MICROCOLEUS *corymbosus*, Harv.; fronds erect, rigid, tufted, multifid, the branches erect, level-topped, linear-clavate, closed at the extremity; filaments densely packed, not oscillating. (TAB. XLVIII. B.)

HAB. On mud-flats, near high-water mark, at Key West, mixed with *Calothrix dura*. W.H.H. (v. v.)

Fronds half sunk in the mud, erect, tufted, from an eighth to a quarter of an inch in length, flexuous, tapering much to the base, gradually increasing in diameter upwards and dividing above into three or four or more erect branches, the lowest of which are longest, the upper gradually shorter, so that the apices of all are nearly on a level. These apices are obtuse, and closed. The investing sheath is tough and firmly membranous, and the enclosed filaments strongly cohere together, and are with difficulty separated. The colour of the sheath is ochraceous yellow, and of the endochrome dull green. The substance is very firm and rigid, and in drying the plant does not adhere to paper.

PLATE XLVIII. B. *Fig.* 1. Tufts of MICROCOLEUS *corymbosus*, the *natural* size. *Fig.* 2. Magnified view of two fronds. *Fig.* 3. Portions of the enclosed filaments, more highly magnified.

VII. RIVULARIA, *Roth.*

Frond globose or lobed, fleshy, firm, composed of continuous radiating filaments, annulated within; each springing from a spherical globule. *(In the sea or in fresh water.)*

A fresh water species resembling the British *R. pisum* has been sent to me by Mr. Ravenel from the Santee Canal, where it grows on submerged leaves and stems of plants. It is hemispherical, very convex, dark blackish-green and soft, and consists of densely set, spuriously branching, slender filaments. The specimens are not in a very perfect state, and I cannot say to which, if any, of the modern species they would belong. In old times they would pass for *R. pisum*, but it is nearly impossible at present to say exactly what that species is.

ORDER X.—NOSTOCHINEÆ.

Nostochineæ, Endl. 3rd Suppl. p. 12. *Berk. Crypt. Bot. p.* 139. *Nostocheæ, Lindl. Veg. Kingd. p.* 18. *Kütz. Phyc. Gen. p.* 30. *Nostochaceæ, Harv. Man. Ed.* 2, *p.* 230.

DIAGNOSIS. Green, fresh water, or rarely marine Algæ, composed of moniliform filaments, lying in a gelatinous matrix. *Filaments* formed of globose cells, here and there interrupted by a single cell *(heterocyst)* of a different character. Propagation by *zoospores.*

NATURAL CHARACTER.—The least organized plants of this Order consist of isolated, moniliform threads, invested with a gelatinous coat, and either lying on the soil, without a root attachment, or floating freely in water. Others a little more compound are made up of numerous similar threads aggregated in bundles, and imbedded in a gelatine common to the colony : while even the most complex, as in the genus *Nostoc*, present but little further in advance, except that the gelatine in which the threads are developed is of a firm consistence, when dry becoming quasi-membranous, and assumes the character of a frond, with definite outline, but generally polymorphous shape. The filaments are almost always simple, consisting of strings of cells, and are curved or twisted, or often spiral ; in one case *(Monormia)* the filaments branch. The *cells* are spherical or oval, never truly cylindrical with flat ends, as in the *Confervaceæ*, and are filled with a dense, bright-green endochrome. In some few cases, as in *Spermosira*, the moniliform thread is enclosed within a tubular, membranous sheath, as in *Oscillatoriæ*, and there is little to distinguish such plants from individuals of that Order, except the occurrence of the cells called " *heterocysts.*" These latter cells are destitute ef endochrome, but often clothed with cilia, and are of a different size and shape from the neighbouring cells. They are always solitary, and occur at intervals in the filaments, but vary in position in the different species. Their use has not been ascertained, but they have been supposed to be connected with the male system of these plants. They never change character, like the ordinary cells, and are always found occupying a definite position in the filament, indicating that they perform some important function, whatever it may be.

Though the process of fertilization has not yet been observed, there can be little doubt but that a true fructification is formed in the ordinary cells, which at first are filled with pale-green matter, and afterwards increase in size, alter their form, and acquire a much denser and more darkly coloured, often deep brown, endochrome. All the cells of the filaments do not exhibit these changes, but only one or more, generally those in the neighbourhood of the heterocyst. Finally, at maturity, the threads break up, and the enlarged brown cells are found to contain *spores* which germinate and continue the species. They have been stated to change into zoospores, but this requires confirmation. *M. Thuret*, in a communication recently made to the Natural History Society of Cherbourg *(Aug.* 1857, *vol.* 5*)* has described and figured the germination of the spores of *Anabaina licheniformis*, and *A. major.* In these species the sporangium is oblong, and contains at maturity a deep brown solitary spore. *M. Thuret* having obtained some specimens with ripe fruit, set them aside in a convenient glass vessel, and observed them from day to day. The filaments soon broke up, the heterocysts and sporangia floating apart in the water. Many of the latter perished, melting away, and disappearing altogether. Some remained sound, and these were carefully supplied with water, until germination commenced. The spore, in germinating, at first lengthens, pushing against one end of the sporangium, which it finally pierces lifting off the tip of the periderm like a lid, and thus its extremity issues, as the radicle from an monocotyledonous seed, capped with the lid of the sporangium. At this period new cells begin to be formed, by the repeated sub-division of the spore, which continues to lengthen till it is transformed into a moniliform filament or string of cells, like that from which it was derived. At first the divisions between the cells are but little distinct, but they become more and more strongly defined as growth proceeds. The filament lengthens at both extremities, but more rapidly at that which projects into the water ; the young articulations are of smaller size than the rest, and thus the filament tapers towards each end. But this character gradually disappears, and the cells acquire a uniform dimension, proper to the species. *M. Thuret's* first experiments were made with freshly gathered sporangia : but he afterwards succeeded in causing to germinate specimens which had been dried and preserved for several months in the herbarium. They began to germinate in about a fortnight. Others (of *Anabaina licheniformis*) which had been kept for nine years in a dried state, germinated in an equal space of time, and the experiment was repeated several times with like success. Several other fresh-water Algæ have been observed to possess the same property of revivification, and it seems a necessary endowment to enable them to continue the existence of their species through the alternate drying and moistening to which they are subjected in nature.

To M. Thuret we are also indebted for observations on the ordinary propagation by gemmation of the *Nostocs*, and for an account of the way in which the compound frond is developed. In the autumnal months, when this process goes forward, the old *Nostoc* may be said to diliquesce, the gelatine becoming loose and exuding, and the filaments contained in it breaking up into small fragments. If these be collected and placed in a glass of water, they may be observed to have a slow, progressive movement, like that of the *Oscillatoriæ*, which enables them to change their place ; and at length they generally fix themselves on that side of the glass next the light. By continuing the observations for some days, the broken threads are seen to become immoveable, and then to be invested with a transparent pellicle. At the same time the green cells increase in size, expanding laterally, till the thread attains nearly twice its ordinary diameter. A cell division, in vertical order, then takes place throughout its component cells, and thus the filament splits into two parallel filaments, which are then contained within a common pellicle. The same process continues ; these split into other threads, and thus, by gradual bisection of the first formed threads, the frond grows until it become of the form and size proper to its kind. As it grows the filaments twist and curl, and loose their parallelism. All these changes have been figured by M. Thuret with the accuracy and delicacy of execution characteristic of that accomplished naturalist.

The Nostochineæ are very rarely marine, and are chiefly found in fresh water streams or ponds and lakes, or in damp places. *Nostoc commune* is dispersed over most countries of the globe, being found lying on the bare soil after rains, or in very damp weather. It may be observed often on garden walks in the autumn and winter months, and is found throughout both temperate zones, extending almost to the tropics. A similar species has been seen in Australia, after a shower of rain, to cover what had seemed previously to be a bare hill side, with such a thick coating of jelly as to render it impossible to walk over it without sliding. Such terrestial species have, in England, the popular name of "fallen stars"; their sudden appearance and disappearance being accounted for by the supposition that they had fallen from the air. In Dr. Sutherland's account of his Arctic voyage a species bearing a close external resemblance to *N. commune* was observed in profusion, occurring on the shores of the Arctic Ocean, but in windy weather frequently blown over the ice, and drifted out to sea. This will be found described below as *N. arcticum.* Dr. Sutherland mentions that he had eaten handfulls of it on several occasions, without any inconvenience ; and although it was generally infested with swarms of the larvæ of flies and gnats, he considered it much more nutritious than "tripe de roche," and perhaps not inferior to Iceland moss. A very similar plant was noticed by Dr. Thomson as occurring in Thibet, up to the height of 17,000 feet, floating on the surface of pools and lakes, in soils impregnated with carbonate of soda, and drifted in heaps by the winds along their banks. Mr. Berkeley, who examined the specimens of both plants chemically, "thinks we may safely assume the jelly of the Nostoc to be a state of bassorin, passing into cellulose or dextrine." Another species of this genus (*Nostoc edule*, Mont. and Berk.) is found abundantly in streams in Tartary, whence it is exported to China, where it is sold in the markets as an article of food, and highly esteemed as an ingredient in soups. It is prepared for sale in boxes, one of which is in the Museum of the Linnæan Society. These particulars are drawn from the abstract of a paper read by Dr. Hooker before the Linnæan Society of London, January 20, 1852. *(See Taylor's An. Nat. Hist. 2nd. Ser. Vol.* 10, *p.* 301-303.*)* As the edible Nostocs closely resemble *N. commune* in substance, it may be worth enquiry whether the latter may not also be used as food. Possibly a new source of luxury may lie hid under this humble exterior. Or it may perhaps be a nourishing and delicate food for weak digestions. The dyspeptic had better seek for it betimes.

NOSTOC. *Vauch.*

Frond gelatinous or coriaceous, globose or lobed, filled with curled, beaded, simple filaments, formed of spherical or ellipsoidal coloured cells, interrupted here and there by a colourless cell of larger size. *Spores* formed from the ordinary cells. *(On damp ground or in fresh water.)*

1. Nostoc *commune*, Vauch.; terrestrial; frond expanded, membranaceous, plaited and waved or curled, olive-green, polymorphous. *Vauch. Tab.* 16. *Fig.* 1, *Ag. Syst. p.* 18. *Harv. Man. Ed.* 1, *p.* 183. *Hass. Br. Fr. W. Alg. p.* 288 *t.* 74, *f.* 2. *Kütz. Sp. Alg. p.* 298.

Hab. On damp soil, in autumn. Common after rain on dry flats, Rio Bravo, *Dr. Schott.* (v. v.)

In dry weather the frond curls up and contracts, looking like a piece of shrivelled skin, and in that state may be blown about without injury. When moistened it expands, and then forms a semi-transparent, semi-gelatinous, elastic membrane, of a dull bottle-green colour. Under the microscope it appears like a transparent jelly traversed in every part with curled strings of beadlike, green cells.

2. Nostoc (Hormosiphon) *arcticum*, Berk.; fronds foliaceous, variously plaited, green or brownish; filaments at length (their gelatinous envelope being dissolved) free. *Berk. in Proc. Lin. Soc. fide An. Nat. Hist.* 2*d Ser. vol.* 10, *p.* 302.

Hab. On the naked soil, in boggy ground. Assistance Bay, lat. 75° 40′ N. *Dr. Sutherland.* (v. s.)

"*Fronds* foliaceous, variously plicate, sometimes contracted into a little ball. Gelatinous envelope at length effused; connecting cells at first solitary, then three together; threads, which are nearly twice as thick as in *N. commune*, breaking up at the connecting cells, so as to form new threads, each terminated with a single large cell, the central cell becoming free." *Berk. l. c.*

"It grows," says Dr. Sutherland, "upon the soft and almost boggy slopes around Assistance Bay; and when these slopes become frozen at the close of the season, the plant lying upon the surface in irregularly plicated masses becomes loosened, and if it is not at once covered with snow, which is not always the case, the wind carries it about in all directions. Sometimes it is blown out to sea, where one can pick it up on the surface of the ice, over a depth of probably one hundred fathoms. It has been found at a distance of two miles from the land, where the wind had carried it. At this distance from the land it was infested with Poduræ, and I accounted for this fact by presuming that the insects of the previous year had deposited their ova in the plant upon the land, where also the same species could be seen in myriads upon the little purling rivulets, at the side of which the Nostoc was very abundant." At p. 205 of his Journal, Dr.

Sutherland further mentions having tried it as an article of food, and found it preferable to the Tripe de Roche of the arctic hunters. Its nutritive qualities are probably equal to those of the jelly derived from other Algæ.

3. NOSTOC *verrucosum*, Vauch. ; aquatic ; fronds large, gregarious, confluent, subglobose, plaited, at length hollow, blackish-green. *Vauch. t.* 16, *fig.* 3. *Ag. Syst. p.* 21. *Harv. Man. Ed.* 1, *p.* 185. *Hass. Brit. Fr. Wat. Alg. p.* 291, *tab.* 75, *fig.* 1. *Kütz. Sp. Alg. p.* 300.

HAB. On stones in fresh water streams. Pools of fresh water, Isle of Disko, and at Beechey Island, Arctic Regions, *Dr. Lyall.* Santa Fe, New Mexico, *Fendler.*

Fronds gregarious, at length confluent, adhering firmly to the rock on which they grow, becoming hollow and torn in age, and finally floating to the surface. *Colour* a bottle-green. Glossy when dry.

4. NOSTOC *cristatum*, Bailey ; aquatic , fronds orbicular, plano-compressed, firm, smooth or tuberculated, attached by a point of the circumference, erect. *N. nummulare, Harv. MS. in Herb.*

HAB. In rivulets, attached to stones under water. Near West Point, *Professor Bailey.* Crumelbow Creek, Hyde Park, N.Y., *W.H.H.* (v. v.)

This pretty little species grows on stones in running water and may possibly be of common occurrence. The fronds are circular, about half an inch in diameter, or rather more, the tenth of an inch in thickness, plano-compressed and solid ; but perhaps in age they would become hollow, and then would probably be spherical. Such inflated fronds, however, have not yet been seen. They are fixed to the stones on which they grow by a single point of the circumference, and stand erect, like miniature cock's-combs, whence the specific name *cristatum* bestowed by *Professor Bailey.* The substance is very firm and cartilaginous. The filaments are much curled and very densely packed together, moniliform, and of a dark bluish-green under the microscope. The colour of the frond to the naked eye is a dark olive-green, blackish rather than blueish.

5. NOSTOC *Sutherlandi*, Dickie; "discoid, coriaceous; filaments crowded; cells mostly spherical." *Dickie in App. Suth. Voy.* 1, *p.* 193.

HAB. South side of harbour, in winter quarters, Baffin's Bay, July, 1851. *Dr. Sutherland.*

"The plant is one to two inches in diameter, attached by one point of the margin. Plicato-venose beneath, the plicæ radiating chiefly from the point of attachment; faintly venose above, especially near the point of adhesion ; toward the margin reticulately venose." *Dickie, l. c.*

This is unknown to me. It seems to be closely allied to the preceding species, if it be distinct. The plicæ and reticulations observed do not appear to be characters of much value for the discrimination of species among these gelatinous plants.

6. Nostoc *microscopicum*, Carm.; fronds densely aggregated, very minute, globose or oblong, immersed in a blackish crust; filaments few. *Carm. in Hook. Brit. Fl.* 2, *p.* 399. *Harv. Man. Ed.* 1, *p.* 184. *N. muscorum*, *Hass. Br. Fr. Wat. Alg. p.* 292, *t.* 74, *fig.* 4.

Hab. "Stones in a small stream, Baffin's Bay, *Dr. Sutherland*, fide *Prof. Dickie.*

I have not seen American specimens. In Britain this species grows among mosses on exposed calcareous rocks, but not in water. The above specific character is taken from the British plant. The fronds are rarely more than the tenth of an inch in diameter, and contain two or three beaded filaments lying in a copious transparent jelly.

7. Nostoc *flagelliforme*, Berk. and Curt.; terrestrial; frond cartilaginous, linear, very narrow, compressed and often channelled, much branched, irregularly dichotomous; branches solid, densely filled with moniliform curved threads. *Berk. and Curt.* No. 3809.

Hab. On naked aluminous soil, at San Pedro, Texas, *Mr. Charles Wright* (v. s.)

Fronds several inches in length, half a line in diameter, lying prostrate on the surface of the soil, much branched in an irregularly dichotomous manner: branches exactly linear, compressed, often channelled on one or both sides, thinned in the middle and incrassated to the edge. *Substance* firm and elastic, cartilaginous, solid, densely filled with moniliform, curved or curled, interlaced threads, which are set longitudinally in the frond, and lie nearly parallel to each other. *Colour* dark olive.

A very curious and most distinctly marked species, differing from others of this genus, much in the same manner that *Chætophora endiviæfolia* does from the ordinary globose forms of *Chætophora*.

Order XIII.*—PALMELLACEÆ.

Palmellaceæ, Harv. Man. Ed. 2, *p.* 234. *Palmelleæ, Dne. Class, p.* 31. *Endl.* 3*rd. Supp. p.* 10. *Kütz. Phyc. Gen. p.* 166. *Hass. Brit. Fr. Wat. Alg. p.* 306. *Lindl. Veg. King. p.* 18. *Kütz. Sp. Alg. p.* 196. *Berk. Crypt. Bot. p.* 114. *Thwaites, in An. Nat. Hist.* 2*nd Ser. vol.* 2, *p.* 312, *and vol.* 3, *p.* 243. *Part of Ulvaceæ, Harv. Man. Ed.* 1, *p.* 169. *Part of Nostochineæ, Ag. Syst. p.* 13. *Harv. in Hook. Br. fl.* 2, *p.* 394.

Diagnosis. Green or red, orange or yellowish, fresh-water Algæ, composed of separate or aggregated (but not united) globose or ellipsoidal cells, free, or lying in a gelatinous matrix ; sometimes stipitate. *Propagation* by division of the endochrome.

Natural character. The plants of this family are the simplest in organization of any of the great class of the Algæ, and therefore fall to the lowest point of the scale in the arrangement we have adopted. In them we no longer find any distinction of root from frond ; most of them are amorphous masses of gelatinous substance, and only in a few, as in *Hydrurus*, does the gelatine assume a tolerably definite form, and display itself as a branching frond. The simplest of the group *(Protococcus)* consists of single, isolated cells, strewn on the surface of the soil or of whatever object to which they happen to attach themselves. These cells are globose or egg-shaped, have a hyaline, often gelatinous coat, and contain a utricle filled with dense endochrome of various colours; sometimes green, but often red or orange. Of this character is the Red Snow plant *(Protococcus nivalis)* which has attracted so much notice, from the accounts of arctic travellers, and which may often be seen tinging the snows of Mount Blanc and other snowy Alps with a pale roseate hue. The mode of propagation of this primordial plant is as simple as its structure. The matter in the cell becomes condensed at maturity, and then subdivides into 4, 8, 16, or more parts, on a quaternary scale of increase ; each frustule acquires a new cell-coat while yet within the parent cell, and when the process is completed, and all the endochrome of the mother cell has thus been used up in providing for the progeny, the cell-coat bursts and a multitude of minute cell-plants, similar in all respects to the parent except in size, are launched into the world. These grow till they attain the dimensions of the parent, when a similar cell division takes place ; and thus in a very few generations millions of new plants may be produced from a few or even from a solitary original. As the process of growth and

* Orders XI. *Desmidiaceæ*, and XII. *Diatomaceæ* are omitted in this work ; the American species having been already partially described and published by Professor Bailey, and the author not being supplied with any new materials for publication.

development is very rapid, we may easily account for the rapidity with which the *Protococcus nivalis* has been seen to extend, and also for the vast surface covered by so minute an organism. Each individual is not more than $\frac{1}{1000}$ of an inch in diameter, yet the surface of snow visibly reddened by the congregated masses often covers hundreds of square miles. A species very similar, if really different, called *P. pluvialis*, is found in shallow pools of rain water, on the surface of rocks, in gutters of houses, &c.; and has been noticed in very distant parts of the globe under various climatial conditions; and of this species a most elaborate monograph,* illustrated by figures, has been given by De Flotow, in the *Nov. Act. Leop. Carol. Nat. Cur. vol.* 20, where no less than twenty-two distinct and many more subdistinct varieties, or rather states, are enumerated, described, and measured to fourteen places of decimals (!) and figured. Several of these forms are endowed with movements resembling those of the infusorial animalcules, and have been described as animalcules by Shuttleworth in his account of the Red Snow *(Bib. Univ. Geneva, Feb.* 1840.*)*

A little higher in organisation than *Protococcus* is the genus *Gloeocapsa (Hæmatococcus)* in which what is only a passing phase of the *Protococcus* becomes a permanent character. In this we have several cells (of the structure of *Protococcus*) enclosed within a common, primary cell, which is persistent, or at least partially so. In some species (as in *G. Hookeri*) the primary cell-coat exfoliates repeatedly, the old coats remaining permanently attached on one side to each other, and to the cell, which perpetually bursts through them; and thus a sort of spurious frond, simple or branching, is formed, consisting of exuviæ, each branch being tipped with the living cell, which shines like a gem at its summit. These plants occur generally in damp situations, on rocks and among mosses, about the spray of cascades, &c., and Kützing has described and figured upwards of fifty.

Next come the *Palmellæ* proper, where a large number of protococcoid cells are enclosed within a common gelatine, in which they sometimes appear to be distributed without order; and sometimes arranged in a subquaternary manner. In this latter case the structure approaches very closely to that of *Tetraspora*, a genus we have already referred to the *Ulvaceæ;* but which is placed by many authors next to Palmella. Possibly among these obscure plants forms are associated in one genus which will be separated when their development is better understood. Among some of the *Palmellæ* Broome and Thwaites have described and figured a more definite organization than was previously known; namely, that the apparently scattered cells of the mass are connected in an early stage of growth, by means of slender gelatinous threads, with a central cell

* This extraordinary essay is well worth looking at—(I will not say carefully perusing)—as one of the most remarkable commentaries on the text, "how great a flame a little fire kindleth." The object to be examined is a microscopic Alga of the simplest possible structure, being in fact merely an isolated living cell. All that need to be said of its history might, one would suppose, easily have been written in a page or two. But the learned and most laborious author has occupied nearly two hundred large quarto pages on this theme; and not content therewith, has appended long tables of decimal measurements of microscopic areas and volumes, whose only reference to his subject appears to be that they enable him to arrive at such important calculations and useful results as describing the mean differences of the shorter and longer diameters of different individuals of his *Protococcus*, and their mean comparative bulk and spherical aberration. In computing these tables, the decimals have been carried sometimes to fourteen places, and in most cases at least to six.

of large size, from which they radiate. Afterwards they become detached, and then each is seen at the end of a mucous prolongation similar in appearance to that already noticed as occurring in *Gloeocapsa.* Mr. Thwaites compares these threads to the mycelium of a fungus, but regards the increase of cells by cell-division as properly an act of gemmation and not of true reproduction. The reproductive process in these plants is by conjugation of two cells, which takes place in a manner similar to that already noticed as occurring in *Zygnemaceæ.* A narrow connecting tube, soon enlarging to the breadth of each cell, is formed between two contiguous cells, through which the contents of both cells are mixed together ; and thus a *sporangium* filled with a denser and more distinctly granular endochrome is formed, the membranes of the original cells being absorbed in the process. Probably at a future stage the contents of this sporangium are resolved into zoospores. *(See Thw. An. Nat. His. ser.* 2, *vols.* 2 *and* 3.*)*

Higher in structure than *Palmella*, and showing some approaches to the *Nostochineæ*, or even to the gelatinous Confervaceæ *(Chætophora)* is *Hydrurus*, the only genus which we shall further describe.

I. HYDRURUS, *Ag.*

Frond fixed at base, cylindrical or compressed, elongated, branched, gelatinous. *Structure :* seriated, but separate, cellules, filled with bright-green endochrome, enclosed in gelatinous parallel tubes, ranged longitudinally in the frond, and surrounded by a common gelatinous envelope.

Of this genus several species have been described by authors, all having a close resemblance to each other, and all very variable in ramification. Indeed it is almost impossible to fix characters by which they can be permanently kept apart ; and instead of adding another specific name to the already too numerous list, I prefer to consider the American specimens received as constituting a luxuriant variety of the best known of the established species. All previously recorded species or varieties of these plants are natives of rapid rivers and streams in various parts of Europe.

1. Hydrurus *penicillatus*, var. *occidentalis*, Harv.; frond very long (1–2 feet or more) much branched ; branches very irregular, scattered or crowded, wormlike, tapering to a fine point, naked or clothed with feathery villous ramuli ; cells ellipsoidal or pearshaped, twice as long as their diameter.

Hab. On the rocky bottom of rivers and streams, in a strong current. Santa Fe, New Mexico, *Mr. Fendler*, February to April, 1847. (v. s. in Herb. T.C.D.)

Fronds attached at base, one or two feet long, from one to four lines in diameter, very much and irregularly branched ; branches scattered or crowded, simple or divided, a foot or more in length, attenuated to a fine point, sometimes smooth and naked, but generally densely clothed with slender, villous ramenta, spreading to all sides. The gelatinous tubes or sheaths in which the cells are seriated are very obvious, and lie close together in longitudinal, parallel strata. The cells are of large size, bright-green colour, and variable shape ; some are twice as long as others.

This I had at first supposed to be a new species, but now regard it as a very gigantic state of *H. penicillatus*, Ag. which under various forms and of various sizes is common in alpine streams in Europe. I fear characters derived from the shape and size of the cellules are not more to be depended upon than are those taken from the ramification.

SUPPLEMENT.

No. 1. Additional Species discovered since the publication of the First and Second Parts.

Part I.—MELANOSPERMEÆ.

Part 1, p. 61, add,

I.* TURBINARIA. *Lamour.*

Root branching. *Frond* alternately decompound, having a distinct stem, branches, vesicated leaves and receptacles. *Branches* filiform, simple or pinnate. *Leaves* spirally inserted, on long petioles, peltate, becoming inflated and changed into peltate air-vessels with leafy dentate margins. *Receptacles* cylindrical, verrucose, much branched, rising from the petiole of the leaf, near its base, on the upper side; of similar structure to those of *Sargassum.*

A genus consisting of two or three tropical or subtropical Algæ, distinguished from *Sargassum* by its peltate leaves, which are at first thin and flat, but afterwards become hollow and are changed into flat-topped, margined air vessels.

1. Turbinaria *vulgaris*, Ag.; frond membranaceo-coriaceous; leaves on an inflated petiole obconic or top-shaped, the margin entire or toothed, the disc naked. *J. Ag. Sp. Alg.* 1, *p.* 267. *Turbinaria denudata and T. decurrens, Bory. Fucus turbinatus, Turn. Hist. t.* 24, *fig. a. and b.*

Hab. At Key West, *Mr. Ashmead.* (v. v.)

Root a mass of branching fibres, as thick as sparrow's quills, loosely entangled together. *Fronds* several from the same mat of roots, either quite simple, or dividing near the base into three or four principal branches; or pinnately compound by the evolution of lateral branches, erect and rigid, 6–10 inches high, cylindrical and smooth. *Leaves* spirally inserted, spreading to all sides, patent, rigid; petioles at first cylindrical, then becoming clubshaped and somewhat inflated, from half an inch to an inch long, crowned with a peltate horizontal lamina, which is either subentire or sharply dentate at the margin. In young specimens or on young branches the peltate leaves are found flat and thin, their upper and lower surfaces forming one substance; but more commonly the centre of the leaf becomes inflated or vesicated, and then is formed a compound top-shaped flat-topped body, half vesicle, half leaf, which is characteristic of the genus. *Receptacles* dichotomous, much branched, shrubby, their branches verrucose. *Colour*, when growing a pale olive, but in the herbarium changing to a dark brown or black. *Substance*, when dry very hard and rigid.

A common plant in tropical seas, both in the eastern and western hemispheres. Mr. Ashmead obtained fine specimens at Key West, but it appears to be of rare occurrence.

Part 1, page 64, add,

III.* CYSTOPHYLLUM.

(Generic character the same as that of *Cystoseira*, except that the *air-vessels* are confined to the ultimate ramuli, which are simple and filiform.)

1. CYSTOPHYLLUM *geminatum*, Ag.; stem . . . . .; fronds elongate, filiform, unarmed, decompound-pinnate; branches issuing from all sides, geminate; vesicles solitary in the ramuli near the summit, oval, tipped with an excurrent point; receptacles paniculate, warted, attenuate, often tipped with a vesicle. *J. Ag. Sp. Alg.* 1, *p.* 232. *Cystoseira thyrsigera*, *Post. and Rupr. Ill. Alg.* 13, *t.* 38, *f.* 4.

HAB. Banks' Island, North Western America, *Mr. Menzies*, 1787. (v. s.)

In Mr. Menzies' Herbarium, now preserved at the Botanic Garden, Edinburgh, is a specimen of this plant, marked *C. trinodis* in Mr. Menzies' handwriting. Two branches are laid on one piece of paper. The largest is about 10 inches long, as thick as sparrow's quill, smooth, decompound, pinnate and ovato-lanceolate in circumscription. The branchlets are mostly geminate, filiform, alternately decompound; their lesser divisions also subgeminate. *Vesicles* oval, $1\frac{1}{2}$ lines long, scarcely a line wide, either solitary in the filiform ramuli, about the middle or a little beyond it, or two in the ramulus, the second one terminal, apiculate, and removed by a rather long pedicel from the first. *Receptacles* lanceolate, 2-3 lines long, verrucose, apiculate, often with a slender beak nearly as long as the receptacle, and sometimes two receptacles occur on the same ramulus. The upper branches are very dense.

Page 71, add,

8. FUCUS *serratus*, Linn.; frond flat, dichotomous, midribbed, serrated, without air-vessels; receptacles flat, terminating the branches, serrated. *J. Ag. Sp. Alg.* 1, *p.* 211. *Kütz. Sp. Alg. p.* 590. *Turn. Hist. t.* 90. *E. Bot. t.* 1221. *Harv. Phyc. Brit. t.* 47, *&c.*

HAB. On rocky sea-shores. Newbury port, Mass. *Captain Pike*, 1852. (v. v.)

Fronds, two feet long or more, from one half-inch to one or two inches in width, dichotomous, with a thick midrib, bordered by a sharply serrated lamina. *Air-vessels* none. *Receptacles* flat, formed in the acuminated extremities of the branches, sharply serrate like the other parts of the frond.

I have received a small fragment of this common European plant, stated to have been found in the above locality on the American coast. It is hardly probable that it is either confined to one locality, or even rare, wherever it occurs; yet none of my other American correspondents have sent it; nor do I know the circumstances under which Captain Pike obtained it. I hope this notice may lead some one on the coast to investigate the subject; for European botanists are yet uncertain whether *F. serratus* be really a bona fide native of the American coast, or merely a stray waif, accidentally cast ashore.

Page 106, add,

2. ZONARIA *flava*, Ag.; frond erect, with an elongated, branched, woolly stipes, the branches expanding into cuneate, flabelliform, vertically cleft and laterally laciniated, naked laminæ; segments wedge-shaped, with radiating, longitudinal striæ; sori roundish, scattered. *J. Ag. Sp. Alg.* 1, *p.* 110. *Stypopodium flavum*, *Kütz. Sp. Alg. p.* 563.

HAB. Pacific Coast, *Dr. Schott.* (v. s.)

A small specimen, apparently referable to this species, was collected by Dr. Schott on the Pacific coast, but the locality is not stated. It is about two inches high, much narrower and more branched than *Z. lobata*, with stupose, linear, riblike patches extending up the principal lobes. Perhaps, therefore, it is rather referable to *Z. stuposa*, J. Ag., if that be a distinct species from *Z. flava*.

Page 113, add,

VI.* STRIARIA, *Grev.*

Root a small, naked disc. *Frond* tubular, membranaceous, continuous, branched. *Fructification*, groups of naked, roundish spores, disposed in transverse lines.

1. STRIARIA *attenuata*, Grev.; branches and ramuli mostly opposite, tapering to each extremity. *Grev. Crypt. Fl. Syn. p.* 44. *tab.* 288. *Alg. Brit. p.* 55. *t.* 9. *Wyatt, Alg. Danm. No.* 160. *J. Ag. Sp. Alg.* 1. *p.* 80. *Harv. Phyc. Brit. t.* 25. *Kütz. Sp. Alg. p.* 553. *Phyc. Gen. t.* 21. *f.* 11.

HAB. Flushing, New York Bay, *Professor Bailey.*

The only American specimen I have yet seen is small and very slender, about two and a half inches long, and not thicker than hog's bristle. It is abundantly in fruit; otherwise it could hardly be recognised. The branches are few, opposite or alternate, some of the larger ones bearing a few ramuli, and all tapering to a very fine point.

On the British coast this species varies greatly in size. Sometimes it is nearly as small and slender as that just noticed. Other specimens, like that figured in Phyc. Brit. are 8–12 inches long, and from one to two lines in diameter. The branching is irregular and sometimes whorled.

Page 137, add,

3. SPHACELARIA *arctica;* filaments naked at the base, erect, elongate, slender, irregularly branched, scarcely pinnate; ramuli filiform, naked, erect.

HAB. In tide pools, Isle of Disko, Greenland, *Dr. Lyall.* (v. s. in Herb. T.C.D.)

Filaments 1–2 inches high, irregularly once or twice compounded, the main branches few, the secondary numerous, densely set and very erect, lateral, either naked or bearing few or many, long, filiform, erect, naked, slender ramuli, from half an inch to an inch in length. *Articulations* short in the stem and branches; once and a half as long as broad in the ramuli. *Colour* a dull olive. *Fruit* unknown.

Page 138, add,

III.* MYRIOTRICHIA, *Harv.*

Frond capillary, flaccid, jointed, (simple), beset with quadrifarious, simple, spinelike ramuli, clothed with byssoid fibres. *Fructification*, elliptical spores, containing dark-coloured endochrome.

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1. MYRIOTRICHIA *filiformis*, Griff.; stem filiform, slender, often flexuous or curled, beset at irregular intervals with oblong clusters of short, papilliform ramuli. *Harv. Phyc. Brit. t.* 156. *Wyatt*, *Alg. Danm. No.* 213. *J. Ag. Sp. Alg.* 1. *p.* 14. *Kütz. Sp. Alg. p.* 470.

HAB. Parasitic on *Dictyosiphon fœniculaceus* at Penobscot Bay, *Mr. Hooper.* (v. v.)

Fronds an inch or more in length, very slender, filiform, but thickened at intervals, as if nodose; the thickening caused by the dense aggregation of short ramuli of two or three cells each. These ramuli emit byssoid fibres. *Spores* roundish, scattered. *Substance* soft. It adheres closely to paper.

On the British Coast this parasite commonly infests *Chorda Lomentaria.*

Page 139, add,

2* ECTOCARPUS *longifructus*, Harv.; tufts large, branching, the divisions feathery; filaments robust, excessively branched, branches mostly opposite, the lesser ones set with short, spine-like, opposite, or rarely alternate ramuli ; articulations as long as broad ; silicules very long, linear-lanceolate, attenuate, densely striate transversely, terminating the principal branches and ramuli. *Harv. Phyc. Brit. t.* 258.

HAB. Penobscot Bay, *Mr. Hooper.* (v. s.)

I have seen an American specimen collected by Mr. Hooper, which I venture to associate with the Orkney plant to which the above character is given in *Phyc. Brit.* Perhaps it is a mere form of *E. littoralis;* though a remarkable one.

Page 140, add,

3* ECTOCARPUS *amphibius*, Harv.; tufts short, loose, soft, pale olive ; filaments very slender, sub-dichotomous ; ultimate branches alternate, spreading ; articulations two or three times longer than broad ; silicules linear-attenuate, spine-like, mostly sessile, scattered. *Harv. Phyc. Brit. t.* 183.

HAB. In fresh (probably brackish ?) water, near New York, *Mr. Hooper.* (v. s.)

Tufts 2–3 inches long, very flaccid and slender ; pale brown when fresh, fading to a dull greenish-olive in drying. This is nearly related to *E. siliculosus*, and may perhaps be regarded as a depauperated variety of that common species, altered by having grown in a less saline medium than usual. In England it occurs in brackish ditches near the coast. The American locality is not particularly specified.

PART II.—RHODOSPERMEÆ.

Page 23, add,

7. CHONDRIA *nidifica ;* frond ultrasetaceous, filiform, sparingly and distantly branched ; branches alternate or secund, quite simple or forked, long, cordlike, naked, or emitting at intervals fascicles of forked or multifid fructiferous ramuli ; tetraspores several, near the tips of the ramuli. (TAB. L. B.)

HAB. Pacific Coast, *Dr. Schott.* (v. s. in Herb. T. C. D.)

Fronds 6-8 inches long, as thick as sparrow's quills, cylindrical, inarticulate, sparingly branched in a manner between alternate and dichotomous ; the branches, by frequent non-development of one of the arms of the fork, appearing unilateral. *Branches* several inches long, quite simple, or once or twice forked ; or bearing a few secondary branches one or more inches long, either quite naked or furnished at intervals of about an inch with tufts of short, fructiferous ramuli. These latter are about quarter-inch long, as thick as hog's bristle, densely tufted, and simple or sub-divided. In the specimen examined some of them bear tetraspores. A transverse slice of the inarticulate frond shows a central axial-cell surrounded by several primary radiating cells, and many external rows of secondary cells which become smaller towards the circumference. *Colour* a dull brownish red. *Substance* cartilaginous, not adhering to paper.

I have seen but a single specimen of this seemingly very distinct plant, which has more the habit of *Champia lumbricalis* than of one of the present genus. It was picked up, it is presumed on the Western coast, by Dr. Schott, during the Mexican Boundary Survey, but no note regarding its exact habitat accompanied the specimen. I am indebted to my friend Professor Torrey for specimens of this and other Algæ collected by the officers attached to the Mexican Boundary Survey.

PLATE L. B.—*Fig.* 1. CHONDRIA *nidifica ;* the natural size. *Fig.* 2. Portion of a branch, with a tuft of ramuli. *Fig.* 3, a ramulus, containing tetraspores. *Fig.* 4, a tetraspore. *Fig.* 5, transverse section of a branch ; the latter figures more or less *magnified.*

Page 26, add,

4.* RHODOMELA *lycopodioides*, Ag. ; frond divided near the base into several long, simple branches, which are densely beset with slender, finely divided branchlets, mixed with the short, rigid, bristlelike remains of a former series. *Ag. Sp. Alg.* 1. *p.* 377. *Harv. Phyc. Brit. t.* 50. *Lophura lycopodioides*, *Kütz. Sp. Alg. p.* 850. *Fucus lycopodioides*, *Linn.* *Turn. Hist. t.* 12. *E. Bot. t.* 1163.

HAB. Whalefish Islands, Davis Straits, *Dr. Lyall.* (v. s.)

Fronds 1–2 feet long, half a line in diameter at base, attenuated upwards, filiform, either quite simple or divided a short way above the root into several long simple branches. In its winter state the virgate branches are closely set with short, rigid, simple or slight divided ramuli,from half an inch to one inch in length. In summer, long, capillary, multifid ramuli from one to two inches in length are thrown out both from the remains of the winter ramuli and from the main branches, and the frond thus acquires a plumose aspect very different from its winter state. *Conceptacles* are abundantly borne on the summer ramuli ; and *tetraspores*, lodged in clustered, podlike branchlets or stichidia, are found on the winter ramuli. *Substance* cartilaginous. *Colour* a purplish brown, becoming very dark in drying.

This interesting addition to the American Nereis occurs abundantly in various places on the shores of Northern Europe. In the British Isles it is almost confined to the coasts of Scotland and of the North of Ireland ; but has occassonally been met with on the East coast of England.

Page 59,

1. DASYA GIBBESII, Harv.

Add to the description : *Conceptacles* of large size ($\frac{1}{20}$ inch in diameter), borne on the penultimate ramuli, at first globose, afterwards broadly ovate, inflated, with thin, highly cellular walls and a berry-like nucleus of much branched filaments, bearing many small, pyriform spores. Specimens in fruit communicated by *Mr. S. Ashmead* from Key West. (v. s.)

Page 61,

3. DASYA *ramosissima*, Harv.

Add to description : *Conceptacles* sessile on the lesser branches, ovato-globose, thin walled, inflated, without prominent orifice, containing a large nucleus. *Stichidia* on the ramelli, either fusiform or ovato-acuminate, always tapering to a slender point ; tetraspores in a single or double row. Specimens in both kinds of fruit communicated by *Mr. S. Ashmead* from Key West. (v. s.)

Page 62, add,

3.* DASYA *Harveyi*, Ashmead ; rose red ; stem cartilagineo-membranaceous, longitudinally striate, glabrous, inarticulate, robust, attenuated upwards, much branched ; branches alternate or secund, once or twice decompound, their ultimate divisions being pinnated with capillary, closely set, articulated (polysiphonous) ramuli, which are densely clothed with byssoid, dichotomous ramelli ; cells of the epidermis of the branches very narrow, parallel ; articulations of the ramelli many times longer than broad ; conceptacles sessile near the tips of the lesser ramuli, urceolate, with a prominent orifice ; stichidia on the ramelli, tapering to each end. (TAB. L. A.)

HAB. Key West, *Mr. Ashmead.* (v. s. in Herb. T.C.D.)

Frond 8—10 inches long, as thick as crow-quill in the main divisions ; very much branched, the successive divisions being more and more slender, till the ultimate ones have become finer than human hair. The branching is irregular, the larger divisions frequently secund, several lateral branches directed successively first to one side and then to the opposite one of the main branch. All the main *branches* and their lesser divisions down to the last are inarticulate, being coated with very slender, coloured, longitudinal, parallel, seriated cells, which give the branches a striated appearance under the microscope ; they are also glabrous, or bare of ramelli. The *ultimate* branchlets, which are half an inch to an inch long, are plumose, very flaccid and soft, and closely set with lateral, but not strictly distichous pinnules, which are clothed with excessively slender, cobweb-like, flaccid ramelli. These latter are many times dichotomous and taper to the points; their articulations are many times longer than broad. The *conceptacles* are nearly of the form of those of *Polysiphonia urceolata*, and are sessile at or near the ends of the pinnules of the plumose branchlets. The *stichidia* spring from the lower forkings of the byssoid ramelli, and are much attenuated, tapering at each end, and containing a double row of tetraspores. The whole plant is of a beautiful, clear, rose-red colour. Its substance is very soft and flaccid, and in drying it adheres very strongly to paper.

For fine specimens of this distinct and beautiful species I am indebted to its discoverer Mr. Ashmead of Philadelphia, who sent them to me marked with the specific name here adopted.

Plate L. A. *Fig.* 1. Dasya *Harveyi*, the *natural* size. *Fig.* 2. A ramulus bearing a *conceptacle* near its summit. *Fig.* 3. Portions of different ramelli bearing *stichidia. Fig.* 4. A portion of a branch, showing the linear striæform surface-cells : the latter figures *magnified.*

Page 64,

7. Dasya *Tumanowiczi*, Gatty. add to the description : *Conceptacles* on very short peduncles, borne by the lesser branches, ovate or sub-urceolate, thin walled, without prominent orifice, with a large nucleus. Specimens from *Dr. Blodgett* and *Mr. Ashmead.*

Page 105, add,

3. Nitophyllum *Fryeanum;* frond sessile, full-red, nerveless, thickish, deeply divided into many cuneate lobes, which are again vertically cleft, the segments rounded, frequently crisped at the margin, specially towards the base, the sinuses narrow ; fruit......?

Hab. Golden-gate, California, *Mr. A. D. Frye.* (v. s. in Herb. T.C.D.)

I propose this species with much hesitation, having as yet seen only very imperfect specimens, which I know not how to dispose of but by giving them a local habitation and name. Two specimens are before me ; one faded, the other in a better state of preservation, but neither in fruit. The frond is about 3 inches long, and 4 in lateral expansion, and is deeply divided into 4 or 5 principal segments which are broadly cuneate, and each again partially cloven into 4 or 5 lesser, vertical segments. The margin towards the base of the lobes is crisped or undulate ; in other parts it is plane. The lesser lobes are somewhat crenate or sub-lobulate, and all the tips are rounded, and the axils or sinuses very narrow. The substance of the membrane is thickish ; the surface-cells large and tessellated ; the cells of the interior appear also to be of large size, and quadrate, but the specimens examined have been too much squeezed in the process of drying, and their cells are consequently broken and difficult to examine. No traces of veins in the specimens seen. More perfect specimens must be had before this species can be considered as other than provisional.

Fragments of one or two other *Nitophylla* have reached me from the Pacific Coast, but not sufficiently perfect to warrant me in naming them.

Page 150, add,

5. Rhodymenia *corallina*, Grev. (?) ; stipes cylindrical, sub-simple, expanding into a fan-shaped, many times dichotomous, rose-red frond ; laciniæ linear, with rounded

interstices and a flat, entire margin ; apices rounded ; conceptacles clustered near the ends of the laciniæ, on the surface of the lamina ; tetraspores forming deep-red sori in the dilated apices. *J. Ag. Sp. Alg.* 2, *p.* 379. *Sphærococcus corallinus*, *Bory*, *Coq. p.* 175, *t.* 16. *Kütz. Sp. Alg. p.* 780.

HAB. San Diego, California, *Mr. A. D. Frye.* (v. s. in Herb. T.C.D.)

A single Californian specimen only has yet been seen, and I doubtfully refer it to *R. corallina*, in preference to founding a new species on such imperfect data. The frond is stipitate ; the stipes filiform, 2–3 inches long, then widening and passing into the cuneate base of a flabelliform, dichotomously parted lamina, with broadly linear or somewhat cuneate segments. The lower part of the stipes throws out 2 or 3 proliferous frondlets, and similar ones spring from the margin of the laciniæ. The *conceptacles* are immersed in the ultimate segments of the laciniæ, which then are truncated and foliiferous. The colour is a deep-red, and the substance rigid and membranaceous. Such is the Californian specimen, and it tolerably agrees with the Chilian species, whose character is given in the above diagnosis.

Page 175, add,

2* GIGARTINA *Chamissoi, (?)* Mont. ; *J. Ag. Sp. Alg.* 2, *p.* 267. *Sphærococcus Chamissoi*, *Ag. Ic. Med. t.* 6. *Mart. Ic. Sel. Bras. t.* 3, *fig.* 1.

HAB. West Coast, *Dr. Schott.*

A fragment of a *Gigartina*, closely allied to *G. Chamissoi*, if not a mere form of it, occurs in Dr. Schott's new Mexican collection. It is too imperfect for description. *G. Chamissoi* is a common species on the coast of Peru, and may very probably extend to the north of the Equator.

Page 180, add,

6. IRIDÆA *dichotoma*, Harv.; stipes linear, compressed, simple or branched, passing into the cuneate base of the broadly cuneiform or obovate, repeatedly forked lamina ; laciniæ shallow and rounded, divaricating, their margin entire or denticulate ; surface smooth and glossy. *I. micans, var. dichotoma. Hook. f. and Harv. Fl. Ant.* 2, *p.* 487. *I. dichotoma*, *Harv. in Hook. Journ.* 1845, *p.* 262.

HAB. California, *Mr. A. D. Frye.* (v. s.)

Stipes 1–2 inches long, about a line wide, throwing out 2–4 minutely stipitate fronds, which are 4–6 inches long, and 3–4 wide, at their greatest width. The base of the frond is cuneate, and the lobes into which it divides are also broadly cuneiform. They divaricate from each other, leaving very wide sinuses between. The frond is thus sometimes thrice forked, the last furcation being minute, and frequently a mere indentation. The substance is rather thin and membranous. The surface is smooth and glossy, and the colour a fine purple-red.

Whether a distinct species or a mere variety of *I. micans* remains to be shewn, when some competent observer on the Pacific Coast shall have properly examined the several reputed species of this most troublesome genus. If we admit more than *one* species it is difficult to refuse admission to many, the forms are so varied. The present is, at least, a well-marked *variety*.

Page 195, add,

4. HALOSACCION *dumontioides ;* stem short, filiform, emitting many crowded, tubular, membranaceous, long branches, which are quite simple, destitute of ramenta, and taper much to the base and apex.

HAB. Northumberland Sound, Queen's Channel, lat. 76° N., *Dr. Lyall.* (v. s. in Herb. T.C.D.)

Stem 1–3 inches long, simple or forked, filiform, about twice as thick as hog's bristle, emitting throughout its length, and directed towards all sides, numerous crowded, perfectly simple branches. *Branches* two feet long, more than quarter inch wide in the middle, cylindrical for their greater extent, but attenuated and fusiform to the base, and tapering at the extremity to an acute point, hollow, destitute of ramenta, smooth and glossy, formed of a very thin membrane. *Colour* a brownish pinky-red, partly discharged in fresh water. *Cellular* structure very dense.

I have some hesitation in proposing this as a species distinct from *H. ramentaceum* ; but if not a good species, it is at least a strongly marked variety, and has so much the external aspect of *Dumontia filiformis*, that until I had submitted a section to the microscope, I supposed I had before me a very luxuriant specimen of that plant. The microscopic structure of the membrane is that proper to *Halosaccion* (section *Halocœlia*), but is not easy to see, as the collapsed cells do not readily expand on reimmersion of the dried frond. The substance is much softer and more membranous than in *H. ramentaceum*, and in drying the branches adhere much more strongly to paper. Dr. Lyall brought home several fine specimens.

Page 242, add,

16.* CALLITHAMNION *tenue ;* filaments tufted, ultra-capillary, irregularly much branched, diffuse, flexuous, the branches and their divisions very generally secund, springing from the middle of the internodes; ramuli few and distant, patent, filiform, beset toward the attenuated apices with whorls of minute, byssoid fibres ; articulations cylindrical, those of the branches 4–6 times, those of the ramuli 3-4 times as long as broad, and gradually shorter towards the extremities. *Griffithsia tenuis*, *Ag. Sp. Alg. p.* 13. *J. Ag. Sp. Alg.* 2, *p.* 84. *Kütz. Sp. Alg p.* 661.

HAB. Beesley's Point, New Jersey, *Mr. Samuel Ashmead.* (v. s. in Herb. T.C.D.)

Filaments 3–4 inches long, somewhat thicker than human hair, loosely tufted, flexuous, very irregularly branched, the ramification on a lateral, not a dichotomous type. *Branches* usually secund, in some cases opposite or alternate, springing from the middle of the articulation (or internode), or from near its base (not from the shoulder), long and filiform, flexuous, furnished with several distant, secund, filiform, patent, secondary branches, which are either simple, or furnished with a few similar, secund ramuli. All the branches and ramuli of every grade spring from the middle of the internodes of the branches of the preceding grade. The ramuli taper to their summit; the last six or eight internodes are very short, or rather are gradually developed whilst the ramulus lengthens, and their nodes are beset, especially those of the younger ones, with whorls of minute and very delicate byssoid ramelli, which seem to be connected with the growing process; but perhaps may also accompany fructification, as they do in the nearly allied *C. thyrsoideum.* The articulations are cylindrical, 4–5 times as long as broad, with a wide, hyaline margin and dissepiment, and are filled with rosy endochrome. *Substance* membranaceous and delicate. The frond closely adheres to paper in drying.

I have compared Mr. Ashmead's specimens with an authentic one of Agardh's *Griffithsia tenuis* from the Mediterranean, and find them to agree in every essential character; the only difference that I can perceive being, that the American specimens are larger and more luxuriant than the European. The fructification has not been observed either in America or Europe, and I may therefore be accused of indiscretion in removing this species from *Griffithsia* to the present genus. I do so because its affinity with *C. thyrsoideum* of Ceylon and Australia is so great that they cannot be placed in separate genera; and the fruit of the latter is known. I only question whether I ought not to go a step further, and unite *C. thyrsoideum* to *C. tenue* as a mere variety. Both are remarkable for the manner in which the branches and ramuli are inserted; and may be known by this character alone from all allied species. But there is no American species to which the present is nearly allied.

Page 247, under Pikea californica, add to the specific diagnosis,

(Tab. XLIX. B.)

And insert the following reference to the figure,

Plate XLIX. B. *Fig.* 1. Pikea *californica*, a robust specimen; and *fig.* 2, a more slender and smaller individual; both of the *natural size. Fig.* 3. Longitudinal section of the frond, showing the central, articulated axial filament, and the two strata of cells. *Fig.* 4, a transverse section of the frond; these two figures equally *magnified.*

No. 2. List of Arctic Algæ, chiefly compiled from collections brought home by Officers of the recent Searching Expeditions.

1. FUCUS *vesiculosus*, Linn. *Ner. Bor. Amer. part* 1, *p.* 71.
HAB. Common along the Arctic Seas, and continuing through Behring's Straits along the North-west Coast. Whalefish Islands, and north end of Disco, *Dr. Lyall.*

2. FUCUS *nodosus*, Linn. *Ner. Bor. Amer. part* 1, *p.* 68.
HAB. North end of Isle of Disco, *Dr. Lyall.*

3. AGARUM *Turneri*, Post. & Rup. *Ner Bor. Amer. part* 1, *p.* 95.
HAB. Navy-board Inlet and Whalfish Islands, *Dr. Lyall.*

4. LAMINARIA *saccharina*, Lamour. *Ner. Bor. Amer. part* 1, *p.* 92.
HAB. Floating off the West Coast of Greenland, five miles from shore, in lat. 63, *Dr. Lyall.*

5. ALARIA *Pylaii*, Grev. *Ner. Bor. Amer. part* 1, *p.* 89.
HAB. Northumberland Sound, Queen's Channel, Lat. 76°. 52′, *Dr. Lyall.*

6. DESMARESTIA *aculeata*, Lamour. *Ner. Bor. Amer. part* 1, *p.* 78.
HAB. Dredged in 6 fathoms, in Queen's Channel, lat. 76° 29′, long 96° 13′ W., *Dr. Lyall.*

7. DICTYOSIPHON *fœniculaceus*, Grev. *Ner. Bor. Amer. part* 1, *p.* 114.
HAB. Whalefish Islands, *Dr. Lyall.*

8. CHORDARIA *flagelliformis*, Ag. *Ner. Bor. Amer. part* 1, *p.* 123.
HAB. Whalefish Islands, *Dr. Lyall.*

9. CHÆTOPTERIS *plumosa*, Kütz. *Ner. Bor. Amer. part* 1, *p.* 136.
HAB. Arctic Coast, *Dr. Seeman.* Roots of large Algæ, floating near Whalefish Islands, *Dr. Lyall.*

10. SPHACELARIA *arctica*, Harv. *Ner. Bor. Amer. part* 3, *suppl. p.* 124.
HAB. Isle of Disco, *Dr. Lyall.*

11. ECTOCARPUS *fasciculatus*, Harv. *Ner. Bor. Amer. part* 1, *p.* 141.
HAB. Whalefish Islands, *Dr. Lyall.*

12. ECTOCARPUS *littoralis*, Lyngb. *Ner. Bor. Amer. part* 1, *p.* 139.
HAB. Whalefish Islands, *Dr. Lyall.*

13. Rhodomela *lycopodioides*, Ag. *Ner. Bor. Amer. part* 3, *suppl. p.* 126.
Hab. Cast ashore on Disco and Whalefish Islands, *Dr. Lyall.*

14. Rhodomela *gracilis*, Kütz. *Ner. Bor. Amer. part* 2, *p.* 26.
Hab. In rock-pools. Disco and Whalefish Islands, *Dr. Lyall.*

15. Polysiphonia *urceolata*, Grev. *Ner. Bor. Amer. part* 2, *p.* 31.
Hab. Dredged in 10 fathoms, off Cape Cockburn, 75° N. 100° W., *Capt. M'Clintock.*

16. Corallina *officinalis*, L. *Ner. Bor. Amer. part* 2, *p.* 83.
Hab. Lively Harbour, Isle of Disco, *Dr. Lyall.*

17. Delesseria *sinuosa*, Ag. *Ner. Bor. Amer. part* 2, *p.* 93.
Hab. Off the Greenland Coast, *Dr. Lyall.* North Shore of Prince of Wales' Strait, *Sir R. McClure.* Cape Cockburn 75°, and Lowther Island 74°, *Capt. McClintock.*

18. Euthora *cristata*, J. Ag. *Ner. Bor. Amer. part* 2, *p.* 150.
Hab. Disco Island, *Dr. Lyall.*

19. Rhodymenia *interrupta*, Grev. *Ner. Bor. Amer. part* 2, *p.* 149.
Hab. Arctic Sea, *Lieut. W. H. Griffiths, R.N.*

20. Rhodymenia *palmata*, Grev. *Ner. Bor. Amer. part* 2, *p.* 148.
Hab. Queen's Channel, Northumberland Sound, 76° 52′ N., *Dr. Lyall.*

21. Halosaccion *ramentaceum*, J. Ag. *Ner. Bor. Amer. part* 2, *p.* 194.
Hab. Whalefish and Disco Islands, and in Queen's Channel, *Dr. Lyall.*

22. Halosaccion *dumontioides*, Harv. *Ner. Bor. Amer. part* 2, *supp. p.* 130.
Hab. Northumberland Sound, Lat. 76° N., *Dr. Lyall.*

23. Kallymenia *Pennyi*, Dickie. *Ner. Bor. Amer.* 2, *p.* 172.
Hab. Dredged in 15–20 fathoms in Assistance Bay, *Dr. Sutherland.* Dredged in 6 fathoms, Queen's Channel, Lat. 76° 29′ N., Long. 96° 13′, *Dr. Lyall.*

24. Ptilota *serrata*, Kütz. *Ner. Bor. Amer.* 2, *p.* 222.
Hab. Arctic Coast, *Sir J. Richardson.* Whalefish Islands and West Coast of Greenland, *Dr. Lyall.*

25. Ptilota *plumosa*, Ag. *Ner. Bor. Amer.* 2, *p.* 224.
Hab. Arctic Sea Coast, *Sir J. Richardson.*

26. Cladophora *arcta*, Kütz. *Ner. Bor. Amer.* 3, *p.* 75.
Hab. Whalefish Island, Davis's Straits, *Dr. Lyall.*

27. Cladophora *rupestris*, Kütz. *Ner. Bor. Amer.* 3, *p.* 74.
Hab. Whalefish Islands, Davis's Straits, *Dr. Lyall.* Fiskernaes, near Cape Farewell, *Dr. Sutherland.*

28. Chætomorpha *Melagonium*, Kütz. *Ner. Bor. Amer.* 3, *p.* 85.
Hab. Roots of large Algæ, Whalefish Islands, *Dr. Lyall.*

29. Chætomorpha *Piquotiana*, Mont. *Ner. Bor. Amer.* 3, *p.* 85.
Hab. Floating in the sea, near Whalefish Islands, Davis's Straits, *Dr. Lyall.* (A single filament only !)

30. Hormotrichum *Carmichaelii*, Harv. *Ner. Bor. Amer.* 3, *p.* 90.
Hab. Wellington Channell, *Dr. Lyall.*

31. Hormotrichum *boreale*, Harv. *Ner. Bor. Amer.* 3, *p.* 90.
Hab. Whalefish Islands, *Dr. Lyall.*

32. Hormotrichum *Wormskioldii*, Kütz. *Ner. Bor. Amer.* 3, *p.* 91.
Hab. Dredged in 6 fathoms, in Queen's Channel, 76° 29′ N., 96° 13′ W., *Dr. Lyall.* Coast of Greenland, *Lyngbye.*

33. Mougeotia *(species innominata.)*
Hab. In fresh water. Isle of Disco, *Dr. Lyall.*

34. Lyngbya *muralis*, var. *aquatica.* *Ner. Bor. Amer.* 3, *p.* 104.
Hab. In pools of fresh water, Whalefish Islands, *Dr. Lyall.*

35. Ulva *latissima*, L. *Ner. Bor. Amer.* 3, *p.* 59.
Hab. Isle of Disco, and dredged in Queen's Channel, *Dr. Lyall.*

36. Ulva *bullosa*, L. *Ner. Bor. Amer.* 3. *p.* 60.
Hab. In pools of fresh water, Whalefish Islands, *Dr. Lyall.*

37. Enteromorpha *intestinalis*, Link. *Ner. Bor. Amer.* 3 *p.* 57.
Hab. Whalefish Island, *Dr. Lyall.* (Probably universally spread.)

38. Oscillatoria *corium*, Ag. *Harv. Man. Ed.* 1 *p.* 166.
Hab. On stones in a running stream. Wellington Channel, *Dr. Lyall.*

39. Nostoc *arcticum*, Berk. *Ner. Bor. Amer.* 3, *p.* 113.
Hab. Assistance Bay, lat. 75° 40′ N., *Dr. Sutherland.*

40. Nostoc *verrucosum*, Vauch. *Ner. Bor. Amer.* 3, *p.* 114.
Hab. Pools of fresh water, Isle of Disco, and at Beechey Islands, *Dr. Lyall.*

41. Nostoc *Sutherlandi*, Dickie. *Ner. Bor. Amer.* 3, *p.* 114.
Hab. Winter quarters, Baffin's Bay, *Dr. Sutherland.*

42. Nostoc *microscopicum*, Carm. *Ner. Bor. Amer.* 3, *p.* 115.
Hab. Baffin's Bay, *Dr. Sutherland.*

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[The systematic names in capitals are those which are adopted. The names in italic indicate synonyms, whilst the vulgar names are in roman. The asterisks refer to the page of description.]

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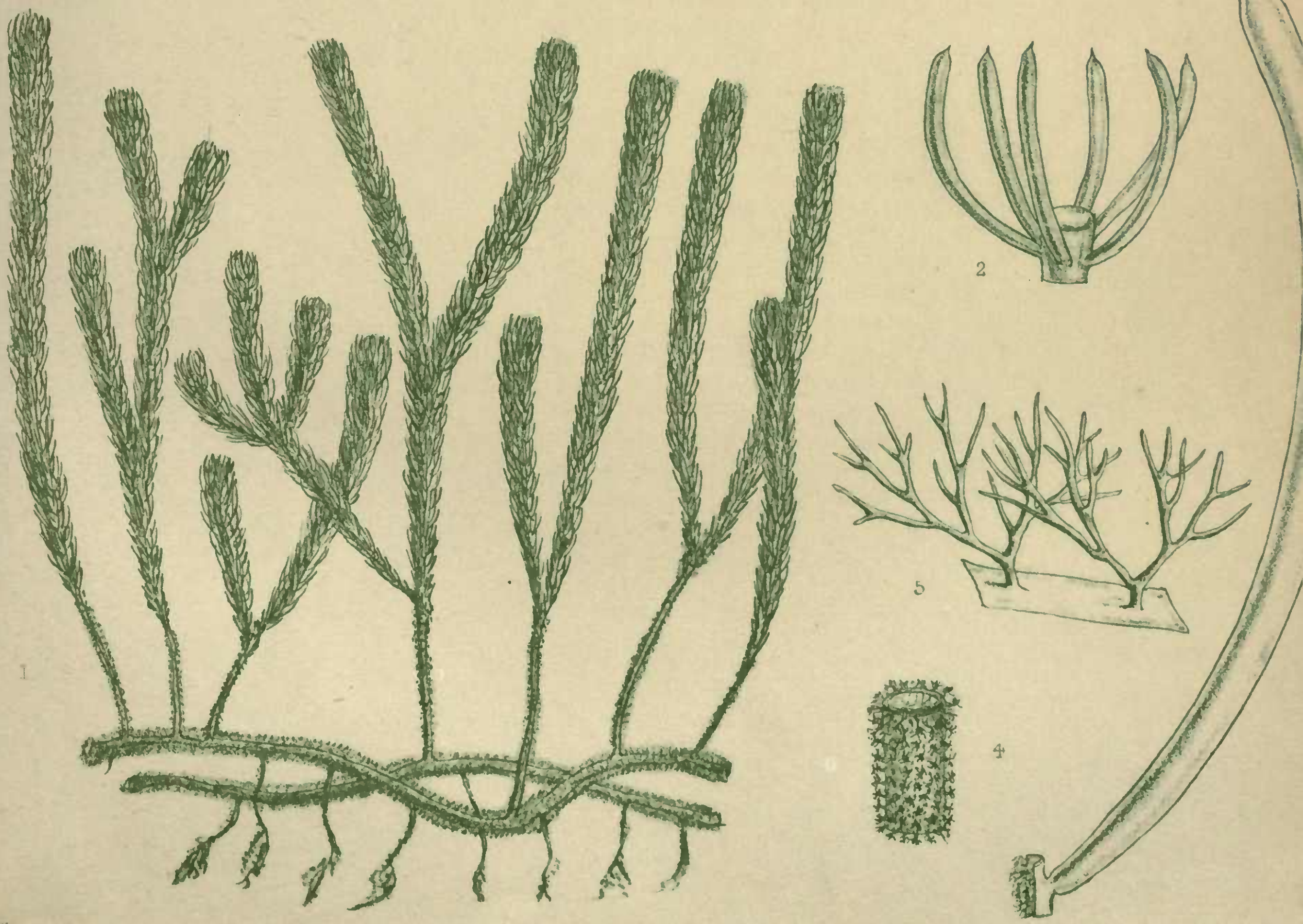

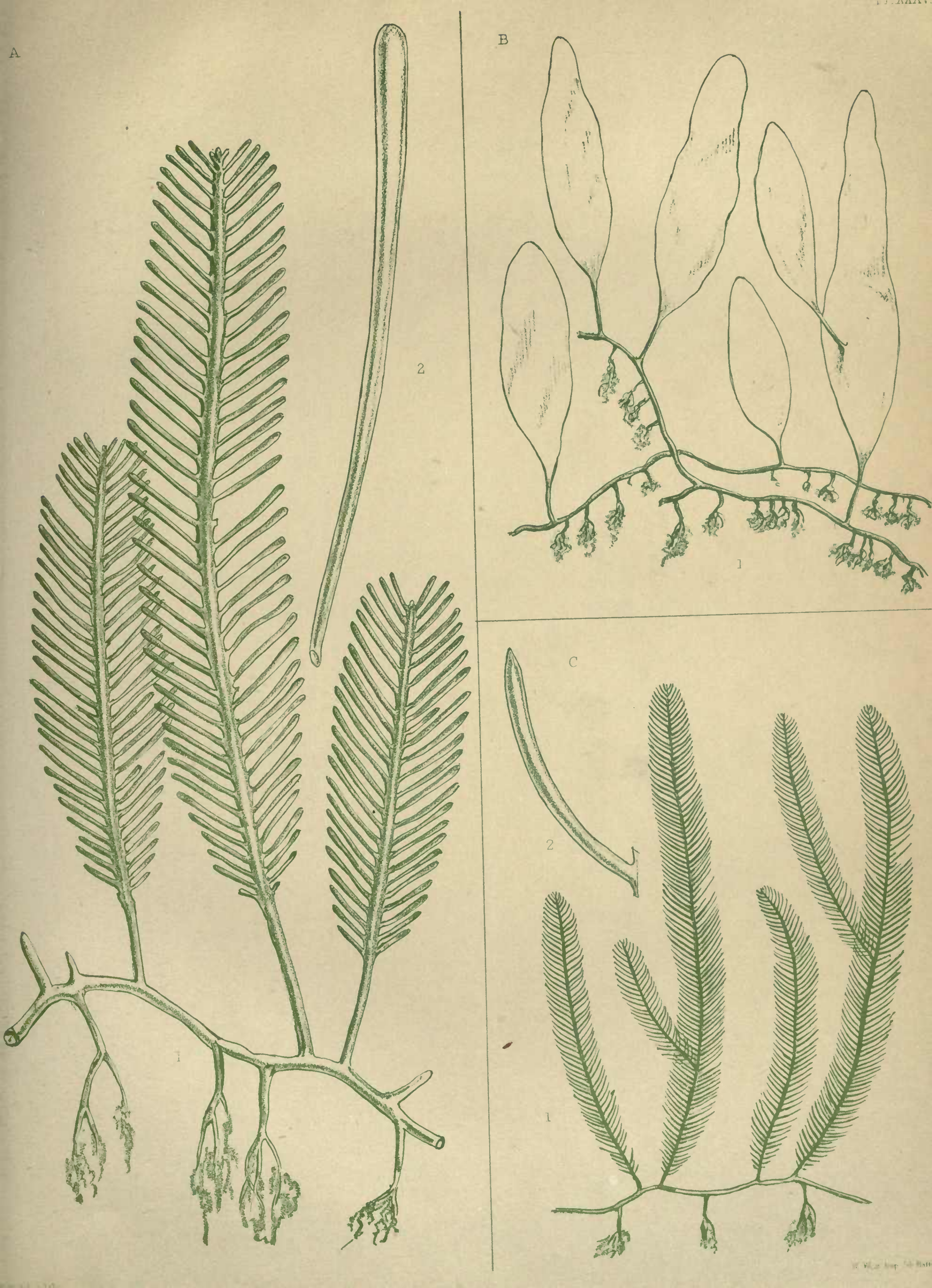
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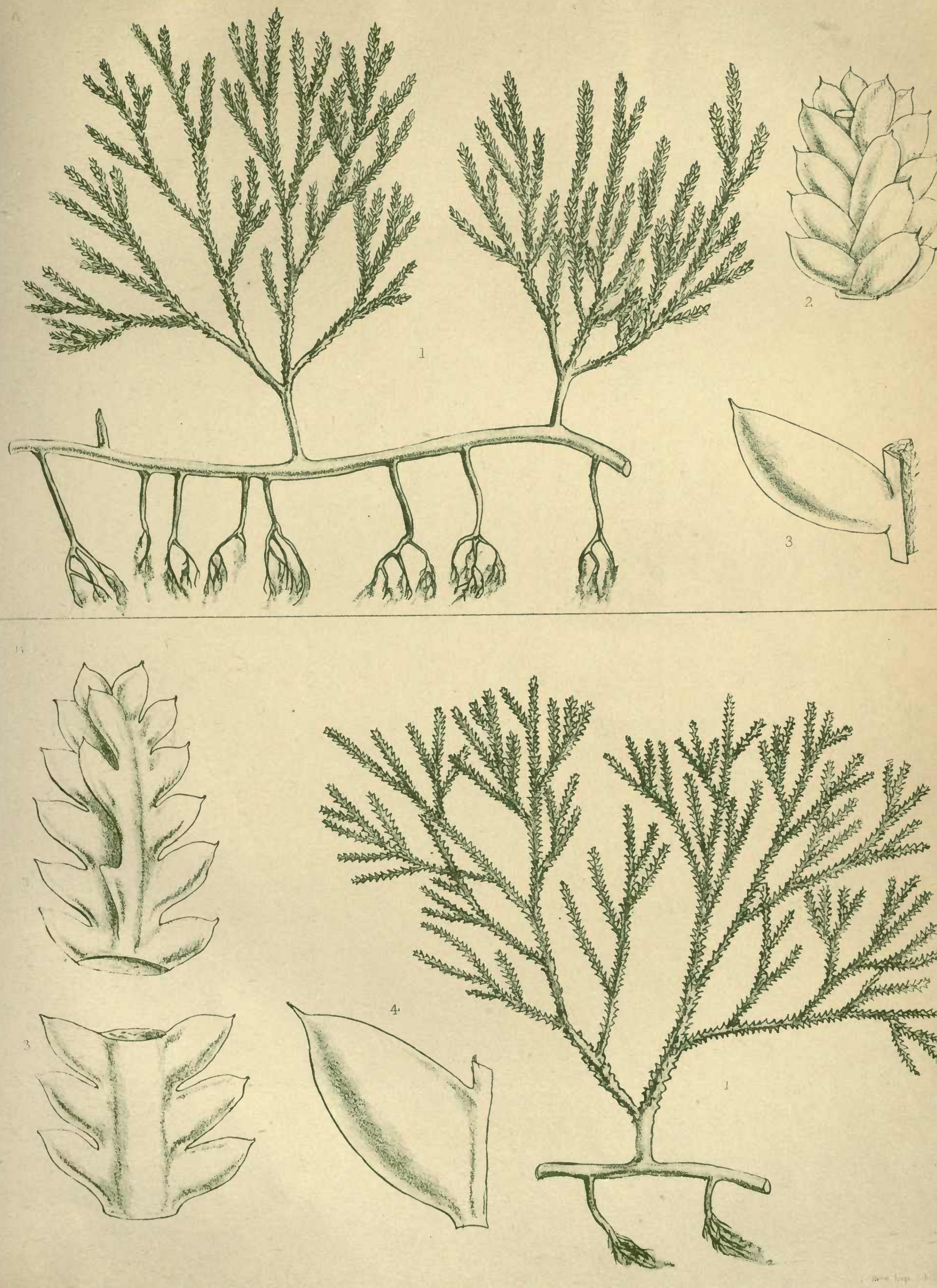
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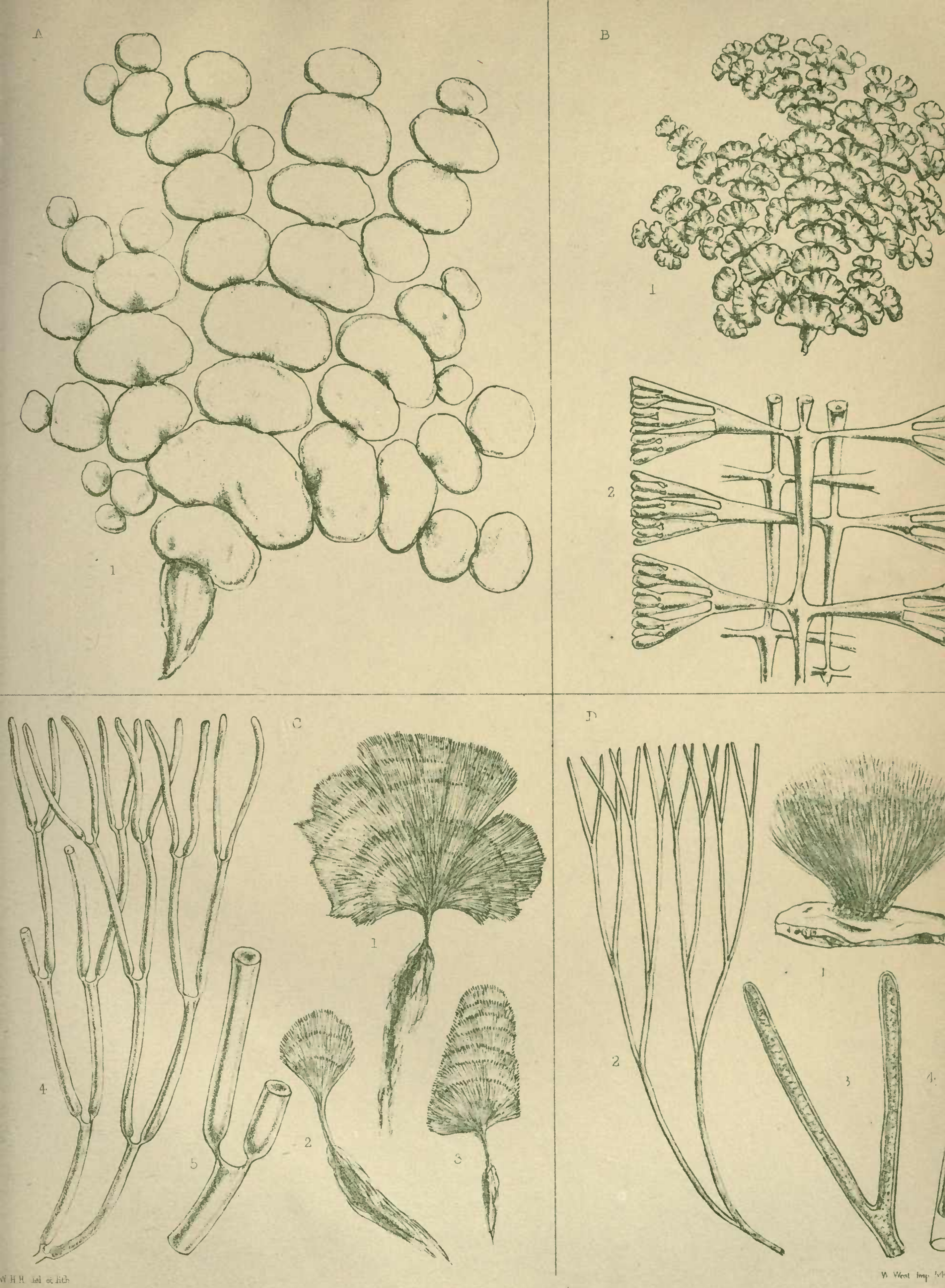

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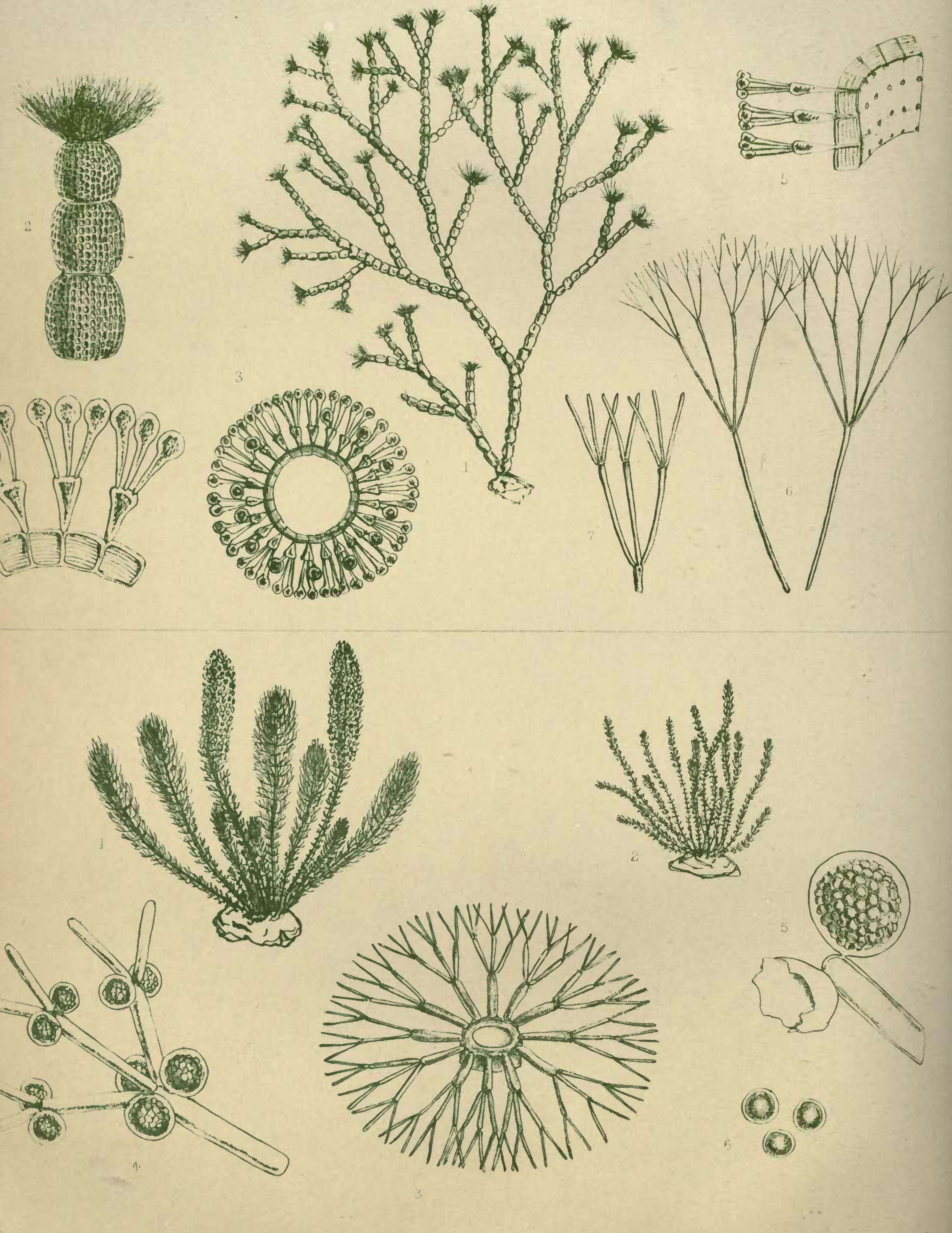

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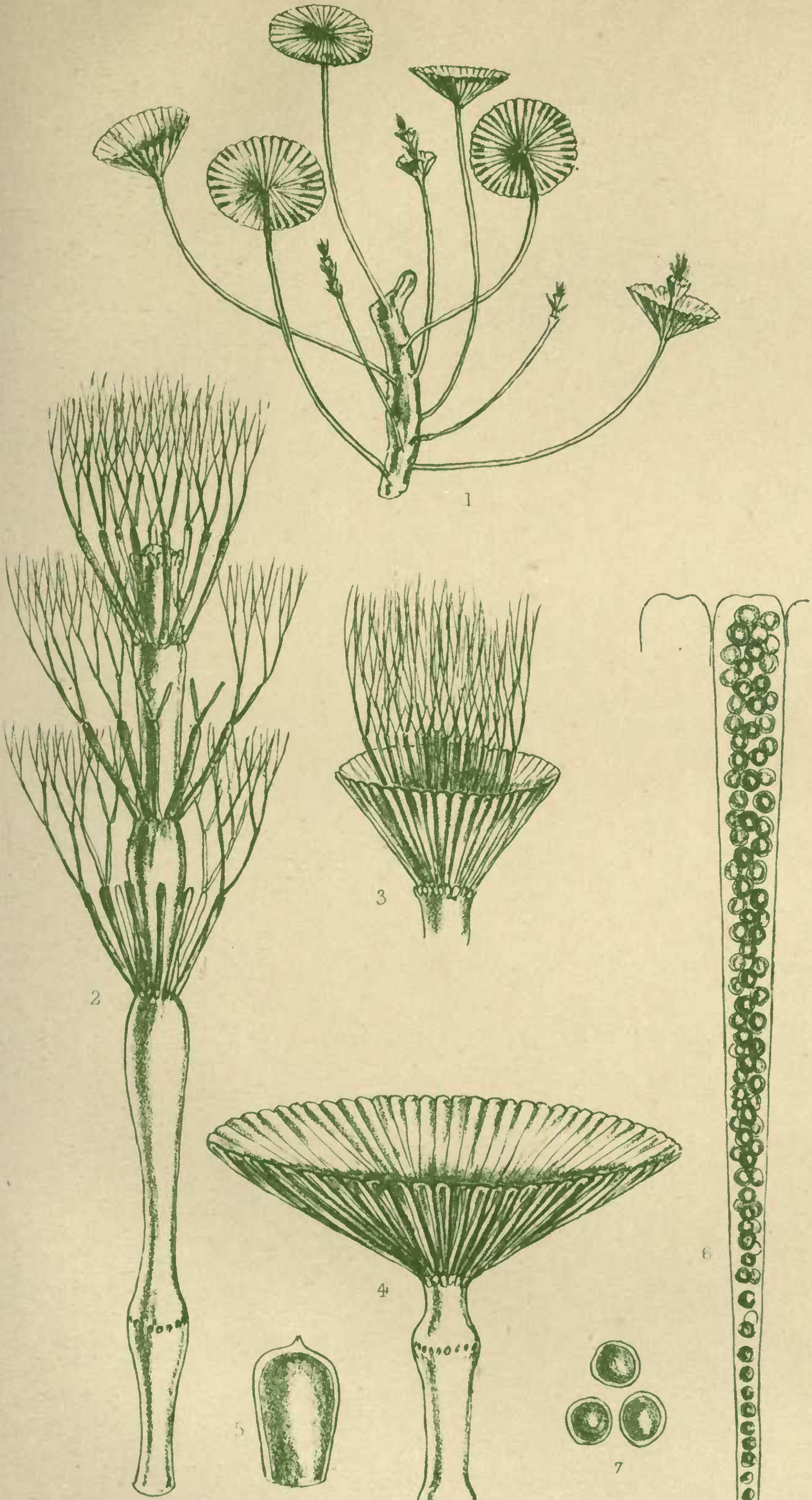

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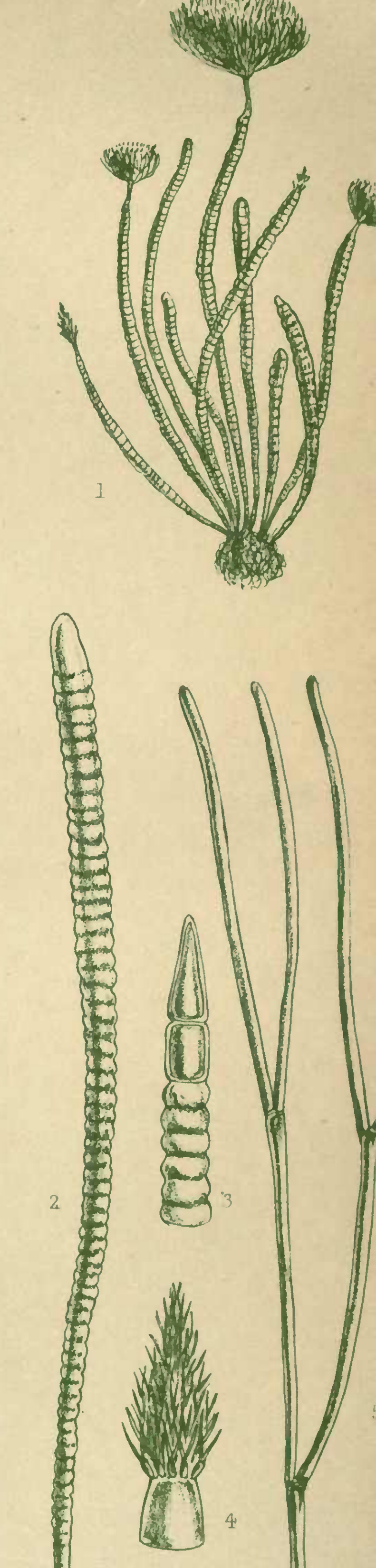

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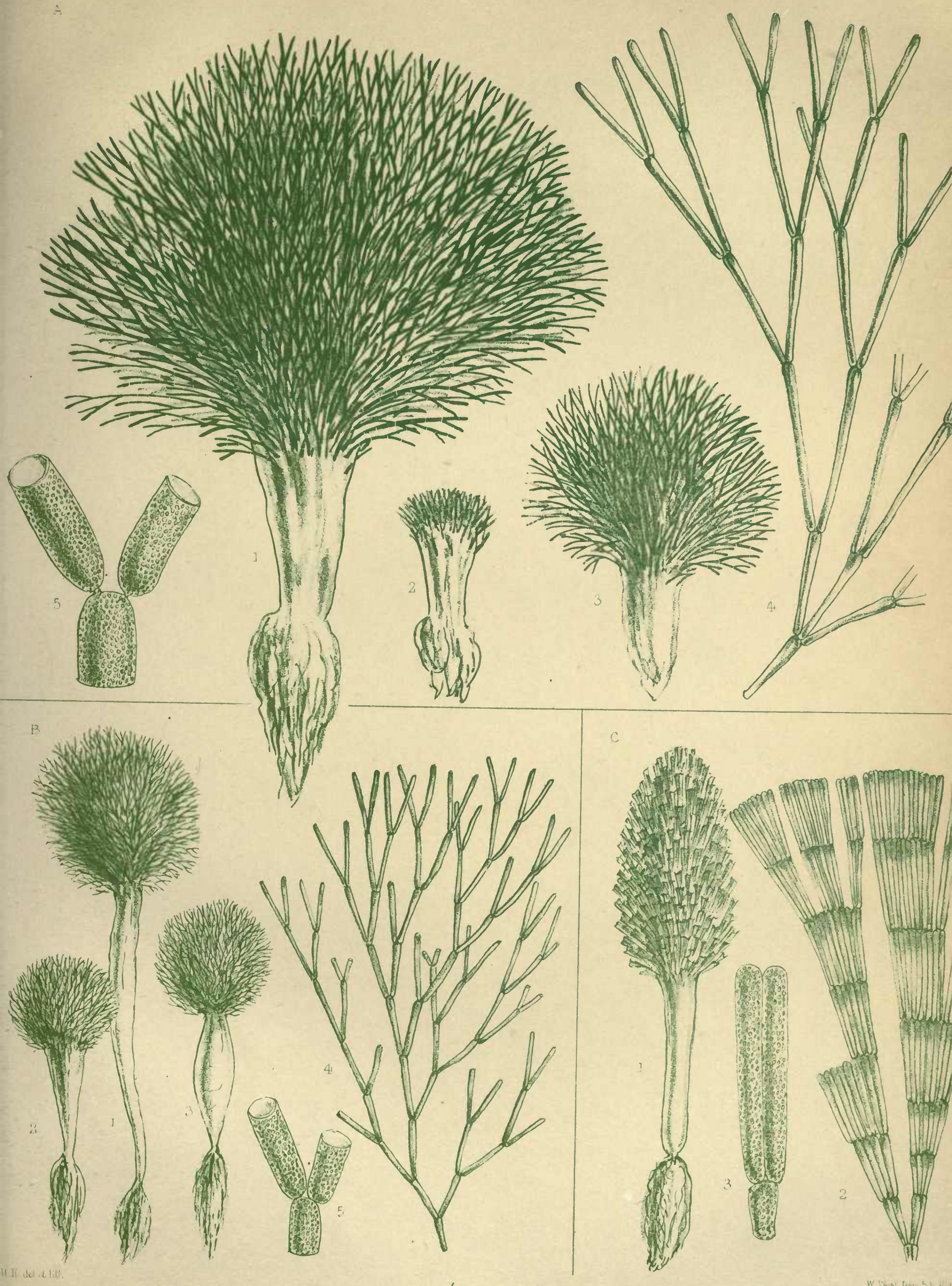

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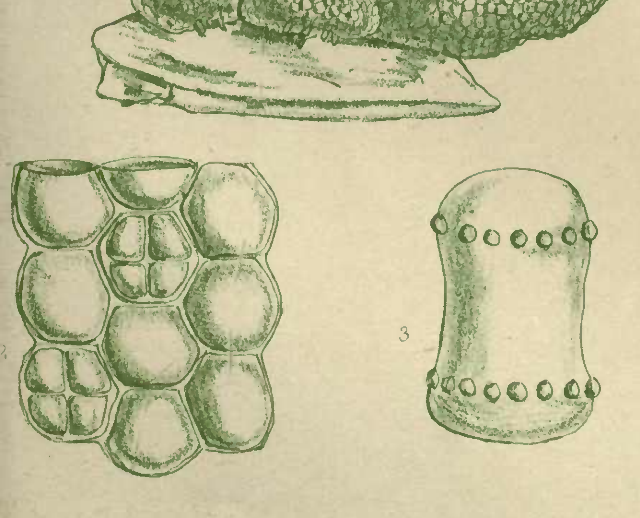

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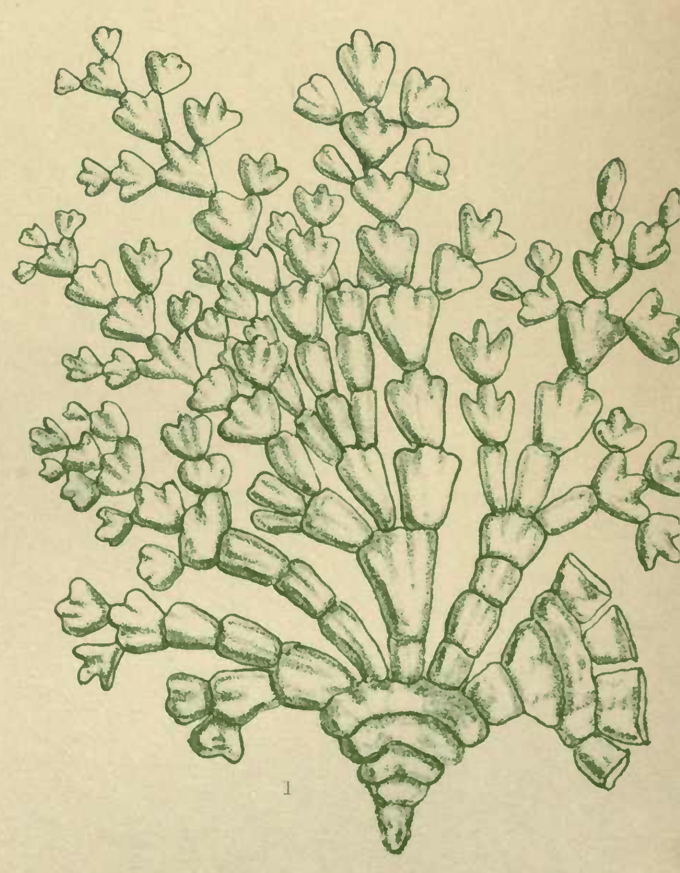

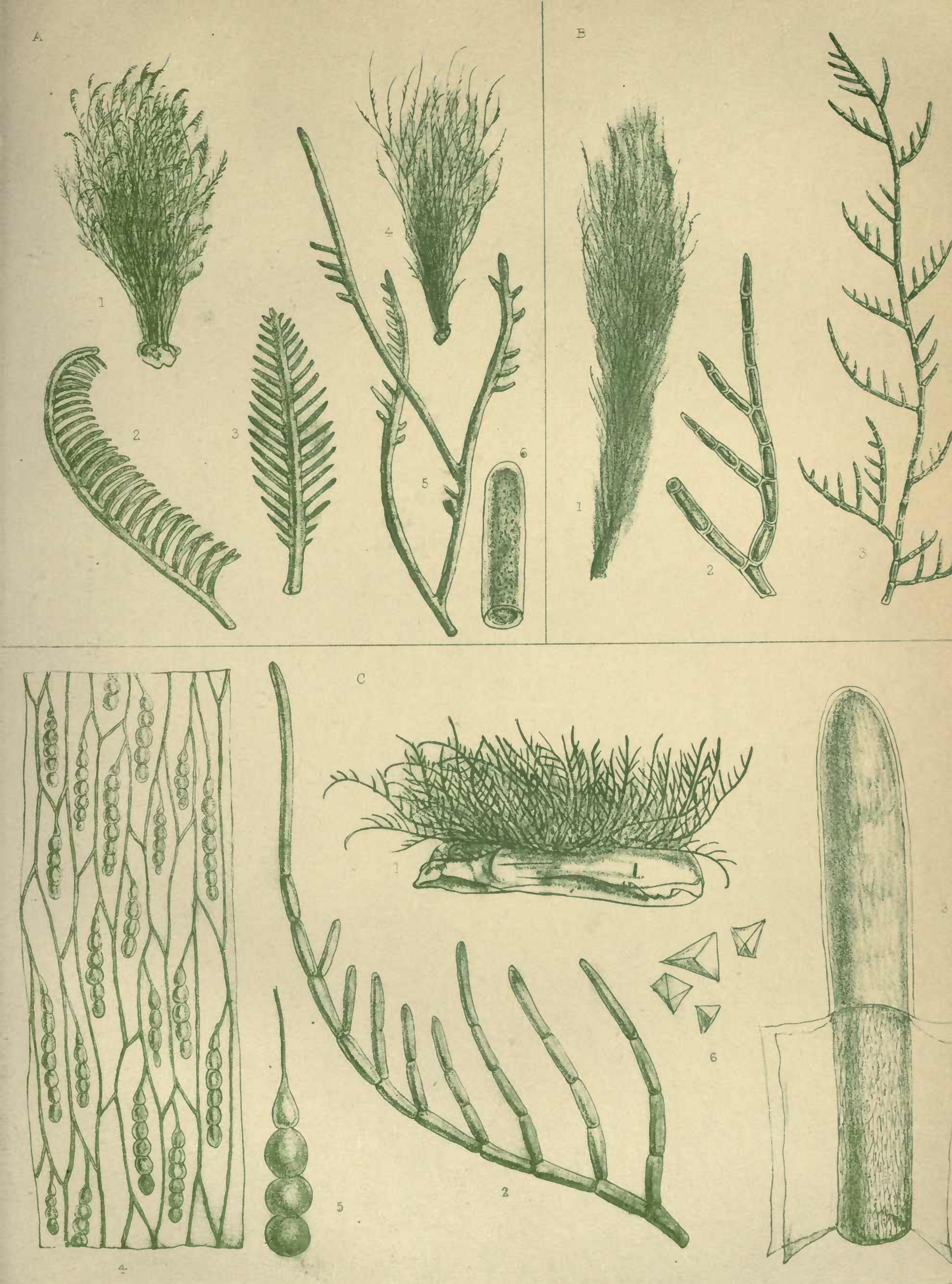

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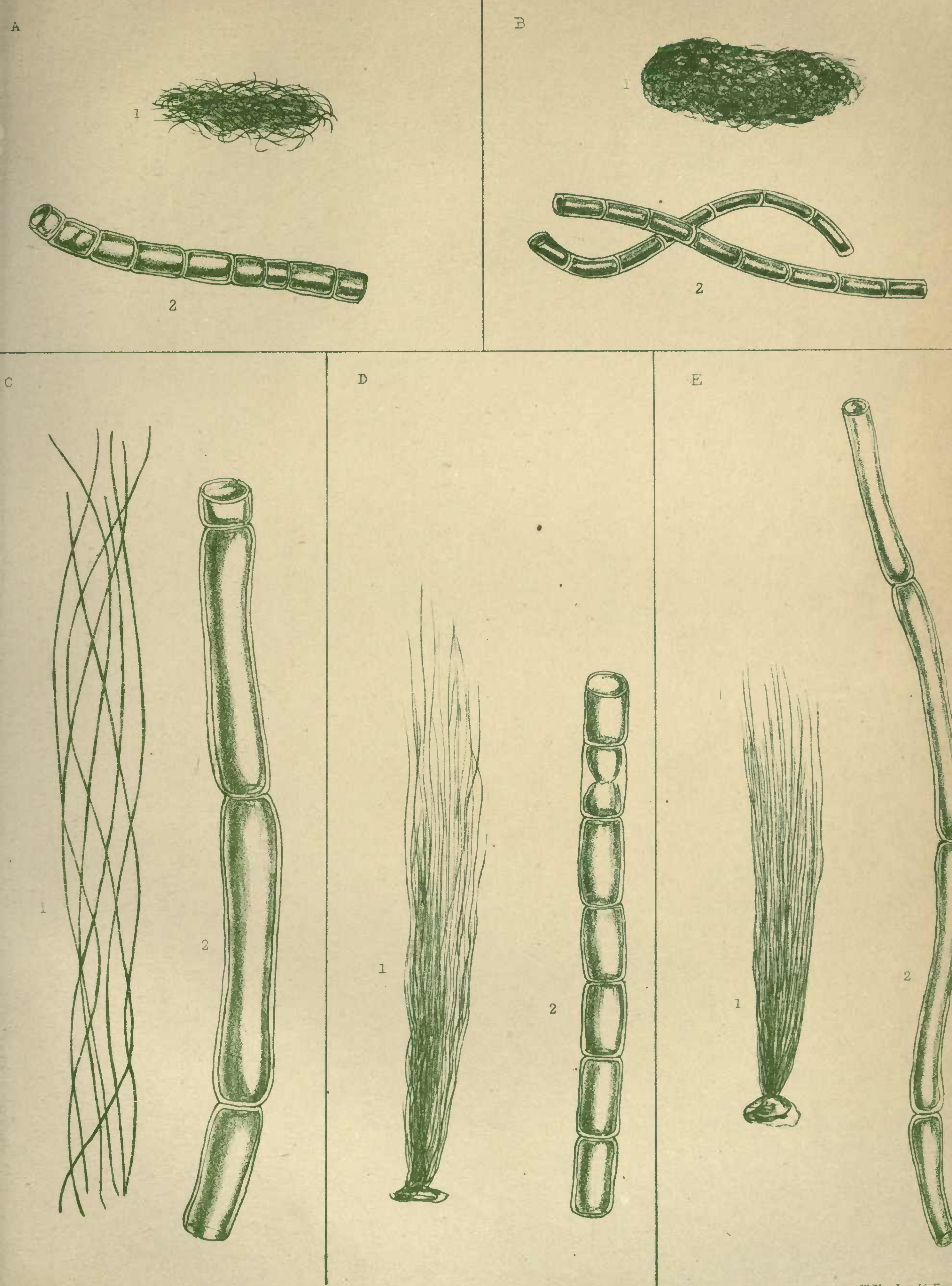

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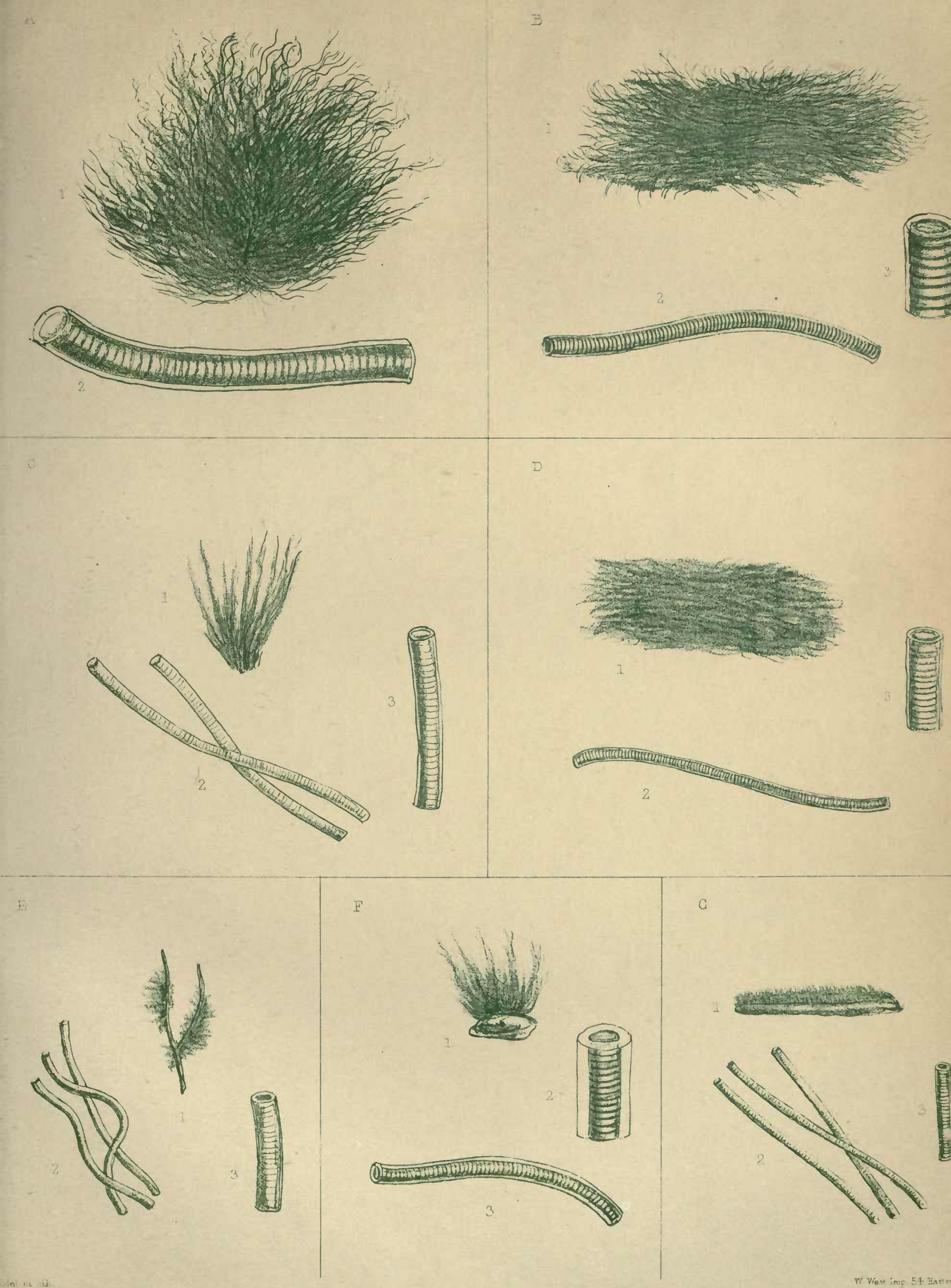

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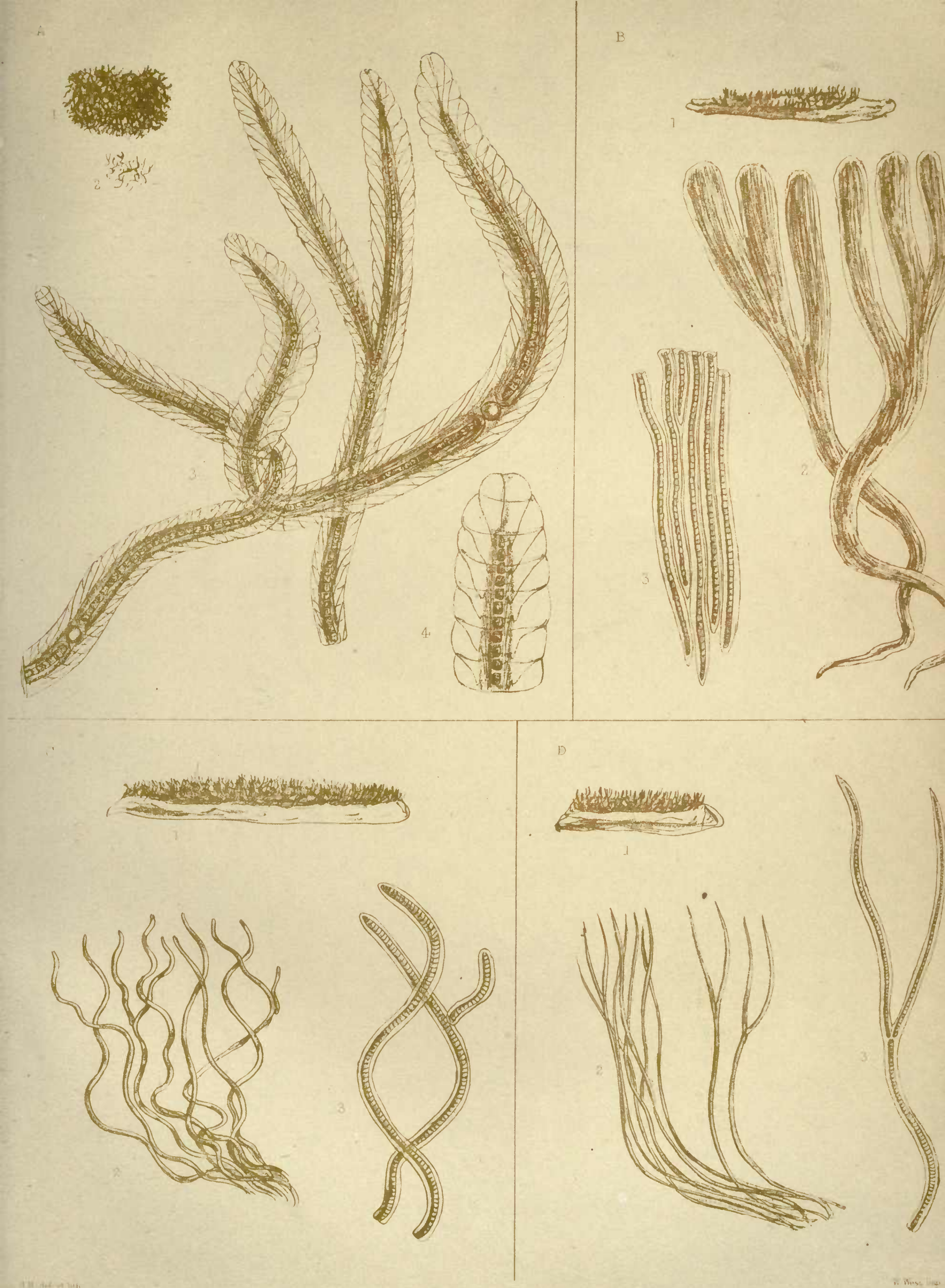
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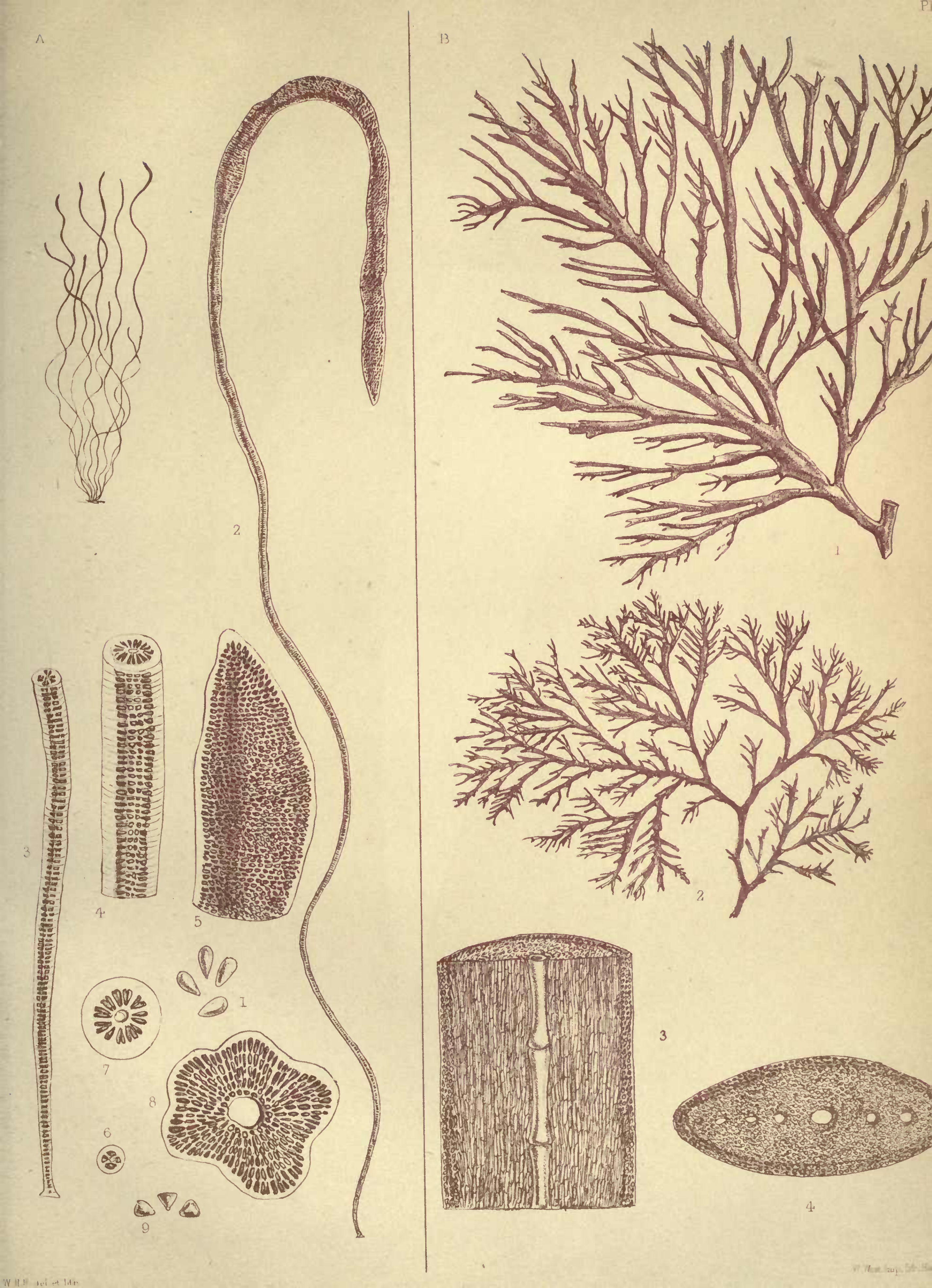
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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

MAGNETICAL OBSERVATIONS

IN THE

ARCTIC SEAS.

BY

ELISHA KENT KANE, M.D., U.S.N.

MADE DURING THE SECOND GRINNELL EXPEDITION IN SEARCH OF SIR JOHN FRANKLIN, IN 1853, 1854, AND 1855, AT VAN RENSSELAER HARBOR, AND OTHER POINTS ON THE WEST COAST OF GREENLAND.

REDUCED AND DISCUSSED,

BY

CHARLES A. SCHOTT,
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CONTENTS.

INTRODUCTORY LETTER.

WASHINGTON, *May* 17, 1858.

PROFESSOR JOSEPH HENRY, LL.D.,

Secretary of the Smithsonian Institution:

DEAR SIR: The records of the magnetic observations made under the direction of Dr. Kane, in the second expedition to the Arctic regions, were placed in my hands by his late lamented father, Judge Kane, in December last.

Dr. Kane had selected Assistant Charles A. Schott, of the Coast Survey, for the reduction of a considerable portion of the observations made in that expedition; and I, therefore, placed these in Mr. Schott's possession for reduction and discussion. The work has been faithfully performed, and I recommend it for publication in the "Smithsonian Contributions to Knowledge." It is proper to state that the instruments were furnished by the Coast Survey and the Smithsonian Institution, and that the computations have been made at the expense of the latter.

Very respectfully, yours,

A. D. BACHE.

SECTION I.

MAGNETIC DECLINATION.

1854.

COMMENTS AND ADJUSTMENTS.

Instruments.—The observations for diurnal inequality as well as those for absolute declination, were made with a Jones unifilar magnetometer (No. 3), kindly loaned by Prof. A. D. Bache, Superintendent U. S. Coast Survey. The azimuth circle reads to 20″ and the centre division of the scale reads 280. The magnet was suspended by means of a silk thread 9½ inches in length. Several trials to determine the effect of torsion gave such small quantities that it was not considered necessary to take the same into account. The instrument was not originally intended to give absolute declinations, but at the Winter Quarters the observer succeeded in obtaining a few values for absolute declination by detaching the box, containing the magnet, from the circle which bears the telescope. The same was then moved in azimuth until a well defined object within the small range of its vertical motion could be observed. The focus of the telescope was adjusted to the distance. We find the instrument "perched on a pedestal of frozen gravel," the contents of two barrels. This mounting was considered as stable as the rock underneath. On the 9th of June, 1854, Mr. Sonntag examined the instrument in reference to local disturbance, and found no sensible deviation arising from such a source. "The local deviation seems to have corrected itself; the iron in our comfortless little cell seems to have been so distributed that our results were not affected by it." (Narrative, vol. I.) The adjustments were made according to Riddel's magnetical instructions. The mirror attached to the suspended magnet faces the magnetic north. The following are the determinations for the angular value of a scale division:—

Circle.	Scale.	Circle.	Scale.	
Readings; January 13, 1854.		Winter Quarters, Van Rensselaer Harbor.		
120° 60′-58′	$45^d.5$	118° 11′-07′	$253^d.0$	Taking alternate means, we obtain from each set the values:— $1^d = 0'.797$.
120 16—14	100.7	117 34—30	303.0	
120 16—14	92,5	117 34—30	303.2	
119 30—27	153.5	116 49—46	351.0	
119 30—27	148.0	116 49—46	354.5	
118 48—45	199.0	116 13—10	394.0	
118 48—45	201.0	116 05—00	405.5	
118 11—07	250.5	115 31—29	451.0	

Circle.	Scale.	Circle.	Scale.	
Readings; January 16, 1854.				(Dr. Hayes, observer.)
119° 31′-31′	452^d	121° 53′-55′	256^d	$1^d = 0'.741$.
120 48—46	350	123 19—18	150	
120 48—46	353	123 19—18	149	
122 09—06	251	124 42—40	42	
Readings; February 16, 1854.				
127° 04′-04′	62^d.5	121° 34′-34′	453^d.0	$1^d = 0'.839$.
125 55—56	153.0	122 55—56	356.0	
125 55—56	136.0	122 55—56	360.0	
124 18—17	257.0	124 23—24	249.0	
124 18—17	259.7	124 23—24	254.0	
123 00—00	355.0	125 47—47	150.0	
123 00—00	354.5	125 47—47	145.5	
121 34—34	463.0	127 05—05	42.0	

Value resulting, equal mean of all or one division of scale = 0′.804.
Value adopted = 0′.80.

An $\left\{\begin{matrix}\text{increase}\\ \text{decrease}\end{matrix}\right\}$ of scale readings indicates a movement of the north end of the magnet to the $\left\{\begin{matrix}\text{east}\\ \text{west}\end{matrix}\right\}$.

A well rated pocket chronometer, nearly showing Greenwich mean time, was used for noting the time.

Diurnal Variation.—The observations for changes of magnetic declination were made during the months of January, February, and March, 1854, at the following dates:—

January	10–11	and	February	10–11
"	13–14	"	"	14–15
"	24–25	"	"	17–18
"	27–28	"	"	21–22
"	31–32	"	"	28–29
February	3–4	"	March	3–4
"	7–8	"	"	7–8

To these must be added the term days during the same period of the year, viz: January 18–19, February 24–25, and March 22–23. The remaining three terms in April, May, and June, of the same year, furnish values of the change of the diurnal inequality at a later season. Readings (the mean of two extremes during a vibration when the magnet was in motion) were taken every sixth minute, commencing, with but one exception, between 4 and 5 o'clock in the afternoon. The error of the chronometer has been applied and the time in the abstracts is given in local mean (astronomical) time. The readings are, as stated above, uncorrected for torsion, and are expressed in scale divisions. In regard to the observers, Dr. Kane remarks in his narrative: "It was not until the close of the winter that I was able to take my share in the preceding (the observations for variation) or the term-day observations; and I desire to express my obligations to Dr. Hayes and

Mr. Bonsal, as well as to George Stephenson, for their zealous and intelligent co-operation with Mr. Sonntag and myself." Each set of observations extends over twenty-four hours; they were taken nearly one minute earlier (between 56^s and 40^s) than indicated in the abstract. The general remark on page 435 of the second volume of the Narrative, "the scale reading 280 corresponds to a magnetic declination of 108° 3′ west, etc.," appears to leave no doubt that the instrument was left undisturbed, and there being no statement to the contrary, we can assume the hourly and daily means at the several days of observation to refer to the same zero or to be comparable amongst themselves. At a later period in June, 1854, the azimuth circle appears to have turned about 19 minutes.

Term-day Observations.—There were six in number. The observations commence at 10 P. M., mean Göttingen time, or about 4^h 37^m 34^s mean Fern Rock time, the difference of longitude being assumed to equal 5^h 22^m 26^s. The observations were not taken at the precise instant as indicated in the abstracts; the small deviation is noted at the head of each table.

Absolute Declination.—The expedition not being provided with a proper instrument, the magnetometer was temporarily converted into a declinometer by Mr. Sonntag, who determined the declination on June 9th, the 14th, and the 26th, 1854. The top of a mountain was used as a mark; it bore south 22° west (magnetic).

The mirror attached to the magnets can be inverted so that the mean reading of mirror direct and mirror reversed corresponds to the reading of the magnetic axis of the magnet.

Geographical Position of Observatory.—The latitude and longitude of the astronomical observatory has been determined as follows: Lat. 78° 37′.0 north, Long. 70° 40′ west of Greenwich. (See p. 305, vol. II. of the Narrative, also pp. 385 and 387 of the same volume.) The island (Observatory Island) on which the observatory (Fern Rock Observatory) was placed, was some fifty paces long by perhaps forty broad. (See p. 116, vol. I. of Narrative.) The magnetic observatory was adjoining; it was of stone, ten feet square, with a wooden floor as well as roof, and supplied with a copper fire grate. No iron was used in its construction.

The following is an extract of note 56, p. 464, of vol. I. of the Narrative: "The subjoined are given as aids to physical inquiry on the part of future travellers: Directions to sites of Rensselaer harbor. The observatory was placed upon the northernmost of the rocky group of islets that formed our harbor. It is seventy-six English feet from the highest and northernmost salient point of this island, in a direction S. 14° E., or in one with said point and the S. E. projection of the southernmost islet of the group. A natural face of gneiss rock formed the western wall of the observatory. A crevice in this rock has been filled with melted lead, in the centre of which is a copper bolt. Eight feet from this bolt, and in the direction indicated by the crevice, stood the magnetometer. This direction is given in case of local disturbance from the nature of the surrounding rocks."

The highest point of the island was about thirty feet above the mean tide level of the harbor. The observatory was known by the name of "Fern Rock Observatory."

Observations for Changes of the Magnetic Declination at Van Rensselaer Harbor, 1854.

Fern Rock Observatory, January 10 and 11, 1854.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
4^h	300^d	300^d	$299^d.3$	299^d	$295^d.5$	294^d	294^d	294^d	293^d	$291.^d5$	5^h	$296^d.0$
5	291	290.8	290.7	300	295.2	292.8	292	290.8	289	288.4	6	292.1
6	290.2	292	290.6	288	290	287.5	284	282.5	281	280	7	286.6
7	280	279	277	276	277.5	278	279.5	280	280.5	281	8	278.9
8	282	283	284	284	285	285	287	286	286	285	9	284.7
9	286	287	286	288	290	289	292	290	287	286	10	288.1
10	289	292	294	295	295	297.5	298	303	304	303	11	297.0
11	300.5	300	300	299	298	298	297	298.5	303	304	12	299.8
12	304	306	307	308	310	307.5	311	311.5	310	310.2	13	308.5
13	310	309	308.5	308.2	309.3	310	309.8	306	313	314	14	309.8
14	312	310	310	309	308	306	303.3	303.5	306	308	15	307.6
15	309.5	308	305.8	306	304.5	303	301.5	306	306	305	16	305.5
16	304	302	298	298	301	301	295	290	289	289	17	296.7
17	289	286	287	288	292	287	302	299	297	299	18	292.6
18	287	285	283	283	282	268	252	241	244	246	19	267.1
19	249	255	256	254	257	270	291	295	294	298	20	271.9
20	290	277	273	271	273	250	275	270	260	251	21	269.0
21	260	266	257	249	248	247	251	253	255.3	248.6	22	253.5
22	246.3	255	260	258	256.5	254	256.5	258.5	257	256	23	255.8
23	258	262	267.5	270	272	278.5	282.3	279.0	280	273.5	0	272.3
0	272	270	263	259	253	251	250	246	254	252	1	257.0
1	252	360	265	268	269	271	273	273	274	274	2	267.9
2	274	279	275	274	278	276	275	276	276	280	3	276.3
3	291	289	294	297	300	301	302	304	304	305	4	298.7
4	312	314	310	312	314							
											Mean	284.7

Fern Rock Observatory, January 13 and 14, 1854.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
								300^d	299^d	295^d	4^h	
4^h	302^d	304^d	308^d	311^d	314^d	317^d	315^d	313	316	319	5	$311^d.9$
5	317	314	311	313	315	319	322	328	335	337	6	321.1
6	339	340	336	331	326	330	328	316	329	335	7	331.0
7	340	338	344	346	348	343	342	342	345	349	8	343.7
8	350	364	371	371	368	366	358	356	350	349	9	360.3
9	344	338	334	329.5	329	327	330	336	342	342	10	335.1
10	339	339.5	335.5	340	347.5	350	349	348.7	350.2	354.8	11	345.4
11	354	352	350.8	353	351	347	343	343	344.8	342.8	12	348.1
12	341	342	343.8	344	343.5	343	342	340.5	340	341	13	342.1
13	341	342	343	347	346	346	347	357	352	348	14	346.9
14	355	352	354	356	352	348	345	344	346	349	15	350.1
15	350	351	352	358	362	371	377	378	374	372	16	364.5
16	370	368	371	374	374	374	371	365	359	358	17	368.4
17	352	352	346	341	339	330	328	325	324	320	18	335.7
18	321	323	330	335	345	347	337	330	293	295	19	325.6
19	295	292.5	288	280	260	263.5	269.5	274	269.8	272	20	276.4
20	274	284	254	263	257.7	266.5	272.5	270	267	285	21	269.4
21	295	297	285	271	272.8	276	271.5	270	266	266	22	277.0
22	265	264	265.5	267	269	270	270	269	266	264	23	267.0
23	261	267	274	275	277	269	262	250	246	242	0	262.3
0	212	218	224	231	242	252	252	255	264	273	1	242.3
1	276	277	278	278	278	276.5	276	277	282	289	2	278.8
2	290	287	288	288	292	301	311	310	305.8	309	3	298.2
3	306	299	296.5	297.5	299.5	300.5	307	318	319.5	315.5	4	305.9
4	315	319	316									
											Mean	317.0

Value of a division of the scale $0'.80$.

Increase of scale readings corresponds to a movement of the north end of the magnet to the east.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
Fern Rock Observatory, January 24 and 25, 1854.												
								305^{d}	305^{d}	305^{d}	4^{h}	
4^{h}	307^{d}.3	310^{d}	313^{d}	315^{d}	317^{d}	318^{d}	323^{d}	326	331	333	5	319^{d}.3
5	337	340	342	346	348	350	353	355	353.5	354	6	347.8
6	355	355	357	357	359	360	361.5	363	361	369	7	359.7
7	373	371	366	363	368	367	366	367	367	366	8	367.4
8	364	363	362	357	356	358	360	362	364	365	9	361.1
9	364	361	358	362	365	367	363	359	357	356.5	10	361.2
10	355	354	354.5	357	356	358	358.5	360.5	359	358.5	11	357.1
11	356.5	354	356	358.5	359	361	363	364	359	352	12	358.3
12	350	352	353.5	351.5	352	354	356	359.5	361	363	13	355.2
13	360	355	359	368	370	370	373	366	361	358	14	364.0
14	360	366	365	361	359	353	351	350.8	350	349	15	356.5
15	347	348	347	344	344	344.5	342	343	340	340	16	344.0
16	340	342	344	344	344	344	343	343	343	342	17	342.9
17	340	338	338	337	337	338	338	339	341	342	18	338.8
18	344	345	348	348	347	346	346	346	347	347	19	346.4
19	347	348	348	349	350.5	350	349.5	348	346	336	20	347.2
20	322	316	318	318.5	320	321	308	305	304	301	21	313.3
21	301.5	300.5	292	291	286	291.5	304	302	310	314	22	299.2
22	317	315	315	314	316	316	318	316	314	314	23	315.5
23	315	313	312	313	314	310	309	309	308	300	0	310.3
0	298	301	304	302	292	287	282	285	288	294	1	293.3
1	300	305	300	294	292	304	304	311	309	310	2	302.9
2	312	314	316	312	308	310.5	314	315	315	314.5	3	313.1
3	316	316.5	318	316	310.5	310	310	312	315.6	318.5	4	314.3
4	311.5	310.5										
											Mean	337.0
Fern Rock Observatory, January 27 and 28, 1854.												
4^{h}	306^{d}	305^{d}	307^{d}	313^{d}	320^{d}	327^{d}	321^{d}	315^{d}	312^{d}	308^{d}	5^{h}	313^{d}.4
5	304	302	302	306	307	308	306	308	314	316	6	307.3
6	320	325	330	332	328	326	324	323	325	326	7	325.9
7	326	328	323	324	324	325	325	320	319	320	8	323.4
8	319	319	319	319	318	319	320.5	321	322	322	9	319.8
9	322	322	322	322	323	324	323.7	324	323	323	10	322.9
10	322	320	322	323.7	325.8	326.5	327	327.3	325	328	11	324.7
11	329	329.8	330	329	328	326	326	337	338	334.7	12	330.7
12	332	342	342.2	341	339.5	334	331	328	330	331	13	335.1
13	331.4	336	337	334	330	336	334	332	331	330	14	333.1
14	330	332	334	330	338	347	357	353	348	344	15	341.3
15	346	348	348	346	345	345	346	351	356	350	16	348.1
16	346	345	347	348	349	355	359	364	368	370	17	355.1
17	378	380	384	386	388	389.5	388	387	387.5	386	18	385.4
18	386	386	386	386	385	381	378	375	375	374	19	381.2
19	374	373	370.8	365	365	360	355	355.5	352	349.5	20	362.0
20	360	365	362	360	356	353	352	351.5	353	356	21	356.8
21	354.5	356	357.5	360	362	364.5	365	365.5	363	361	22	363.8
22	359	360	361	362	363	365	367	368	365	363	23	363.3
23	360	356	341	346	341.5	336	337	338	338	335	0	342.8
0	332	335	339	342	341	340	340	341	342	346	1	339.8
1	351	356	360	359	358	363	355	362	357	354	2	357.5
2	350	350	350	348	346	350	345	344	349	350	3	348.2
3	352	352	353	355	358	359	354	340	333	332	4	348.8
4	336	340	343	345	345							
											Mean	342.9

Value of a division of the scale 0′.80.

Increase in scale readings corresponds to a movement of the north end of the magnet to the east.

Aurora visible on the 27th and 28th.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
Fern Rock Observatory, January 31 and February 1, 1854.												
								304$^{\mathrm{d}}$	306$^{\mathrm{d}}$	325$^{\mathrm{d}}$	4$^{\mathrm{h}}$	
4$^{\mathrm{h}}$	332$^{\mathrm{d}}$.5	340$^{\mathrm{d}}$	341$^{\mathrm{d}}$.5	335$^{\mathrm{d}}$.5	345$^{\mathrm{d}}$	333$^{\mathrm{d}}$.5	334$^{\mathrm{d}}$.5	330	330	328	5	335$^{\mathrm{d}}$.0
5	326	327	328.5	324	318	311	313	320	325	330	6	322.2
6	338	344	348	356	358	359.5	356	357	358	358	7	353.2
7	359	359	360	360.5	361	362	363.5	365	367	368.5	8	362.5
8	370	372	372	374	371	370	371	371	371	372	9	371.4
9	372	372	373	373	374	372	372	372	371	370	10	372.1
10	368	368	367	364	361	365	371	370	369	367	11	367.0
11	365	366	370	377	376	377	380	387	384	382	12	376.4
12	379	374	375	376	374	373	370	368	374	375	13	373.8
13	376	376	380	384.5	385	384	383.5	382	380	378	14	380.9
14	379	381.5	383	384	385.5	383	380	379	376	370	15	380.1
15	368	365	364	365	367	369	371	373.5	374	375	16	369.1
16	374.5	375	375	374.5	374	375	374	374	373	373	17	374.2
17	373	374	374.5	375	374	374	374	375	378	382	18	375.3
18	385	387	390	389	388	388	389	390	385	386	19	387.2
19	387	388	389.8	387	389	389	389	387	387	386	20	387.9
20	385	385	385	384.5	383	382	382	382	376	370	21	381.4
21	367	369	370	370	292	288	278	284	285	291	22	319.4
22	294	297	311	328	338	348	359	359.5	351	350	23	333.5
23	342	338	334	318.5	314	312	311	314	318	323	0	322.4
0	329.5	331	322	332	333	342	346	350	359	365	1	340.9
1	370	370	370	375	381	379	375	372	368	364	2	372.4
2	359	356	355	354	352	351	351	350	363	373	3	356.4
3	375	377	377	380	383	376	376	378	380	386	4	378.8
4	390	396	400	398	396	407	419	430	440		5	
											Mean	362.2
Fern Rock Observatory, February 3 and 4, 1854.												
								336$^{\mathrm{d}}$	335$^{\mathrm{d}}$	342$^{\mathrm{d}}$	8$^{\mathrm{h}}$	
8$^{\mathrm{h}}$	348$^{\mathrm{d}}$	353$^{\mathrm{d}}$	358$^{\mathrm{d}}$	363$^{\mathrm{d}}$.5	367$^{\mathrm{d}}$.5	372$^{\mathrm{d}}$	374$^{\mathrm{d}}$	374	374	376	9	366$^{\mathrm{d}}$.0
9	377	376	375	373	370	365	363	362	362	363	10	368.6
10	369	370	372	372.5	374	377	378	378.7	379	385	11	375.5
11	386	388	390	393	400	408	407	404	402	398	12	397.6
12	403	408	406	407	410	408	406	405	408	410	13	407.1
13	413	410	411	415	435	450	454	456	457	430	14	433.1
14	425	415	412	411	411	410	406	405	400	400	15	409.5
15	400.5	400	398	397	396	394	390	385	392	408	16	396.0
16	411	414	418.5	408	397	393	389	389.5	389	389	17	399.8
17	390	392	393	391	389	388	378	362	342	337	18	376.2
18	335.5	336	342	351	362	380	386	409	367	350	19	361.8
19	339	320	308	323	316	309	296	285	270	262	20	302.8
20	261.5	260	258	261	262	275	270	274	278	287	21	268.6
21	295	302	303	299	296	300	303	320	334	340	22	309.2
22	355	354	344	332	340	362	350	342	340	344	23	346.3
23	348	352	345	341	330	320	315	314	314	315	0	329.4
0	320	332	336	340	345	340	339	350	348	346	1	339.6
1	346.5	346	345	350	340	332	340	346	325	305	2	337.5
2	298	308	315.5	316	314	311	311	310	308.5	306	3	309.8
3	304	302	300	294	286	294	301	307	319	333	4	304.0
4	345	349	349	353	358	361	362	364	364	362	5	356.7
5	360	358	356	359	362	362	364	362	368	370	6	362.1
6	369	366	371	375	378	377	375	380	390	389	7	376.0
7	389	379	373	371	370	370	370	371	371		8	(373.5)
											Mean	358.6

Value of a division of the scale 0′.80.

Increase in scale readings corresponds to a movement of the north end of the magnet to the east.

NOTE.—Another stove had been put up temporarily; it was removed at the close of the observations

Fern Rock Observatory, February 7 and 8, 1854.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
								316^{d}	317^{d}	317^{d}	4^{h}	
4^{h}	$316^{d}.5$	317^{d}	317^{d}	316^{d}	314^{d}	314^{d}	315^{d}	315	316	317	5	$315^{d}.7$
5	319	320	322	323	322	320	321	323	326	329	6	322.5
6	333	336	339	342	344	345	347	349	345	339	7	341.9
7	341	345	349	355	355	361	454	346	352	356	8	351.4
8	357	356.5	356	355	354	354	355	355	355	356	9	355.3
9	356	356	356	355	354	352	352	354	355	360	10	355.0
10	369	370	369	368	368	369	370	372	374	375	11	370.4
11	377	379	375	370	367	368	368	368	368	368	12	370.8
12	367	367	368	369	370	372	375	377	380	383	13	372.8
13	386	389	392	395	396	394	392	389	389	390	14	391.2
14	389	387	386	384	381	378	375	372	369	365	15	378.6
15	362	359	355	350	346	342	337	336	334	333	16	345.4
16	333	334	334	335	336	338	339	339	338	336	17	336.2
17	330	325	320	314	311	308	304	302	301	302	18	311.7
18	302	302	298	294	290	287	284	280	276	273.5	19	288.6
19	271	270	268	266.5	274	283	287	290	294	294	20	279.7
20	295	297	298	300	301	305	307	310	313	313	21	303.9
21	313	312	312	311	303	295	287	294	294	295	22	301.6
22	297	298	296	295	293	294	301	310	319	326	23	302.9
23	322	323	325	323	322	321	319	318	314	312	0	319.9
0	306	299	300	301	303	306	310	320	328	334	1	310.7
1	335	336	337	336	332	329.5	330	332	332	330	2	332.9
2	327.5	320	313	308	301	296	288	291	308	315	3	306.7
3	317	315	312	309	313	320	329	333	333	334	4	321.5
4	336	341	347	350	352						5	
											Mean	332.8

Fern Rock Observatory, February 10 and 11, 1854.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
								251^{d}	254^{d}	256^{d}	4^{h}	
4^{h}	261^{d}	266^{d}	272^{d}	284^{d}	294^{d}	300^{d}	306^{d}	312	318	323	5	$293^{d}.6$
5	330	340	352	366	368	362	354	352	355	362	6	354.1
6	360	358	357.5	360	366	365	365	364	366	368	7	362.9
7	371	373	376	378	380	384	385	385	390	396	8	381.8
8	396	395.5	394	392.7	394	390	390	389	387	387	9	391.4
9	387	386	386	386	380	382	382	382	382	382	10	383.5
10	382	381	380	378	377	376	376	375	374	374	11	377.3
11	376	380	383	385	385	385	386	386	386	387	12	383.9
12	388	389	389	392	393	392	390	390	392	394	13	390.9
13	396	397	396	394	392	400	412	420	424	422	14	405.3
14	422	430	444	460	464	470	487	480	493.5	498	15	464.8
15	501	504	503	499	479	460	448	429	417	407	16	464.7
16	405	400	398	397	395	389	383	379	371	368	17	388.5
17	362	370	377	373	369	365	357	348	348	350	18	361.9
18	350	329	329	325	321	317	312.5	297	288	280	19	314.8
19	272	265	263	261	261	262	262	263	265	266	20	264.0
20	267	268	269	270	273	276	279	274	270	265	21	271.1
21	261	256	251	246	240	238	225	231	239	235	22	242.2
22	216	196	196	193	203	203	202	201	206	211	23	202.7
23	215	216	215	215	211	208	205	203	200	195	0	208.3
0	200	203	201	201	200	199	203	211	215	220	1	205.3
1	227	232	239	254	280	300	314	325	320	320	2	281.1
2	319	319	319	321	327	331	345	350	362	369	3	336.2
3	353	359	361	363	365	365	361	364	365	364	4	362.0
4	361	361	354	351	347						5	
											Mean	337.2

Value of a scale division 0′.80.

Increase of scale readings corresponds to a movement of the north end of the magnet to the east.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
Fern Rock Observatory, February 14 and 15, 1854.												
4^h			304^d	303^d	304^d	303^d	307^d	311^d	316^d	324^d	5^h	($307.^d0$)
5	331^d	339^d	343	347	350	352	355	358	359	360	6	349.4
6	362	362	365	369	372	380	387	396	401	410	7	380.4
7	393	398	398	401	417	449	440	435	440	440	8	421.1
8	435	434	428	420	420	412	405	408	413	422	9	419.7
9	439	450	470	478	487	486	486	494	482	465	10	473.7
10	462	458	451	443	438	432	426	431	443	457	11	444.1
11	472	483	494	493	491	487	483	477	458	436	12	477.4
12	434	414	410	409	410	407	406	408	413	419	13	413.0
13	428	441	452	456	459	462	473	464	465	462	14	456.2
14	458	454	450	449	447	446	458	473	478	481	15	459.4
15	486	489	491	492	490	492	494	494	490	485	16	490.3
16	478	470	468	460	452	444	434	430	428	420	17	448.4
17	416	420	414	414	409	404	401	399	396	394	18	406.7
18	391	376	376	377	378	392	391	366	359	356	19	376.2
19	349	344	338	320	312	334	340	336	329	329	20	333.1
20	331	339	350	356	359	354	349	345	331	317	21	343.1
21	296	292	289	292	292	291	289	287	284	278	22	289.0
22	275	273	258	246	244	238	234	228	223	218	23	243.7
23	212	208	211	180	160	138	146	136	132	129	0	165.8
0	131	144	159	171	181	192	203	211	218	226	1	183.6
1	236	244	245	246	247	257	269	252	236	238	2	247.0
2	241	242	240	243	247	254	249	249	251	254	3	247.0
3	257	266	278	292	316	322	316	311	319	332	4	300.9
4	331	351	360									
											Mean	360.7
Fern Rock Observatory, February 17 and 18, 1854.												
								193^d	193^d	194^d	4^h	
4^h	190^d	184^d	172^d	172^d	169^d	172^d	181^d	188	196	198	5	$182^d.2$
5	193	183	185	188	180	182	185	195	207	208	6	190.6
6	208	230	258	298	296	286	272	271	270	270	7	265.9
7	265	258	252	244	237	230	227	225	226	228	8	239.2
8	232	235	238	242	249	255	260	260	261	262	9	249.4
9	262	263	265	268	273	276	279	281	291	300	10	275.8
10	302	300	280	273	260	249	242	236	228.5	237	11	260.7
11	241	247.5	245	240	236	231	232	230	229	227.8	12	235.9
12	225	222	240	238	242	239	236	230	247	253	13	237.2
13	261	248	240	231	233	237	250	244	242	240	14	242.6
14	238	236	235	238	243	242	240.5	237	234	231	15	237.4
15	229	229.5	234	239.5	239	238	240	241	243	247	16	238.0
16	249	251	250	247	245	242	237	233	228	223	17	240.5
17	218	220	223	228	232	235	237	238	239	240	18	231.0
18	235	232	230	233	235	237	233	228	234	237	19	233.4
19	240	234	228	220	204	166	164	147	130	152	20	188.5
20	179	188	206	230	256	250	241	236	226	217	21	222.9
21	218	221	224	221	217	208	221	237	244	245	22	225.6
22	244	248	254	250	247	244	242	241	240.5	240	23	245.0
23	240	250	252	247.5	238	227	220	219	216	214	0	232.3
0	214	215	216	220	226	232	236	240	247	255	1	230.1
1	262	271	180*	190	187	184	181	177	175	174	2	198.1
2	169	163	156	150	144	146	148	147	152.5	151	3	152.6
3	154	151	161	175	187	192	201	202	202	208	4	183.3
4	210	209	226	233								
											Mean	226.6

Value of a scale division 0′.80.

Increase of scale readings corresponds to a movement of the north end of the magnet to the east.

NOTE.—The mean in brackets includes two interpolated values.

* A sudden change of 90^d occurring at 6^h 30^m chronometer time (Greenwich time nearly).

Fern Rock Observatory, February 21 and 22, 1854.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
								270^{d}	269^{d}	268^{d}	4^{h}	
4^{h}	268^{d}	268^{d}	273^{d}	276^{d}	271^{d}	260^{d}	252^{d}	252	252	252	5	262^{d}.4
5	252	253	256	256	253	254	256	257	258	260	6	255.5
6	261	263	263	265	267	267	268	269	271	273	7	266.7
7	274	275	276	277	280	282	286	291	296	301	8	283.8
8	302	302	303	303	302	302	301	302	301	299	9	301.7
9	296	293	290	289	287	286	284	283	283	283.5	10	287.4
10	282.5	280.5	278.5	276	274	274	274	279	284	287	11	278.9
11	288	289	290	294	297	299	300	296	294	293	12	294.0
12	292	292	290	287	284	281	276	276	275	280	13	283.3
13	285	287	290	293	297	290	282	280	278	276	14	288.3
14	276	278	282	282	284	285	287	287	287	288	15	283.6
15	288	288	289	290	293	293	294	294	296	296	16	292.1
16	295	295	293	292	291	291	293	290	287	283	17	291.0
17	280	278	275	272	271	268	267	266	265	263	18	270.5
18	261	260	258	255	254	255	257	260	262	263	19	258.5
19	264	262	259	260	261	261	260.5	260	259	256	20	260.2
20	251	244	240	242	230	218	216	212	205	203	21	226.1
21	206	210	216	221	223	224	230	237	250	250	22	226.7
22	250	250	254	257	258	262	260	260	261	263	23	257.5
23	261	260	260	258	260	261	262	262	262	262	0	260.8
0	262	262	262	262	263	263	262	261	261	260	1	261.8
1	259	259	258	257	258	259	259	260	261	263	2	259.3
2	264	266	269	271	273	275	277	280	278	274	3	272.7
3	274	275	278	290	294	304	293	286	282	280	4	285.6
4	283	282	279	276								
											Mean	271.2

Fern Rock Observatory, February 28 and March 1, 1854.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
								220^{d}	220^{d}	219^{d}	4^{h}	
4^{h}	218^{d}	216^{d}	213^{d}	207^{d}	200^{d}	191^{d}	183^{d}	179	180	182	5	196^{d}.9
5	184	186	189	191	192	193	193	192	193	193	6	190.6
6	195	198	202	210	219	227	230	244	256	260	7	224.1
7	272	274	280	278	242	226	220	250	300	320	8	266.2
8	344	333	321	310	306	322	335	341	350	362	9	332.4
9	353	352	350	355	368	365	360	370	371	372	10	361.6
10	374	378	399	402	408	404	398	394	390	400	11	394.7
11	398	396	397	402	405	408	407	421	436	440	12	411.0
12	452	476	484	483	450	438	418	400	390	381	13	437.2
13	372	363	354	343	337	343	347	352	357	364	14	353.2
14	372	355	340	324	315	320	326	330	333	335	15	335.0
15	331	327	325	324	322	325	314	320	315	314	16	321.7
16	326	338	346	363	362	356	348	342	342	339	17	346.2
17	325	322	324	318	316	324	312	310	318	322	18	319.1
18	319	318	317	314	312	316	317	314	314	317	19	315.8
19	320	315	314	310	308	309	308	307	308	308	20	310.7
20	306	306	302	298	297	299	302	302	301	301	21	301.4
21	298	299	300	301	296	284	274	269	264	268	22	285.3
22	272	278	280	283	286	288	284	279	276	280	23	280.6
23	285	303	320	332	341	350	362	374	366	356	0	338.9
0	345	333	321	310	296	293	305	296	289	280	1	306.8
1	274	276	266	264	258	256	252	259	251	255	2	261.1
2	278	260	261	262	265	268	276	280	286	291	3	272.7
3	299	301	299	302	306	310	314	316	317	320	4	308.4
4	319	317	318	315	312						5	
											Mean	311.3

Value of a scale division 0′.80.

Increase of scale readings corresponds to a movement of the north end of the magnet to the east.

Mean local time.	36m.	42m.	48m.	54m.	00m.	06m.	12m.	18m.	24m.	30m.	Mean local time.	Hourly means.
Fern Rock Observatory, March 3 and 4, 1854.												
								250^{d}	247^{d}	246^{d}	4^{h}	
4^{h}	248^{d}	249^{d}	240^{d}	238^{d}	242^{d}	245^{d}	248^{d}	250	260	265	5	248^{d}.5
5	258	269	281	284	380	279	277	274	275	277	6	275.4
6	280.5	279	272.5	275	270	280	286	290	298	296	7	282.7
7	283	311	315	332	329	326	321	329	347	349	8	324.2
8	356	356	360	352	347	346	330	302	291	283	9	332.3
9	287	290	282	286	275	264	265	267	269	270	10	275.5
10	272	274	276	278	280	282	285	287	290	292	11	281.6
11	295	298	302	306	313	318	322	325	327	329	12	313.6
12	330	337	345	349	352	350	348	345	343	336	13	343.5
13	325	321	313	302	295	299	308	314	309	302	14	308.8
14	297	294	288	292	286	284	280	276	272	285	15	285.4
15	291	294	291	289	282	276	268	264	260	258	16	277.3
16	257	257	256	258	259	260	262	260	258	258	17	258.5
17	257	255	251	244.5	238	230	220	205	190	172	18	226.2
18	152	144	133	134	136	140	143	160	174	198	19	151.4
19	209	216	210	205	201	195	190	186	181	177	20	197.0
20	173	170	167	164	171	178	184	189	193	199	21	178.8
21	206	200	194	188	183	178	172	170	169	164	22	182.4
22	152	160	156	156	153	155	157	154	150	150	23	154.3
23	156	176	195	184	155	160	125	131	131	134	0	154.7
0	135	137.5	155	179	195	184	187	200	197.5	192	1	176.2
1	195	200	190	185	182	179	150	136	150	156	2	172.3
2	173	190	200	206	217	204	196	190	186	183	3	194.5
3	189	192	199	204	209	216	222	229	234	243	4	213.7
4	249	251	254	257								
											Mean	242.0
Fern Rock Observatory, March 7 and 8, 1854.												
									190^{d}	202^{d}	4^{h}	
4^{h}	218^{d}	223^{d}	213^{d}	218^{d}	228^{1}	224^{d}	221^{d}	231^{d}	230	235	5	224^{d}.1
5	242	243	246	247	251	270	275	275	274	274	6	259.7
6	269	261	268	260	273	270	269	255	268	271	7	266.4
7	275	271	279	284	278	269	281	282	281	286	8	278.6
8	292	304	294	302	303	312	306	299	297	293	9	300.2
9	284	288	286	287	291	294	300	305	298	290	10	292.3
10	287	280	276	270	277	280	286	281	278	273	11	278.8
11	269	272	267	270	272	274	267	268	272	280	12	271.1
12	273	279	284	290	289	291	294	291	283	274	13	284.8
13	290	288	285	282	283	291	297	300	296	291	14	290.3
14	285	278	281	284	298	291	289	286	284	283	15	285.9
15	281	282	285	288	290	292	295	297	298	298	16	290.6
16	299	300	302	297	291	285	280	278	283	288	17	290.3
17	292	296	299	297	295	293	289	287	281	275	18	290.4
18	269	264	260	256	260	255	258	260	266	270	19	261.8
19	275	272	277	264	270	268	270	259	271	268	20	269.4
20	264	276	278	270	264	260	268	282	284	286	21	273.2
21	280	278	281	285	287	274	291	297	295	291	22	285.9
22	284	276	274	268	263	257	264	271	286	293	23	273.6
23	300	299	287	285	281	274	278	271	267	265	0	280.7
0	261	246	252	245	247	243	242	246	250	252	1	248.4
1	252	252	250	250	249	250	252	255	256	258	2	252.4
2	260	265	270	272	275	276	276	280	285	280	3	273.9
3	285	284	274			258	242	247	258	263	4	(264.3)
4	262	265	268	258	245						5	
											Mean	274.5

Value of a scale division 0′.80.

Increase of scale readings corresponds to a movement of the north end of the magnet to the east.

NOTE.—The mean in brackets includes two interpolated values.

Diurnal Range of the Declination.—The diurnal range being an index to the magnitude of the diurnal excursions, is best presented before the examination of the diurnal inequality. The following table contains the highest and lowest scale readings in the hourly series, and the maximum and minimum values observed, together with the corresponding ranges. One division of scale = 0′.80.

Daily Range of the Declination.

DATE.	IN HOURLY SERIES.		OBSERVED.		RANGE.	
1854.	Highest.	Lowest.	Maximum.	Minimum.	In hourly series.	Total observed.
January 10–11	309^d.8	253^d.5	314^d.0	241^d.0	56^d.3	73^d.0
" 13–14	368.4	242.3	378.0	212.0	126.1	166.0
" 18–19	357.9	109.7	369.0	85.0	248.2	284.0
" 24–25	367.4	293.3	373.0	282.0	74.1	91.0
" 27–28	385.4	307.3	389.5	302.0	78.1	87.5
" 31–32	387.9	319.4	440.0	278.0	68.5	162.0
February 3– 4	433.1	268.6	457.0	258.0	164.5	199.0
" 7– 8	391.2	279.7	396.0	266.5	111.5	119.5
" 10–11	464.8	202.7	504.0	195.0	262.1	309.0
" 14–15	490.3	165.8	494.0	129.0	324.5	365.0
" 17–18	275.8	152.6	302.0	130.0	123.2	172.0
" 21–22	301.7	226.1	304.0	203.0	75.6	101.0
" 24–25	531.3	321.4	558.5	268.0	209.9	290.5
March 0– 1	437.2	190.6	484.0	179.0	246.6	305.0
" 3– 4	343.5	151.4	360.0	125.0	192.1	235.0
" 7– 8	300.2	224.1	312.0	190.0	76.1	122.0
" 22–23	290.5	238.8	304.0	228.0	51.7	76.0

The mean diurnal total range observed during the above period becomes 2° 28′.6, and the maximum diurnal range observed took place on the 14–15 February, and amounted to 4° 52′.0. For comparison with similar quantities at other high latitude stations we may take Lake Athabasca, where the greatest range in any one day between October, 1843, and February, 1844, was 2° 35′, it happened October 16, 1843; at Fort Simpson the maximum range was 7° 27′, observed on the 16th of April, 1844, in a series of observations extending over April and May, 1844. The mean diurnal range during January and February, 1844, at Lake Athabasca, was 31′.4, and the mean range at Fort Simpson in April and May of that year was 1° 12′, these two quantities, however, were taken from the hourly series.

If we classify the ranges according to this magnitude we obtain the following results:—

Daily range less than	1°	1
" " between	1 and 2°	6
" " "	2 and 3	4
" " "	3 and 4	3
" " "	4 and 5	3
" " greater than	5	0

The diurnal range in the winter months, January, February, and March, when compared with its annual fluctuation, is probably below the mean value of the year.

Diurnal Inequality of the Declination.—The following table contains the hourly means of all observations at the Winter quarters, between January 10 and March 23, 1854. The remaining observations on term-days at a later season have been excluded on account of their isolation. The above period includes the coldest season of the year, and during more than one-half of the period the sun was below the horizon.

The hourly means were made out separately for each month, the general mean includes seventeen values for each of the twenty-four hours. In January we have complete observations on six days, in February on seven, and in March on four days. The table also contains the monthly means, and all numbers are expressed in scale divisions (one division = 0′.80).

Abstract of Hourly Means during the months of January, February, and March, 1854, observed at Fern Rock Magnetic Observatory.

(The readings are given in scale divisions; the values taken from the term-day observations embrace the same number of single readings between the same times.)

Fern Rock mean time.	5h.	6h.	7h.	8h.	9h.	10h.	11h.	12h.	13h.	14h.	15h.	16h.	17h.
Fern Rock Observatory, January and March, 1854.													
Jan'y 10–11	296.0	292.1	286.6	278.9	284.7	288.1	297.0	299.8	308.5	309.8	307.6	305.5	296.7
" 13–14	311.9	321.1	331.0	343.7	360.3	335.1	345.4	348.1	342.1	346.9	350.1	364.5	368.4
" 18–19	308.2	316.9	317.3	313.3	319.9	321.8	343.3	346.7	338.4	345.3	347.8	353.8	357.9
" 24–25	319.3	347.8	359.7	367.4	361.1	361.2	357.1	358.3	355.2	364.0	356.5	344.0	342.9
" 27–28	313.4	307.3	325.9	323.4	319.8	322.9	324.7	330.7	335.1	333.1	341.3	348.1	355.1
" 31–32	335.0	322.2	353.2	362.5	371.4	372.1	367.0	376.4	373.8	380.9	380.1	369.1	374.2
Means	313.9	317.9	329.0	331.5	336.2	333.6	339.1	343.3	342.2	346.7	347.2	347.5	349.2
Feb'y 3– 4	*356.7	*362.1	*377.0	*(373.5)	366.0	368.6	375.5	397.6	407.1	433.1	409.5	396.0	399.8
" 7– 8	315.7	322.5	341.9	351.4	355.3	355.0	370.4	370.8	372.8	391.2	378.6	345.4	336.2
" 10–11	293.6	354.1	362.9	381.8	391.4	383.5	377.3	383.9	390.9	405.3	464.8	464.7	388.5
" 14–15	(307.0)	349.4	380.4	421.1	419.7	473.7	444.1	477.4	413.0	456.2	459.4	490.3	448.4
" 17–18	182.2	190.6	265.9	239.2	249.4	275.8	260.7	235.9	237.2	242.6	237.4	238.0	240.5
" 21–22	262.4	255.5	266.7	283.8	301.7	287.4	278.9	294.0	283.3	288.3	283.6	292.1	291.0
" 24–25	344.7	429.6	461.2	514.1	531.3	526.4	491.8	498.3	498.2	496.2	501.2	512.4	520.8
Means	294.6	323.4	350.9	366.4	373.5	381.5	371.3	379.7	371.8	387.6	390.7	391.3	375.0
March 0– 1	196.9	190.6	224.1	266.2	332.4	361.6	394.7	411.0	437.2	353.2	335.0	321.7	346.2
" 3– 4	248.5	275.4	282.7	324.2	332.3	275.5	281.6	313.6	343.5	308.8	285.4	277.3	258.5
" 7– 8	224.1	259.7	266.4	278.6	300.2	292.3	278.8	271.1	284.8	290.3	285.9	290.6	290.3
" 22–23	261.3	246.3	258.5	258.6	240.9	238.8	270.1	280.3	274.3	266.7	260.8	269.6	269.8
Means	232.7	243.0	257.9	281.9	301.5	292.1	306.3	319.0	334.9	304.8	291.8	289.8	291.2
General means	286.9	302.5	321.3	334.2	343.3	343.5	344.6	352.6	352.7	353.5	352.0	352.1	346.2

Fern Rock mean time.	18h.	19h.	20h.	21h.	22h.	23h.	Noon. 0h.	1h.	2h.	3h.	4h.	Daily means.
Jan'y 10–11	292.6	267.1	271.9	269.0	253.5	255.8	272.3	257.0	267.9	276.3	298.7	284.7
" 13–14	335.7	325.6	276.4	269.4	277.0	267.0	262.3	242.3	278.8	298.2	305.9	317.0
" 18–19	347.7	327.9	348.1	336.3	306.4	236.2	109.7	246.6	289.3	333.1	321.3	313.9
" 24–25	338.8	346.4	347.2	313.3	299.2	315.5	310.3	293.3	302.9	313.1	314.3	337.0
" 27–28	385.4	381.2	362.0	356.8	363.8	363.3	342.8	339.8	357.5	348.2	348.8	342.9
" 31–32	375.3	387.2	387.9	381.4	319.4	333.5	322.4	340.9	372.4	356.4	378.8	362.2
Means	345.9	239.2	332.3	321.0	303.2	295.2	270.0	286.7	311.5	320.9	328.0	326.8
Feb'y 3– 4	376.2	361.8	302.8	268.6	309.2	346.3	329.4	339.6	337.5	309.8	304.0	358.6
" 7– 8	311.7	288.6	279.7	303.9	301.6	302.9	319.9	310.7	332.9	306.7	321.5	332.8
" 10–11	361.9	314.8	264.0	271.1	242.2	202.7	208.3	205.3	281.1	336.2	362.0	337.2
" 14–15	406.7	376.2	333.1	343.1	289.0	243.7	165.8	183.6	247.0	247.0	300.9	360.7
" 17–18	231.0	233.4	188.5	222.9	225.6	245.0	232.3	230.1	198.1	152.6	183.3	226.6
" 21–22	270.5	258.5	260.2	226.1	226.7	257.5	260.8	261.8	259.3	272.7	285.6	271.2
" 24–25	492.4	494.0	448.1	433.8	321.4	401.2	(389.9)	378.7	377.7	407.7	443.7	454.8
Means	350.1	332.5	296.6	295.6	273.7	285.6	272.3	272.8	290.5	290.4	314.4	334.6
March 0– 1	319.1	315.8	310.7	301.4	285.3	280.6	338.9	306.8	261.1	272.7	308.4	311.3
" 3– 4	226.2	151.4	197.0	178.8	182.4	154.3	154.7	176.2	172.3	194.5	213.7	242.0
" 7– 8	290.4	261.8	269.4	273.2	285.9	273.6	380.7	248.4	252.4	273.9	(264.3)	274.5
" 22–23	255.0	286.0	(285.0)	(275.8)	254.7	287.0	290.1	287.0	247.3	244.8	290.5	266.6
Means	272.7	253.8	265.5	257.3	252.1	248.9	266.1	254.6	233.3	246.5	269.2	273.6
General means	330.4	316.3	302.0	295.5	279.0	280.3	270.0	273.5	284.4	290.8	308.6	317.3

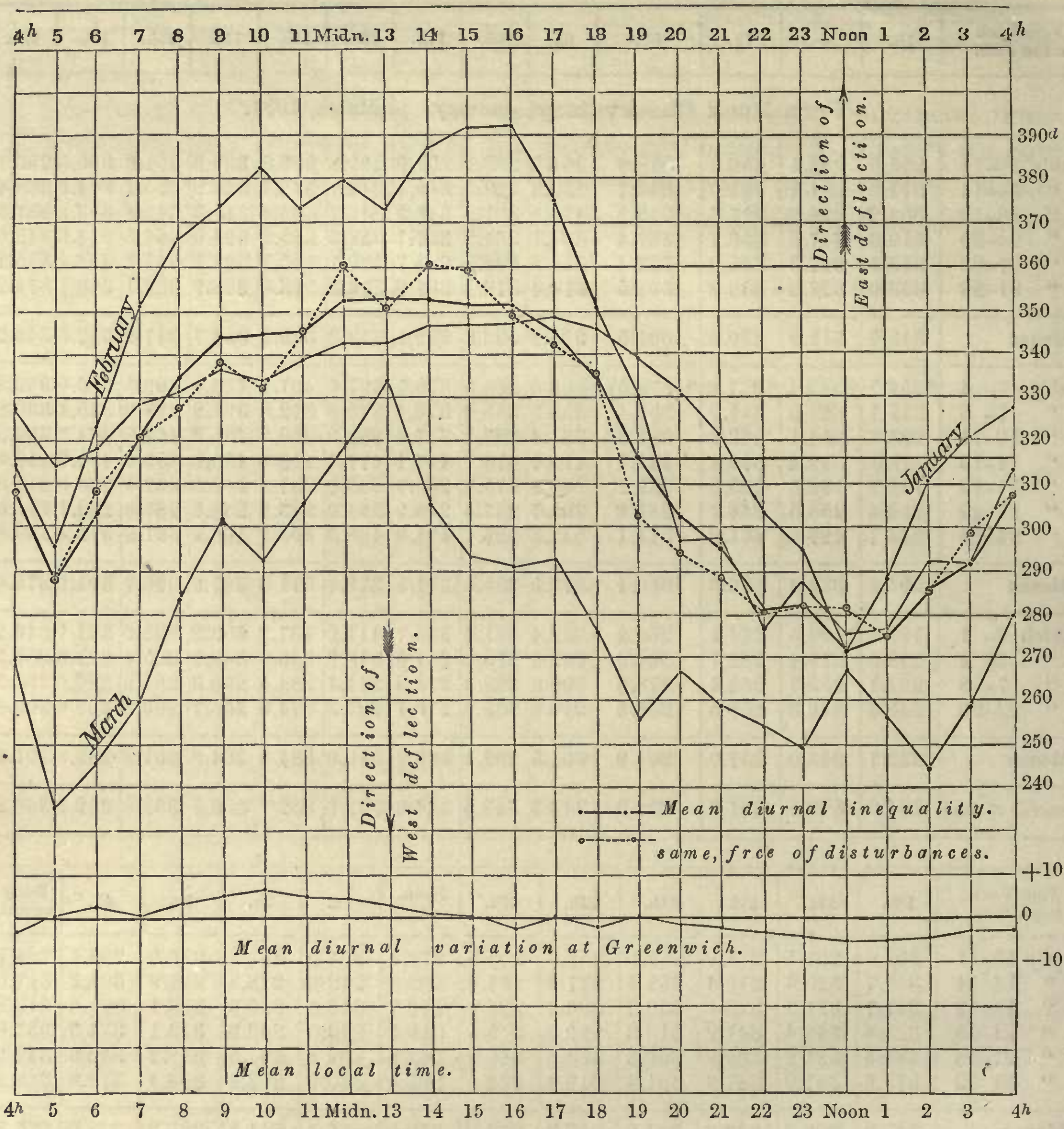
The values in the above table do not refer exactly to the even hour but to 3^{m} later.

Figures between brackets ( ) are means derived from less that ten readings.

* These four values were observed on the 4th at the hours indicated.

MEAN MONTHLY CURVES OF THE DIURNAL CHANGES OF THE MAGNETIC DECLINATION AT VAN RENSSELAER HARBOR, 1854.

AND SIMULTANEOUS MEAN DIURNAL VARIATION AT GREENWICH.



The irregularities in the daily curves compared on succeeding days are very considerable, as may be seen by glancing the eye over the last column of the preceding table, headed "daily means." No observations on account of disturbances have been excluded from the table, and the following mean diurnal inequality, therefore, contains their full effect. Comparing each hourly mean in the last horizontal line of the above table with the general mean, the following figures represent the resulting diurnal inequality of the declination during the first three months of the year 1854. For the sake of comparison the diurnal inequality observed at Greenwich during the same seventeen days has been made out and is given in the last column.

Mean Diurnal Inequality of Declination during Seventeen Days in January, February, and March, 1854, at Van Rensselaer Harbor, and at Greenwich during the same days; expressed in Minutes of Arc.

Local mean time.	Van Rensselaer.	Green-wich.	Local mean time.	Van Rensselaer.	Green-wich.	Local mean time.	Van Rensselaer.	Green-wich.	Local mean time.	Van Rensselaer.	Green-wich.
5^h	+24′.3	—0.′5	11^h	—21′.8	—4′.5	17^h	—23′.1	—0′.3	23^h	+29′.6	+3′.5
6	+11.8	—2.5	Midn.	—28.2	—4.1	18	—10.5	+0.6	Noon	+37.8	+5.8
7	— 3.2	—1.6	13	—28.3	—3.1	19	+ 0.8	—0.4	1	+35.0	+5.8
8	—13.5	—3.9	14	—29.0	—0.8	20	+12.2	+0.5	2	+26.3	+5.0
9	—20.8	—4.5	15	—27.8	—0.3	21	+17.4	+1.0	3	+21.2	+3.9
10	—21.0	—5.1	16	—27.8	+0.5	22	+30.6	+2.3	4	+ 7.0	+2.6

A negative sign indicates a deflection to the east, a positive one a deflection to the west of the mean position.

The diurnal inequality at the two stations presents in general the same characteristic features, namely, the principal deflection to the west shortly after noon, and the opposite eastern position about midnight; in regard to the diurnal inequality, therefore, the motion of the magnet at Van Rensselaer Harbor follows in general the same law as recognized in lower geographical latitudes.

The extreme westerly position is attained at noon; after this hour the westerly declination diminishes gradually, with an exception of a period of opposite motion of very limited range between the hours of four and five. The easterly extreme is reached two hours after midnight. Whether the small irregularity just noticed, producing apparently a secondary minimum and maximum, is real or only caused by the accidental deviations of the few observations under discussion, it is not easy to decide with certainty. The motion from 14 hours to 24 hours is performed with great uniformity. Thus, while the diurnal motion agrees with that observed at Lake Athabasca, Fort Simpson, Sitka, Toronto, etc., it shows no trace of that marked deviation observed at Reikiavik, in Iceland, or at Fort Confidence. In 1824 (June), at the Whalefish islands the maximum westerly deviation happened about a quarter past one o'clock P. M.; the time of the maximum eastern deflection was not determined. At Port Bowen the maximum westerly variation appears to have occurred between the hours of 10 A. M. and 1 P. M., the mean result being $11^h\ 49^m$; the greatest deflection of the north end of the needle to the eastward took place between 8 P. M. and 2 A. M., the mean hour being 10 P. M. These observations were made during January, February, March, and April, 1825.

The range of the mean diurnal inequality is 1° 06′.8, when it is at Greenwich during the same time 10′.9.

Analysis of Disturbances of the Declination.—The declination at the commencement and end of the observations appears to have remained nearly the same; the daily and monthly means indicate at first a gradual decrease of westerly declination, which motion, however, is speedily overcome in the month of March. No further attention need be paid to this circumstance in the following discussion of the disturbances, and of their effect upon the diurnal inequality.

The mean disturbance for each of the 24 hours has been obtained by comparing the monthly mean with each hourly reading; let Δ equal this difference, n the number of hourly readings (equal to 17), and m the mean disturbance, then $m = \pm\sqrt{\frac{\Sigma\Delta^2}{n-1}}$. This quantity is analogous to the mean error of an observation. In the following comparisons we must always bear in mind that the observations for the present discussion are rather limited, and that the comparisons with results at Lake Athabasca and Fort Simpson are of a date nearly ten years earlier. This interval is perhaps favorable to the comparison.

At Van Rensselaer Harbor the mean disturbance force is greater than at either place just named, and pretty regular during two well-marked periods, as shown by the following table:—

TABLE OF THE MEAN DISTURBANCE OF THE DECLINATION AT VAN RENSSELAER HARBOR, TAKEN WITHOUT REGARD TO DIRECTION, FOR EACH OF THE OBSERVATION HOURS, AND EXPRESSED IN MINUTES OF ARC.

Local Mean Time.

5h.	6h.	7h.	8h.	9h.	10h.	11h.	Midn.	13h.	14h.	15h.	16h.
±31′	41	37	47	49	50	46	52	51	47	50	±53′
17h.	18h.	19h.	20h.	21h.	22h.	23h.	Noon.	1h.	2h.	3h.	4h.
±49′	42	54	48	46	31	46	60[1]	46	39	45	±41′

The disturbing force is least during the day (if such an expression is admissible in this case), from 10 A. M. to 7 P. M., and greater and equally regular during the hours of the night (?), from 8 P. M. to 8 or 9 A. M. At Lake Athabasca the hours of least disturbance are between 9 A. M. and 7 P. M., and at Fort Simpson from 10 A. M. to 7 P. M. Captain Lefroy, in his discussion of the disturbances of the declination remarks: "There are indications in each of the three curves (for Lake Athabasca, Toronto and Sitka) of a small increase in the mean disturbance about noon." At Van Rensselaer Harbor we find the maximum disturbance at this very hour preceded and followed by quite small values; this circumstance certainly deserves our particular attention. Further coincidences of the disturbing force can be noticed at 5 P. M., at which hour at Van Rensselaer, Lake Athabasca, and Sitka the minimum disturbance has been observed. At Fort Simpson, in April and May, 1844, the mean disturbance was but one-fourth of that observed in January, February and March at Van Rensselaer, and the ratio of the minimum to the maximum value was 5.6 and 2.0 at the two places respectively.

By adding the squares of the differences for each hour of the day and month, we find the mean monthly disturbance by the formula $\sqrt{\frac{[\Sigma\Delta^2]}{N-24}}$. The mean disturbance for each month is as follows:—

In January, 1854	±30′
In February, "	±65
In March, "	±40

[1] Principally due to a very large disturbance.

The month of February was, therefore, that of the maximum amount of disturbance. At Lake Athabasca the greatest mean disturbance occurred in January (from observations between October and February inclusive). At Toronto,[1] on the contrary, the months of January and June are those of least disturbance. It is quite possible that at Van Rensselaer the above values are surpassed in other months of the year, yet relatively February contains the greatest mean disturbance during the period of observations.

Hitherto the recognition and separation of the disturbed observations have been effected by an arbitrary process of fixing upon a certain deviation from the mean as the greatest allowable departure, and regarding all observations beyond this limit as disturbances. In the present case, I have sought to introduce a more definite idea by the application of Pierce's criterion for the rejection of doubtful observations,[2] or what is equivalent—for the recognition of the disturbances—they following a different law from the general one. The average mean deviation of the readings composing an hourly mean I find = $\pm$ 46′, and for 17 values $x^2 = 4.55$; hence readings deviating from the mean more than 1° 38′ or 123d are to be recognized as disturbances.

The table of hourly readings contains 23 such values, or one disturbed observation for every 18 ordinary readings. In the five years of hourly observations ending June 30, 1848, at Toronto, the disturbances averaged one in 17 of the whole body. Excluding the above 23 values from the mean, the diurnal inequality freed of the disturbances undergoes no material change, as shown by the following table:—

5h.	6h.	7h.	8h.	9h.	10h.	11h.	Midn.	13h.	14h.	15h.	16h.
+23′.7	+6.0	—3.8	—9.3	—16.4	—12.5	—22.5	—34.7	—27.3	—35.1	—34.1	—26′.0
17h.	**18h.**	**19h.**	**20h.**	**21h.**	**22h.**	**23h.**	**Noon.**	**1h.**	**2h.**	**3h.**	**4h.**
—20′.1	—8.0	+9.0	+19.0	+23.3	+30.0	+29.0	+29.2	+34.4	+25.7	+13.6	+6′.9

The maximum west deflection is displaced from noon to one o'clock. The general mean changed from 317.3^d to 316.5^d, and the range of the mean inequality from 1° 06′.8 to 1° 09′.5. Eleven deflections were towards the east and twelve towards the west. The limited number of observations renders it necessary to conclude the foregoing examination of the disturbances.

Aurora Borealis.—In connection with the disturbances, a short notice of the auroral displays witnessed at the winter quarters will here find an appropriate place. In conformity with the supposed periodicity of this phenomenon, as recognized by Prof. Olmstead, no brilliant and complete auroras have been seen; with an exception of a very few, they may all be placed in his fourth class, to which the most simple forms of appearances have been referred. The aurora of October 24, 1854,

[1] See Vol. III. of the Magnetical and Meteorological Observations at Toronto, Canada. Discussion by Major-General E. Sabine. London, 1857.

[2] See Gould's Astronomical Journal, Nos. 45 and 83.

at 9 P. M. (see first volume of the Narrative), appears to have been one of the more conspicuous displays. A full record of the rest will be found in the 8th volume of the Smithsonian Contributions to Knowledge, in the collection made by Peter Force, Esq. There are 19 in number. The following statement is given in a foot-note: "The processes have no apparent connection with the magnetic dip, and in *no* case did the needle of our unifilar indicate disturbance."

Term-day Observations for Change of Magnetic Declination.—These observations were made at the following dates: January 18–19, February 24–25, March 22–23, April 19–20, May 26–27, and June 21–22, 1854. The readings are given in the following tables:—

TERM-DAY OBSERVATIONS FOR CHANGES OF MAGNETIC DECLINATION AT VAN RENSSELAER HARBOR, 1854.

Fern Rock Observatory, January 18 and 19, 1854.
Readings taken 2^m 14^s earlier than indicated.

Göttingen mean time.	0m.	06m.	12m.	18m.	24m.	30m.	36m.	42m.	48m.	54m.	Fern Rock mean time. (to 0m.)
10^h	305^d	305^d	305^d	307^d	308^d	312^d	311^d.8	306^d.5	309^d.5	312^d.5	4^h 37^m.5
11	311.2	313	314	315.8	318.5	317	317	319.7	320.5	322.5	5 "
12	320	314.8	315	315.7	317	320	321	320	316	314	6 "
13	311	307	309	311	313	315	317	318	317	315	7 "
14	320	322	319	316	320	320	322	318	320	322	8 "
15	321	323	323.3	322.3	320	319	320	320	325	325	9 "
16	329	329	330	330	327	336	350	366	367	369	10 "
17	362	354	353	347	347	346	346	341	337	334	11 "
18	330	332	335	338	338	340	342	343.5	342	344	12 "
19	344	346.5	345	344	344	345	346	346.5	347	345	13 "
20	346	345	345.5	345	348	347.5	349	351.5	351.5	349.5	14 "
21	349	354	359	363.5	359.5	351	350	351	350.8	351	15 "
22	356	358	359	361.5	361	355	352.3	357.8	358	360.5	16 "
23	360.5	358	355	351.5	350	349	346	340	332	335	17 "
0	336	333	330.5	326	320	320	323	226	328	337	18 "
1	343	352	350	346	340	348	353	357	349	343	19 "
2	337	332	328	324	332	336	340	343	346	345	20 "
3	342	339	329	320	313	300	292	284	277.5	268	21 "
4	251	244.5	240.5	250	261	254	243	230	235	155	22 "
5	115	90	89	96	88	85	105	129	145	155	23 "
6	163	180	193	220	254	290	291	307	298	270	0 "
7	268	254	240	266	289	297	320	318	320	321	1 "
8	336	336	336	331	337	337	337	330	327	324	2 "
9	314	326	332	338	323	318	316	316	316	314	3 "
10	312	310									4 "

The series commences with readings 304^d, 303^d, and 304^d, at 9^h 42^m, 48^m, and 54^m.

Fern Rock Observatory, February 24 and 25, 1854.
Readings taken 2^m 15^s earlier than indicated.

Göttingen mean time.	0m.	06m.	12m.	18m.	24m.	30m.	36m.	42m.	48m.	54m.	Fern Rock mean time. (to 0m.)
10^h	312^d	322^d	329^d	338^d	341^d.5	319^d.5	342^d	359^d	377^d	407^d	4^h 37^m.5
11	408	411	405	418	437	445	445	447	441	439	5 "
12	438	438	440	432	460	482	477	471	480	494	6 "
13	490	493	506	520	516	509	519	531	530	527.5	7 "
14	541	558.5	532	527	518	511	521	532	538	535	8 "
15	532	529	527	528	530.5	542	526	521	516	513	9 "
16	510	508	506	504	493	483	446	470	503	495	10 "
17	490	493	496	498	500	502	500	500	501	503	11 "
18	503	502	502	502	503	500	494	490	492	494	12 "
19	496	495	495	492	488	499	506	498	492	501	13 "
20	514	509	502	506	509	501	491	490	492	498	14 "
21	504	509	517	516	514	512	511	512	512	517	15 "
22	521	529	535	536	529	508	510	516	514	510	16 "
23	511	507	490	491	489	489	488	488	486	485	17 "
0	502	499	496	489	496	500	499	500	484	475	18 "
1	456	448	440	435	442	447	451	457	456	449	19 "
2	445	440	425	412	427	438	449	445	440	417	20 "
3	370	312	284	289	268	298	326	332	360	375	21 "
4	390	400	415	408	405	404	392	396	401	401	22 "
5	404	408	390	375	370	372	—	393	403	402	23 "
6	402	407	390	374	370	358	355	370	381	380	0 "
7	376	377	379	380	382.5	365	370	373	380	395	1 "
8	381	385	372	386	398	406	435	437	438	439	2 "
9	438	438	437	442	446	444	455	448	446	443	3 "
10	450	469	482	497							4 "

The series commences with readings 290^d, 288^d, 282^d, at 9^h 42^m, 48^m, and 54^m.

Value of a scale division 0′.80.
Increase of scale readings denotes a movement of the north end of the magnet to the east.

Göttingen mean time.	0m.	06m.	12m.	18m.	24m.	30m.	36m.	42m.	48m.	54m.	Fern Rock mean time. (to 0m.)
Fern Rock Observatory, March 22 and 23, 1854. Readings taken 1^{m} 34^{s} earlier than indicated.											
10^{h}	269^{d}	262^{d}	265^{d}	272^{d}	285^{d}	295^{d}	250^{d}	232^{d}	228^{d}	255^{d}	4^{h} $37^{m}.5$
11	240	261	243	246	232	228	236	260	259	258	5 "
12	258	256	254	256	258	258	259	260	263	263	6 "
13	262	253	258	264	263	267	265	256	251	247	7 "
14	235	237	239	239	240	244	243	247	245	240	8 "
15	240	238	239	237	234	233	234	237	245	251	9 "
16	268	265	267	279	280	277	272	264	260	269	10 "
17	275	279	277	282	279	280	282	284	283	282	11 "
18	281	280	278	277	275	273	272	270	269	268	12 "
19	269	268	268	268	267	267	268	266.5	264	262	13 "
20	261	261	262	261	261	258	258	259	262	265	14 "
21	269	267	266	264	264.5	262	269	273	278	284	15 "
22	283	282	278.5	275	270.5	263	265	260	260	261	16 "
23	260	257	256	250	253	256	248	250	257	263	17 "
0	272	280	283	285	292	288	289	287	290	294	18 "
1	300	302	291	290	292	283	277	273	271	[1]—	19 "
2	—	—	—	—	—	280	284	278	271	269	20 "
3	267	267	263	255	248	247	252	249	248	251	21 "
4	260	265	274	292	296	295	298	298	297	295	22 "
5	291	290	290	293	292	294.5	291	292	288	290	23 "
6	293	291	291	290	294	295	290	281	276	269	0 "
7	264	252	250	249	242	239	235	242	252	248.5	1 "
8	246	245	243	242	240	239	241	244	250	258	2 "
9	270	282	284	286.5	288	292	297	300	304	302	3 "
10	301	300	299								4 "
Fern Rock Observatory, April 19 and 20, 1854. Readings taken 2^{m} 14^{s} earlier than indicated.											
10^{h}	—	—	—	—	—	—	—	—	—	—	4^{h} $37^{m}.5$
11	—	—	—	—	—	—	—	—	—	—	5 "
12	—	—	—	—	—	—	—	—	—	—	6 "
13	—	—	—	—	—	—	—	—	—	—	7 "
14	—	—	—	—	—	—	—	—	—	—	8 "
15	—	—	—	—	—	—	—	—	—	—	9 "
16	—	—	—	272^{d}	271^{d}	275^{d}	273^{d}	$272^{d}.5$	278^{d}	282^{d}	10 "
17	289^{d}	299^{d}	298^{d}	312	310	305	301	296	299	262	11 "
18	271	287	294	290	289	286	280	268	254	230	12 "
19	236	250	245	242	239	234	229	230	242	256	13 "
20	265	262	260	256	252	247	243	236	231	228	14 "
21	225	224	230	236	229	226	231	233	230	227	15 "
22	226	222	218	215	213	189	187	183	190	187	16 "
23	184	182	194	220	221	223	218	220	222	225	17 "
0	231	236	242	236	238	240	235	224	215	203	18 "
1	194	190	187	184	181	180	178	178	168	164	19 "
2	175	208	236	242	212	205	202	190	190	193	20 "
3	194	196	199	200	210	192	180	175	164	152	21 "
4	140	137	139	148	147	160	164	152	140	121	22 "
5	107	113	116	136	145	132	130	120	90	63	23 "
6	+62	+43	+30	+32	—	—	—4	—7	+4	+8	0 "
7	+30	+23	+16	+12	+16	+11	+5	—2	+25	+58	1 "
8	71	67	73	77	79	81	75	73	76	80	2 "
9	75	74	97	110	128	132	138	147	142	134	3 "
10	126	122	128	132							4 "

Value of a scale division 0′.80.

Increase of scale readings denotes a movement of the north end of the magnet to the east.

[1] Watch stopped.

Göttingen mean time.	0m.	06m.	12m.	18m.	24m.	30m.	36m.	42m.	48m.	54m.	Fern Rock mean time. (to 0m.)
Fern Rock Observatory, May 26 and 27, 1854. Readings taken 1^m 34^s earlier than indicated.											
10^h	244^d	243^d	258^d	262^d	278^d	280^d	279^d	276^d	292^d	304^d	4^h $37^m.5$
11	330	345	357	365	372	369	365	360	364	368	5 "
12	360	355	345	342	350	348	341	333	330	338	6 "
13	349	356	364	359	354	351	355	360	381	395	7 "
14	403	413	411	408	400	389	395	400	407	410	8 "
15	414	423	428	436	442	443	442	438	436	433	9 "
16	435	434	440	450	476	490	520	555	570	575	10 "
17	593	600	575	548	533	523	516	506	498	492	11 "
18	485	482	479	477	477	476	475	475	477	480	12 "
19	483	487	493	495	488	495	527	552	568	587	13 "
20	595	612	624	630	633	631	625	620	612	604	14 "
21	599	603	609	612	615	626	633	635	644	650	15 "
22	663	667	665	661	658	659	653	646	640	637	16 "
23	639	641	632	618	595	590	583	572	559	541	17 "
0	543	545	546	546	544	540	537	536	535	537	18 "
1	538	525	523	539	527	520	515	513	480	479	19 "
2	487	493	498	503	506	509	509	533	562	571	20 "
3	573	553	537	517	495	489	486	488	496	510	21 "
4	512	510	507	513	514	512	511	506	497	487	22 "
5	486	485	483	484	480	477	476	476	477	463	23 "
6	449	443	442	440	441	443	447	454	463	470	0 "
7	478	483	487	489	488	483	471	459	457	446	1 "
8	435	447	460	468	475	490	487	478	485	491	2 "
9	493	513	525	530	533	535	534	515	500	—	3 "
10	—										4 "
Observations commence at 9^h 24^m, scale readings 280^d, 271^d, 266^d, 235^d, 231^d, 240^d, corresponding to 9^h 24^m, 30^m, 36^m, 42^m, 48^m, and 54^m respectively.											
Fern Rock Observatory, June 21 and 22, 1854. Readings taken 1^m 34^s earlier than indicated. (Magnet suspended, I. 7.)[1]											
10^h	—	—	—	—	—	—	—	—	—	295^d	4^h $37^m.5$
11	297^d	299^d	300^d	302^d	305^d	309^d	312^d	313^d	313^d	314	5 "
12	315	315	314	314	313	312	310	316	325	333	6 "
13	337	340	344	347	351	352	350	350	351	352	7 "
14	348	346	343	337	333	334	338	348	350	355	8 "
15	354	355	358	364	366	374	374	374	373	367	9 "
16	366	367	366	370	373	377	377	377	378	383	10 "
17	384	385	379	379	379	381	383	384	383	384	11 "
18	387	384	385	382	384	386	386	382	385	387	12 "
19	384	382	383	385	387	386	387	390	392	396	13 "
20	400	402	400	396	394	394	388	376	384	394	14 "
21	390	383	382	381	379	370	364	368	372	370	15 "
22	367	363	358	355	357	361	367	369	367	364	16 "
23	364	363	361	355	350	350	352	355	359	362	17 "
0	363	363	370	369	367	368	370	363	355	351	18 "
1	348	343	337	335	333	329	330	331	331	328	19 "
2	322	318	320	322	325	327	328	328	326	324	20 "
3	322	318	319	322	323	323	322	324	326	331	21 "
4	326	315	334	330	326	326	319	318	318	318	22 "
5	312	316	318	317	323	321	317	310	312	308	23 "
6	306	320	316	316	318	323	304	303	312	290	0 "
7	291	287	286	286	291	283	275	281	283	288	1 "
8	289	290	292	289	291	293	297	298	302	304	2 "
9	304	309	313	312	308	303	295	290	282	273	3 "
10	264	257	245	283	232	230	234	239	242	228	4 "
11	212	207									5 "

Value of a division of the scale 0′.80.

Increase of scale readings denotes a movement of the north end of the magnet to the east.

The results of the preceding tables have been thrown into curves, to which the corresponding readings at Greenwich and Washington have been added.[1] These readings have all been referred to the same scale, and thus present at a glance the great difference in the magnitude of the diurnal motion as well as that of the disturbances. The Greenwich observations were taken by means of photography; the Washington corresponding observations were also obtained by means of Brooke's automatic photographic registration, and have as yet only been published in the 6th volume of the Astronomical Expedition to Chili, under the direction of Lieut. Gilliss, U. S. N.; Washington, D. C., 1856.

For the Greenwich curves the zero line corresponds to 22° west declination. A remarkable absence of disturbances of any magnitude as well as a small diurnal range of motion at the time of the vernal equinox, is shown by the March curves both for Van Rensselaer and Greenwich.

There appear to be some disturbances common to both places, and if these indications should not be accidental they are of an opposite character, that is, a magnetic east deflection is presenting itself as a magnetic west deflection at the other station, and *vice versa.* For this the reader may examine hours 17 and 5½ of the curve for January 18 and 19, hours from 6 to 8, April 20th, and one or two other less striking cases. The needle at Van Rensselaer Harbor actually points with its north end to the south of the astronomical west, and its meridional component of the direction is pointing in a southern or opposite direction to the same component at Greenwich or Washington.

Absolute Declination.—The magnetic declination at Van Rensselaer Harbor was determined on three occasions in the summer of 1854. Two different magnets were used.

Determination of June 9th. Magnet A 68, mirror facing magnetic north.

Position.	Circle reads. Mark.	P.	Circle reads. Magnetic meridian (south).	P.	Circle reads. Mark.
I.	338° 06′	I.	316° 01′	I.	338° 02′
	06′		00		01
II.	338 00	II.	315 57	II.	338 05
	337 59		56		04
Means	338 02.8		315 58.5 at 6^h 35^m Green. t.		338 03.0

Mean reading on mark	338° 03′
Astronomical bearing (N.)	93 29 E.
Reading of meridian (N.)	244 34
Magnetic meridian (N.)	135 59
Declination	108° 35′

W. (of north) at 1^h 52^m P. M. local time.

[1] See accompanying plates 1 and 2.

Determination of June 14. Magnet I. 10. Mirror facing magnetic north.

Mark.			Magnetic south meridian.			Mark.		
I.	338°	09′	I.	317°	10′	I.	338°	04′
		08			at 5^h 12^m Gr. t.			02
II.	338	05			09	II.	338	09
		04	II.	317	02			08
					01			
Means	338	06.5		317	05.5		338	05.8

Mean reading on mark	338° 06′
Astronomical bearing (N.)	93 29 E.
Reading of true meridian	244 37
Reading of magnetic meridian	137 05
Declination	107° 32′
	W. at 0^h 29^m P. M. local time.

The magnet showed considerable agitation during the day.

Determination of June 26. Mirror facing magnetic north.

Magnetic south meridian.			Mark.			Magnetic south meridian.		
I.	315°	49′	I.	338°	24′	I.	315°	52′
		47			23			50
II.	316	18	II.	338	20	II.	315	40
		17			19			38
Means	316	02.7		338	21.5		315	45.0
at 1^h 3^m P. M. local time.						at 2^h 0^m P. M. local time		

Mark reads	338° 21′
Astronomical bearing (N.)	93 29 E.
N. meridian (true)	244 52
Magnetic meridian	135 53
Declination	108° 59′
	W. at 1^h 31^m P. M.

Resulting mean declination (for June 16) 108° 22′ W.; if we omit the 2d determination on account of disturbance, and apply a correction for diurnal change to the mean of the first and last determination, we find 108° 12′ W.

SECTION II.

OBSERVATIONS OF THE MAGNETIC INCLINATION.

1853, 1854, AND 1855.

SECTION II.

MAGNETIC INCLINATION.

Instrument and Remarks.—The observations for dip were made by Mr. Sonntag by means of a Barrow dip circle received from Prof. Henry, of the Smithsonian Institution, through the courtesy of Col. Sabine. The inclinometer was supplied with Lloyd needles, for determining the total intensity, but unfortunately the complete record of these observations could not be recovered; the absence of the record for determining the constants necessary for their reduction being wanted, no use could be made of these observations, even for relative intensity at Saikatle and Marshall Bay, and the partial results given in Appendix XV., vol. II. of the Narrative, must, therefore, remain fruitless for the present. There is likewise a deficiency in the record of the dip observations at Van Rensselaer Harbor after February 23, 1854; the results, however, are all preserved in the Appendix just mentioned.

In regard to the index error of the dipping needles, we can only make an approximate comparison. The observations at New York, where the dip has been represented by the formula

$$I = 72^\circ.69 - 0.00491\,(t - 1845) + 0.00114\,(t - 1845)^2,$$

with a probable error of any single observation[1] of $\pm 3'.3$, would apparently produce a correction to needle 1 of $-9'$, and to needle 2 of $-14'$, the changes, however, from one station to another in the immediate vicinity of the city are much greater, and these quantities may, therefore, as well indicate local deviation as index error. The polarity of the needles has been reversed at each station, the effect of this operation upon the resulting dip is somewhat irregular, and will be found exhibited in tabular form.

[1] See Coast Survey Report of 1856, p. 240. The formula includes dip observations taken between December, 1822, and August, 1855 (exclusive of the observations of the present expedition).

STATION NO. I. NEW YORK, AT MR. RUTHERFORD'S OBSERVATORY.

Latitude 40° 43′.8. Longitude 73° 58′.9. W. of G.

May 18, 1853. 4h P. M. Needle No. 2. Poles direct. Magnetic meridian reads 248° 10′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	b	a	b	a	b	a	b
72° 57′	72° 37′	73° 08′	73° 27′	72° 51′	72° 52′	72° 53′	73° 25′
72 56	72 35	73 05	73 24	72 54	72 54	72 56	73 29
72 56.5	72 36.0	73 06.5	73 25.5	72 52.5	72 53.0	72 54.5	73 27.0
72 46.2		73 16.0		72 52.7		73 10.7	
73 01.1				73 01.7			
73 01.4							

Needle No. 2. Poles reversed.

CIRCLE WEST.				CIRCLE EAST.			
Face west.		Face east.		Face west.		Face east.	
a	b	a	b	a	b	a	b
72° 08′	72° 16′	72° 17′	73° 17′	73° 20′	72° 38′	73° 00′	73° 05′
72 10	72 18	72 30	73 30	73 19	72 36	73 00	73 06
72 09.0	72 17.0	72 23.5	73 23.5	73 19.5	72 37.0	73 00.0	73 05.5
72 13.0		72 53.5		72 58.2		73 02.8	
72 33.2				73 00.5			
72 46.8							

May 18, 1853. 22h 30m. Needle No. 2. Poles reversed. Magnetic meridian reads 248° 10′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	b	a	b	a	b	a	b
73° 07′	73° 28′	72° 42′	72° 44′	72° 50′	73° 11′	72° 37′	72° 37′
73 03	73 26	72 40	72 47	72 54	73 13	72 40	72 34
73 05.0	73 27.0	72 41.0	72 45.5	72 52.0	73 12.0	72 38.5	72 35.5
73 16.0		72 43.2		73 02.0		72 37.0	
72 59.6				72 49.5			
72 54.6							

Needle No. 2. Poles direct.

CIRCLE WEST.				CIRCLE EAST.			
Face west.		Face east.		Face west.		Face east.	
a	b	a	b	a	b	a	b
72° 52′	72° 51′	72° 49′	72° 54′	73° 37′	73° 51′	72° 58′	73° 20′
72 55	72 55	72 52	72 59	73 34	73 48	72 57	73 17
72 53.5	72 53.0	72 50.5	72 56.5	73 35.5	73 49.5	72 57.5	73 18.5
72 53.2		72 53.5		73 42.5		73 08.0	
72 53.4				73 25.2			
73 09.3							

May 20, 1853. 4h. Needle No. 1. Poles direct.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
71° 37′	72° 00′	75° 55′	76° 22′	73° 11′	73° 02′	73° 41′	74° 04′
71 34	71 59	75 52	76 21	73 13	73 04	73 45	74 06
71 35.5	71 59.5	75 53.5	76 21.5	73 12.0	73 03.0	73 43.0	74 05.0
71 47.5		76 07.5		73 07.5		73 54.0	
73 57.5				73 30.7			
73 44.1							

Needle No. 1. Poles reversed.

CIRCLE WEST.				CIRCLE EAST.			
Face west.		Face east.		Face west.		Face east.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
69° 58′	70° 10′	73° 17′	72° 52′	72° 32′	73° 08′	72° 56′	73° 09′
70 00	70 13	73 16	72 55	72 30	73 06	72 53	73 06
69 59.0	70 11.5	73 16.5	72 53.5	72 31.0	73 07.0	72 54.5	73 07.5
70 05.2		73 05.0		72 49.0		73 01.0	
71 35.1				72 55.0			
72 15.1							

May 20, 1853. Needle No. 1. Poles direct.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
71° 48′	72° 03′	74° 18′	74° 48′	72° 38′	72° 33′	74° 26′	74° 27′
71 45	72 01	74 17	74 45	72 40	72 35	74 29	74 31
71 46.5	72 02.0	74 17.5	74 46.5	72 39.0	72 34.0	74 27.5	74 29.0
71 54.2		74 32.0		72 36.5		74 28.2	
73 13.1				73 32.3			
73 22.7							

Needle No. 1. Poles reversed.

CIRCLE EAST.				CIRCLE WEST.			
Face west.		Face east.		Face west.		Face east.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
72° 47′	73° 21′	73° 13′	73° 32′	69° 55′	69° 48′	72° 24′	72° 27′
72 45	73 19	73 11	73 30	69 59	69 51	72 28	72 29
72 46.0	73 20.0	73 12.0	73 31.0	69 57.0	69 49.5	72 26.0	72 28.0
73 03.0		73 21.5		69 53.2		72 27.0	
73 12.2				71 10.1			
72 11.2							

STATION NO. II. FISKERNAES, FLAGSTAFF NEAR THE GOVERNOR'S HOUSE.
Latitude 63° 05′.3. Longitude 50° 34′4. W. of G.

June 29, 1853. Needle No. 2. Poles reversed. Meridian reads 106° 01′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
80° 07′	80° 05′	82° 08′	81° 59′	80° 28′	80° 36′	80° 30′	80° 50′
80 11	80 07	82 08	81 58	80 25	80 34	80 28	80 49
80 09.0	80 06.0	82 08.0	81 58.5	80 26.5	80 35.0	80 29.0	80 49.5
80 07.5		82 03.3		80 30.7		80 39.2	
81 05.4				80 34.9			
80 50.2							

Needle No. 2. Poles direct.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
80° 47′	80° 38′	80° 28′	80° 29′	80° 13′	80° 24′	80° 42′	80° 41′
80 46	80 41	80 28	80 29	80 10	80 22	80 40	80 39
80 46.5	80 39.5	80 28.0	80 29.0	80 11.5	80 23.0	80 41.0	80 40.0
80 43.0		80 28.5		80 17.2		80 40.5	
80 35.7				80 28.9			
80 32.3							

STATION NO. III. FISKERNAES HARBOR, ON A SMALL ISLAND ON THE NORTH SIDE OF HARBOR.

July 1, 1853. Needle No. 2. Poles direct. Meridian reads 150° 22′.

CIRCLE WEST.				CIRCLE EAST.			
Face west.		Face east.		Face west.		Face east.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
82° 24′	83° 01′	79° 54′	80° 03′	81° 59′	82° 05′	80° 53′	79° 49′
82 27	83 04	79 57	80 06	81 59	82 03	80 50	79 51
82 25.5	83 02.5	79 55.5	80 04.5	81 59.0	82 04.0	80 51.5	79 50.0
82 44.0		80 00.0		82 01.5		80 20.7	
81 22.0				81 11.1			
81 16.6							

Needle No. 2. Poles reversed.

CIRCLE WEST.				CIRCLE EAST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
81° 07′	81° 23′	79° 52′	80° 00′	80° 49′	80° 52′	79° 54′	79° 54′
81 11	81 23	79 55	80 02	80 46	80 58	79 53	79 53
81 09.0	81 23.0	79 53.5	80 01.0	80 47.5	80 55.0	79 53.5	79 53.5
81 16.0		79 57.2		80 51.2		79 53.5	
80 36.6				80 22.3			
80 29.4							

Station No. IV. Saikatle, island south from Sukkertoppen.

(Latitude and longitude not determined.)

The magnetic station was on a small bay on the southeast side of the island, and is covered with water at high tide. The Lloyd needles only were used.

Station No. V. Sukkertoppen, in the garden near the Governor's House.

(Latitude and longitude not determined.)

July 9, 1853. 15^h. Needle No. 2. Poles reversed. Meridian reads 75° 20′.

CIRCLE WEST.				CIRCLE EAST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
80° 30′	80° 43′	81° 15′	81° 48′	80° 46′	80° 30′	81° 20′	81° 20′
80 28	80 46	81 15	81 45	80 46	80 33	81 20	81 21
80 29.0	80 44.5	81 15.0	81 46.5	80 46.0	80 31.5	81 20.0	81 20.5
80 36.7		81 30.7		80 38.8		81 20.2	
81 03.7				80 59.5			
81 01.6							

Needle No. 2. Poles direct.

CIRCLE WEST.				CIRCLE EAST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
81° 30′	82° 25′	80° 17′	80° 40′	80° 53′	80° 42′	79° 31′	79° 04′
81 28	82 24	80 14	80 37	80 57	80 45	79 34	79 05
81 29.0	82 24.5	80 15.5	80 38.5	80 55.0	80 43.5	79 32.5	79 04.5
81 56.7		80 27.0		80 49.2		79 18.5	
81 11.8				80 03.8			
80 37.8							

Station No. VI. Proven, ground near the Governor's House.

Latitude 72° 25′.9. Longitude 55° 25′ (both approximate).

July 19, 1853. Needle No. 2. Poles direct. Magnetic meridian 0° 33′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
82° 35′	82° 45′	83° 16′	83° 19′	82° 38′	82° 41′	83° 44′	83° 44′
82 34	82 44	83 14	83 17	82 40	82 43.	83 47	83 47
82 34.5	82 44.5	83 15.0	83 18.0	82 39.0	82 42.0	83 45.5	83 45.5
82 39.5		83 16.5		82 40.5		83 45.5	
82 58.0				83 13.0			
83 05.5							

Needle No. 2. Poles reversed.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
83° 15′	83° 14′	83° 11′	83° 30′	83° 30′	83° 19′	82° 14′	82° 23′
83 14	83 12	83 10	83 28	83 30	83 21	82 17	82 25
83 14.5	83 13.0	83 10.5	83 29.0	83 30.0	83 20.0	82 15.5	82 24.0
83 13.7		83 19.7		83 25.0		82 19.8	
83 16.7				82 52.4			
83 04.5							

Needle No. 2. Poles direct. Meridian reads 0° 33′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
83° 10′	83° 02′	81° 30′	81° 35′	82° 22′	82° 27′	83° 28′	83° 41′
83 08	83 01	81 30	81 34	82 23	82 29	83 29	83 44
83 09.0	83 01.5	81 30.0	81 34.5	82 22.5	82 28.0	83 28.5	83 42.5
83 05.2		81 32.2		82 25.2		83 35.5	
82 18.7				83 00.3			
82 39.5							

Needle No. 2. Poles reversed.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
83° 13′	83° 20′	82° 57′	82° 52′	83° 03′	83° 19′	82° 30′	82° 32′
83 15	83 19	82 55	82 49	83 05	83 20	82 32	82 34
83 14.0	83 19.5	82 56.0	82 50.5	83 04.0	83 19.5	82 31.0	82 33.0
83 16.7		82 53.3		83 11.7		82 32.0	
83 05.0				82 51.8			
82 58.4							

STATION No. VII. UPERNAVIK, STATION IN GARDEN NEAR THE GOVERNOR'S HOUSE.
(Latitude and longitude not determined.)

July 22, 1853. Needle No. 2. Poles direct. Magnetic meridian reads 239° 18′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
82° 42′	82° 43′	84° 22′	84° 21′	83° 13′	83° 33′	83° 59′	84° 12′
82 39	82 40	84 21	84 18	83 16	83 36	84 01	84 14
82 40.5	82 41.5	84 21.5	84 19.5	83 14.5	83 34.5	84 00.0	84 13.0
82 41.0		84 20.5		83 24.5		84 06.5	
83 30.7				83 45.5			
83 38.1							

Needle No. 2. Poles reversed.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
84° 15′	84° 40′	83° 22′	83° 20′	83° 33′	83° 44′	83° 40′	83° 28′
84 13	84 37	83 20	83 18	83 34	83 45	83 42	83 30
84 14.0	84 38.5	83 21.0	83 19.0	83 33.5	83 44.5	83 41.0	83 29.0
84 26.2		83 20.0		83 39.0		83 35.0	
83 53.1				83 37.0			
83 45.0							

STATION No. VIII. BEDEVILLED REACH, FORCE BAY. STATION HALF A MILE EAST OF ANCHORAGE(?).
Latitude 78° 34′.5. Longitude 71° 33′.6.

August 12, 1853. Needle No. 2. Poles direct. Meridian reads 248° 30′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
84° 54′	85° 03′	86° 12′	86° 35′	84° 16′	84° 17′	86° 18′	86° 02′
84 48	84 59	86 17	86 30	84 14	84 14	86 19	86 04
84 51.0	85 01.0	86 14.5	86 32.5	84 15.0	84 15.5	86 18.5	86 03.0
84 56.0		86 23.5		84 15.2		86 10.7	
85 39.7				85 12.9			
85 26.3							

Needle No. 2. Poles reversed.

CIRCLE WEST.				CIRCLE EAST.			
Face west.		Face east.		Face west.		Face east.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
84° 15′	84° 04′	84° 55′	85° 04′	84° 13′	84° 43′	85° 44′	85° 43′
84 20	84 10	84 55	85 03	84 09	84 38	85 40	85 39
84 17.5	84 07.0	84 55.0	85 03.5	84 11.0	84 40.5	85 42.0	85 41.0
84 12.2		84 59.3		84 25.8		85 41.5	
84 35.8				85 03.6			
84 49.7							

Station No. IX. Near Marshall Bay.

Latitude 78° 52′. Longitude 69° 01′.[1]

The observations on September 3d, 1853, were made with the Lloyd needle, No. 1, Box B. The dip by the statical needle is 85° 26′, and the resulting corrected dip 84° 49′. See Narrative, vol. I. p. 99.

Station No. X. Van Rensselaer Harbor, Winter Quarters. Magnetic Observatory on Fern Rock.

Latitude 78° 37′. Longitude 70° 40′. W. of G.

January 26, 1854. Needle No. 2. Poles direct. Magnetic meridian reads on circle 9° 02′.

Circle west.				Circle east.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
83° 05′	83° 02′	83° 48′	85° 06′	82° 53′	82° 30′	85° 16′	85° 22′
83 05	83 03	83 47	85 05	82 47	82 26	85 10	85 17
83 05.0	83 02.5	83 47.5	85 05.5	82 50.0	82 28.0	85 13.0	85 19.5
83 03.7		84 26.5		82 39.0		85 16.2	
83 45.1				83 57.6			
83 51.3							

Needle No. 2. Poles reversed.

Circle west.				Circle east.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
84° 48′	85° 22′	84° 09′	84° 40′	86° 20′	86° 05′	84° 27′	85° 20′
84 48	85 23	84 15	84 39	86 15	86 00	84 21	85 16
84 48.0	85 22.5	84 12.0	84 39.5	86 17.5	86 02.5	84 24.0	85 18.0
85 05.2		84 25.8		86 10.0		84 51.0	
84 45.5				85 30.5			
85 08.0							

[1] Erroneously given 67° 01′ in the Narrative, vol. II. p. 431; the date should also be changed as given above.

February 16, 1854. Needle No. 2. Poles direct. Meridian reads 69° 30′.

CIRCLE WEST.				CIRCLE EAST.			
Face west.		Face east.		Face west.		Face east.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
85° 38′	86° 02′	84° 41′	84° 30′	85° 24′	85° 38′	83° 51′	83° 44′
85 38	86 02	84 41	84 28	85 23	85 39	83 56	83 44
85 38.0	86 02.0	84 41.0	84 29.0	85 23.5	85 38.5	83 53.5	83 44.0
85 50.0		84 35.0		85 31.0		83 48.7	
85 12.5				84 39.9			
84 56.2							

Needle No. 2. Poles reversed.

CIRCLE WEST.				CIRCLE EAST.			
Face west.		Face east.		Face west.		Face east.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
84° 28′	84° 25′	84° 53′	84° 49′	84° 35′	84° 33′	85° 11′	85° 38′
84 30	84 23	84 52	84 49	84 36	84 33	85 13	85 38
84 29.0	84 24.0	84 52.5	84 49.0	84 35.5	84 33.0	85 12.0	85 38.0
84 26.5		84 50.7		84 34.2		85 25.0	
84 38.6				84 59.6			
84 49.1							

February 23, 1854. Needle No. 2. Poles reversed. Magnetic meridian 67° 35′.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
85° 30′	85° 35′	85° 11′	85° 14′	85° 06′	85° 04′	84° 26′	84° 12′
85 26	85 30	85 06	85 10	85 08	85 07	84 27	84 14
85 28.0	85 32.5	85 08.5	85 12.0	85 07.0	85 05.5	84 26.5	84 13.0
85 30.2		85 10.2		85 06.2		84 19.8	
85 20.2				84 43.0			
85 01.6							

Needle No. 2. Poles direct.

CIRCLE EAST.				CIRCLE WEST.			
Face east.		Face west.		Face east.		Face west.	
a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
84° 27′	84° 08′	85° 01′	85° 21′	84° 28′	84° 12′	85° 06′	85° 13′
84 24	84 04	84 57	85 18	84 29	84 14	85 07	85 15
84 25.5	84 06.0	84 59.0	85 19.5	84 28.5	84 13.0	85 06.5	85 14.0
84 15.7		85 09.3		84 20.7		85 10.2	
84 42.5				84 45.4			
84 44.0							

Recapitulation of Results for Magnetic Inclination.

No. of station.	Locality.	Date.	No. of needle.	Dip. Pole direct.	Dip. Pole reversed.	Difference for change of polarity.	Mean and resulting dip.	
I.	New York city	May 18, 1853	2	73° 01′.4	72° 46′.8	+14′.6	72° 54′.1	72° 55′.6
"	" "	" "	2	73 09.3	72 54.6	+14.7	72 61.9	
"	" "	May 20, "	1	73 44.1	72 15.1	+89.0	72 59.6	
"	" "	" "	1	73 22.7	72 11.2	+71.5	72 47.0	
II.	Fiskernaes	June 29, "	2	80 32.3	80 50.2	—17.9	80 41.3	
III.	Fiskernaes Harbor	July 1, "	2	81 16.6	80 29.4	+47.2	80 53.0	
IV.	Saikatle	July 9, "	Ll.	(Approx	imate.)	—	80 56.0	
V.	Sukkertoppen	July 9, "	2	80 37.8	81 01.6	—23.8	80 49.7	
VI.	Proven	July 19, "	2	83 05.5	83 04.5	+ 1.0	83 05.0	82 57.0
"	"	" "	2	82 39.5	82 58.4	—18.9	82 49.0	
VII.	Upernavik	July 22, "	2	83 38.1	83 45.0	— 6.9	83 41.5	
VIII.	Bedevilled Reach	Aug. 12, "	2	85 26.3	84 49.7	+36.6	85 08.0	
IX.	Marshall Bay	Sept. 3, "	Ll.	(Approx	imate.)	—	84 49.0	
X.	Fern Rock Observatory, Van Rensselaer Harbor	Jan. 26, 1854	2	83 51.3	85 08.0	—76.7	84 29.7	84 45.8
"	" "	Feb. 16, "	2	84 56.2	84 49.1	+ 7.1	84 52.6	
"	" "	Feb. 23, "	2	84 44.0	85 01.6	—17.6	84 52.8	
"	" "	March 2, "	2	—	—	—	84 49.0	
"	" "	June 10, "	2	—	—	—	84 47.2	
"	" "	" "	2	—	—	—	84 51.0	
"	" "	April 24, 1855	2	(12	sets.)	—	84 48.7	
"	" "	May 20, "	2	—	—	—	84 35.6	

The resulting dip at Van Rensselaer Harbor may be taken as corresponding in time to June, 1854.

SECTION III.

OBSERVATIONS OF MAGNETIC INTENSITY.

1854 AND 1855.

SECTION III.

OBSERVATIONS AND DISCUSSION OF THE MAGNETIC INTENSITY.

THE instrument used (a unifilar magnetometer) has already been described. For the determination of the intensity, the long magnet A. 67 has exclusively been used for oscillations and deflections. The effect of the torsion in the suspension was found so small that it was neglected. The vibrations have been observed in sets of two, one containing the readings of the chronometer when the magnet was moving in the direction of the scale readings, and the other when the magnet was moving in the opposite direction.[1] A mean time pocket chronometer was generally used for noting the time, and its rate was too small to affect sensibly the duration of a single vibration. In the deflections, the magnets were always kept at right angles to one another; the distance of the middle of the deflecting magnet, A. 67, from the suspended magnet, is given by a scale divided into feet and decimals of a foot.[2] The observations were made by Mr. A. Sonntag. At Van Rensselaer Harbor the observations extend over the time from January, 1854, to May, 1855. Two other stations were occupied, one in June, 1855, at Hakluyt Island, the other in July, on the coast between Parker Snow Point and Cape York, at the return of the party.

The necessary constants have been determined at Washington, D. C.

Magnet A. 67 is nearly three inches in length, the two other magnets, I. 7 and I. 10, are somewhat shorter.

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[1] The vibrations given in the Narrative, vol. II., Appendix, No. XV., pp. 431—434, are, therefore, double vibrations, and should have been noted as such.

[2] By some inadvertence, Appendix No. XV. of vol. II. of the Narrative contains the distances expressed in inches; it should have been given in feet and decimals, thus, 13 inches should be 1.3 feet, and 9 inches should read 0.9 feet.

January 17, 1854. **Fern Rock Observatory,** Van Rensselaer Harbor.

A. 67 suspended. Experiments of vibrations. (From right to left.)

No.	Time by pocket chronometer.	No.	Time by pocket chronometer.	Time of 45 double vibrations.
1	$5^h\ 58^m\ 37^s.3$	46	$6^h\ 10^m\ 10^s.8$	$11^m\ 33^s.5$
2	52.9	47	26.3	33.4
3	59 08.0	48	41.4	33.4
4	23.8	49	57.0	33.2
5	38.7	50	11 12.7	34.0
6	54.5	51	28.0	33.5
7	6 00 09.9	52	43.3	33.4
8	25.9	53	58.4	32.5
9	40.2	54	12 14.0	33.8
10	55.8	55	29.6	33.8
				Mean $11^m 33^s.45$

Arc at beginning 4° 40′. Temp. 50°. Time of 2 vibrations
" end 1 28 $15^s.410$.

The vibrations from left to right could not be observed.

January 18, 1854. **Fern Rock Observatory.**

Experiments of vibrations. (From right to left.)

No.	Time by pocket chronometer.	No.	Time by pocket chronometer.	Time of 50 double vibrations.
1	$5^h\ 30^m\ 43^s.0$	51	$5^h\ 43^m\ 37^s.5$	$12^m\ 54.5$
2	58.8	52	53.8	55.0
3	31 14.0	53	44 08.8	54.8
4	29.3	54	23.9	54.6
5	44.4	55	39.8	55.4
6	32 00.0	56	54.0	54.0
7	15.3	57	45 10.8	55.5
8	31.5	58	25.8	54.3
9	46.5	59	41.8	55.3
10	33 02.0	60	57.0	55.0
11	18.1	61	46 12.5	54.5
				12 54.81

Arc at beginning 4° 40′. Temp. 68. Time of 2 vibrations
" end 1 12 $15^s.496$.

January 18, 1854. **Fern Rock Observatory.**

Experiments of vibrations. (From left to right.)

No.	Time by pocket chronometer.	No.	Time by pocket chronometer.	Time of 50 double vibrations.
1	$5^h\ 30^m\ 50^s.8$	51	$5^h\ 43^m\ 46^s.7$	$12^m\ 55^s.9$
2	31 06.7	52	44 02.0	55.3
3	22.0	53	18.4	56.4
4	36.9	54	32.7	55.8
5	52.9	55	49.0	56.1
6	32 08.0	56	45 04.8	56.8
7	23.8	57	20.0	56.2
8	39.2	58	35.3	56.1
9	54.8	59	51.0	56.2
10	33 10.3	60	46 07.0	56.7
11	26.0	61	22.2	56.2
				12 56.15

Arcs and temp. as before. Time of 2 vibrations $15^s.523$.

(Dr. Hayes assisted in these observations.)

February 21, 1854. **Fern Rock Observatory.**

Experiments of vibrations. (From right to left.)

No.	Time by pocket chronometer.	No.	Time by pocket chronometer.	Time of 50 double vibrations.
1	4^h 59^m $26^s.0$	51	5^h 12^m $23^s.5$	12^m 57.5
2	41.8	52	39.4	57.6
3	56.4	53	55.0	58.6
4	5 00 12.6	54	13 10.2	57.6
5	28.2	55	26.2	58.0
6	43.5	56	41.5	58.0
7	58.9	57	57.3	58.4
8	01 14.6	58	14 12.8	58.2
9	30 2	59	28.3	58.1
10	45.6	60	43.5	57.9
11	02 01.3	61	59.2	57.9
				12 57.98

Arc at beginning 5° 52′. Temp. 79°. Time of 2 vibrations
" end 2 24 $15^s.560$.

Experiments of vibrations. (From left to right.)

No.	Time by pocket chronometer.	No.	Time by pocket chronometer.	Time of 50 double vibrations.
1	4^h 59^m $33^s.5$	51	5^h 12^m $31^s.8$	12^m $58^s.3$
2	48.3	52	47.1	58.8
3	5 00 04.8	53	13 02.8	58.0
4	20.4	54	18.4	58.0
5	35.7	55	34.0	58.3
6	51.2	56	49.5	58.3
7	01 06.9	57	14 05.2	58.3
8	22.5	58	20.8	58.3
9	38.0	59	36.2	58.2
10	53.5	60	51.7	58.2
11	02 09.5	61	15 07.4	57.9
				12 58.24

Arcs and temp. as before. Time of 2 vibrations $15^s.565$.

February 21, 1854. **Fern Rock Observatory.**

Experiments of vibrations. (From right to left.)

No.	Time by pocket chronometer.	No.	Time by pocket chronometer.	Time of 50 double vibrations.
1	6^h 20^m $47^s.5$	51	6^h 33^m $42^s.6$	12^m 55.1
2	21 03.0	52	58.0	55.0
3	19.0	53	34 14.0	55.0
4	34.3	54	29.6	55.3
5	49.5	55	45.0	55.5
6	22 05.5	56	35 00.3	54.8
7	20.9	57	16.8	55.9
8	36.3	58	32.0	55.7
9	51.5	59	47.0	55.5
10	23 07.0	60	36 03.7[1]	56.7
				12 55.45

Arc at beginning 5° 20′. Temp. 55°. Time of 2 vibrations
" end 1 36 $15^s.509$.

[1] Corrected by 10^s.

February 21, 1854. **Fern Rock Observatory.**

Experiments of vibrations. (From left to right.)

No.	Time by pocket chronometer.	No.	Time by pocket chronometer.	Time of 50 double vibrations.
1	6h 20m 55s.2	51	6h 33m 51s.0	12m 55.8
2	21 11.0	52	34 06.5	55.5
3	27.0	53	22.6	55.6
4	42.0	54	37.5	55.5
5	57.5	55	53.4	55.9
6	22 13.3	56	35 08.6	55.3
7	29.0	57	25.0	56.0
8	43.8	58	39.6	55.8
9	59.2	59	55.5	56.3
10	23 15.3	60	36 12.0	56.7
				12 55.84

Arcs and time as before. Time of 2 vibrations 15s.517.

RECAPITULATION OF RESULTS.

January 17, 1854.	Time of 2 vibrations	15s.410	Temp. 50°
" 18, "	" "	15.496 }	" 68 }
" 18, "	" "	15.523 }	" 68 }
February 21, "	" "	15.560 }	" 79 }
" 21, "	" "	15.565 }	" 79 }
" 21, "	" "	15.509 }	" 55 }
" 21, "	" "	15.517 }	" 55 }
	Combination by two means	15.499	63.0
	Time of one vibration	7.749	

January 31, 1854. Experiments of deflections. Distance 1.3 feet. Deflecting magnet A 67.

Magnet.	North pole.	Circle reads.	Mean.	Diff. or 2 u.	Temp.
E.	W.	318° 40′ / 41	40′.5	30° 43′.5	68°
"	E.	287 57 / 57	57.0		73
W.	E.	288 47 / 47	47.0	30 50.0	75
"	W.	319 37 / 37	37.0		72.5
				Means 30 46.7	72.1

February 13, 1854. Experiments of deflections. Distance 0.975 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
E.	E.	162° 07′ / 06	06′.5	78° 56′.5	50°
"	W.	83 10 / 10	10.0		61
W.	W.	86 24 / 24	24.0	78 23.0	65
"	E.	164 47 / 47	47.0		66
				Means 78 40.0	60.5

February 27, 1854. Experiments of deflections. Distance 1.3 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
E.	E.	140° 54′.5	54′.5		58°
		54.5			
"	W.	109 58	58.5	30° 56′.0	58
		59			
W.	W.	110 31	31.5		58
		32			
"	E.	141 15	15.0	30 43.5	56
		15			
				30 49.7	57.5

June 7, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 45 double vibrations.
1	$3^h\ 04^m\ 34^s.2$	46	$3^h\ 16^m\ 02^s.5$	$11^m\ 28^s.3$
2	49.4	47	17.8	28 4
3	05 05.0	48	33.0	28.0
4	20.3	49	48.3	28.0
5	35.8	50	17 03.6	27.8
6	51.1	51	19.0	27.9
7	06 06.3	52	34.2	27.9
8	21.8	53	49.4	27.6
9	36.9	54	18 04.8	27.9
10	52.1	55	20.0	27.9
				11 27.97

Arc at beginning 6° 8′. Temp. +33°. Time of 2 vibrations $15^s.288$.
" end 2 48

Rate of mean time chronometer 2721 (showing nearly Greenwich time), about $2^s.0$ losing.

June 7, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 45 double vibrations.
1	$3^h\ 04^m\ 42^s.3$	46	$3^h\ 16^m\ 10^s.2$	$11^m\ 27^s.9$
2	57.6	47	25.5	27.9
3	05 12.7	48	40.8	28.1
4	28.1	49	56.0	27.9
5	43.3	50	17 11.2	27.9
6	58.8	51	26.5	27.7
7	06 13.8	52	41.9	28.1
8	29.2	53	57.4	28.2
9	44.4	54	18 12.5	28.1
10	07 00.0	55	27.8	27.8
				11 27.96

Arcs and temp. as before. Time of 2 vibrations $15^s.288$.

June 7, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 45 double vibrations.
1	3^h 22^m $08^s.0$	46	3^h 33^m $37^s.0$	11^m $29^s.0$
2	23.3	47	52.3	29.0
3	38.5	48	34 07.6	29.1
4	53.8	49	23.0	29.2
5	23 09.2	50	38.2	29.0
6	24.5	51	53.7	29.2
7	39.7	52	35 09.0	29.3
8	55.0	53	24.5	29.5
9	24 10.3	54	39.6	29.3
10	25.7	55	54.9	29.2
				11 29.18

Arc at beginning 6° 8′. Temp. 33°. Time of 2 vibrations $15^s.315$.
" end 2 48

June 7, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 45 double vibrations.
1	3^h 22^m $16^s.0$	46	3^h 33^m $45^s.0$	11^m $29^s.0$
2	31.2	47	34 00.2	29.0
3	46.3	48	15.5	29.2
4	23 01.8	49	30.9	29.1
5	17.0	50	46.3	29.3
6	32.3	51	35 01.5	29.2
7	47.8	52	16.8	29.0
8	24 03.1	53	32.2	29.1
9	18.3	54	47.3	29.0
10	33.3	55	36 02.5	29.2
				11 29.11

Arcs and temp. as before. Time of 2 vibrations $15^s.313$.

June 7, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 54 double vibrations.
1	8^h 12^m $39^s.1$	55	8^h 26^m $30^s.7$	13^m $51^s.6$
2	54.5	56	46.0	51.5
3	13 09.8	57	27 01.5	51.7
4	25.1	58	17.0	51.9
5	40.3	59	32.2	51.9
6	56.0	60	47.8	51.8
7	14 11.3	61	28 03.2	51.9
8	26.5	62	18.8	52.3
9	42.1	63	34.0	51.9
10	57.5	64	49.3	51.8
				13 51.83

Arc at beginning 6° 40′. Temp. 35. Time of two vibrations $15^s.403$.
" end 2 56

June 7, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 54 double vibrations.
1	$8^h\ 12^m\ 46^s.8$	55	$8^h\ 26^m\ 38^s.5$	$13^m\ 51^s.7$
2	13 02.0	56	54.0	52.0
3	17.2	57	27 09.3	52.1
4	32.6	58	24.8	52.2
5	48.1	59	40.3	52.2
6	14 03.3	60	55.7	52.4
7	18.7	61	28 11.1	52.4
8	34.0	62	26.4	52.4
9	49.5	63	41.9	52.4
10	15 05.0	64	57.4	52.4
				13 52.22

Arcs and time as before. Time of 2 vibrations $15^s.412$.

June 7, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 50 double vibrations.
1	$8^h\ 35^m\ 17^s.1$	51	$8^h\ 48^m\ 07^s.8$	$12^m\ 50^s.7$
2	32.2	52	23.1	50.9
3	48.0	53	38.6	50.6
4	36 03.3	54	54.0	50.7
5	19.0	55	49 09.3	50.3
6	34.3	56	24.8	50.5
7	49.6	57	40.1	50.5
8	37 05.1	58	55.6	50.5
9	20.6	59	50 10.9	50.3
10	36.2	60	26.3	50.1
11	51.5	61	41.6	50.1
				12 50.47

Arc 7° 28′. Temp. 35°. Time of 2 vibrations $15^s.409$.
3 12

June 7, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 50 double vibrations.
1	$8^h\ 35^m\ 24^s.7$	51	$8^h\ 48^m\ 15^s.2$	$12^m\ 50^s.5$
2	40.0	52	30.7	50.7
3	55.2	53	46.0	50.8
4	36 10.8	54	49 01.3	50.5
5	26.2	55	16.8	50.6
6	42.0	56	32.2	50.2
7	57.2	57	47.7	50.5
8	37 12.7	58	50 03.0	50.3
9	28.3	59	18.7	50.4
10	43.8	60	33.8	50.0
11	59.0	61	49.2	50.2
				12 50.43

Arcs and temp. as before. Time of 2 vibrations $15^s.409$.

RECAPITULATION OF RESULTS, JUNE 7, 1854.

Set No. 1.	Time of 2 vibrations	15ˢ.288	Temp. 33°
		15.288	" 33
Set No. 2.	" "	15.315	" 33
		15.313	" 33
Set No. 3.	" "	15.403	" 35
		15.412	" 35
Set No. 4.	" "	15.409	" 35
		15.409	" 35
June 7, 1854.	Mean	15.355	+34.0
	Time of 1 vibration . . .	7.678	

June 7, 1854. Experiments of deflections.

Deflecting magnet A. 67. Deflected magnet I. 10. Distance 0.9 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
W.	E.	374° 16′.3 15.0	15′.7	108° 21′.2	36°.2
"	W.	265 55.0 54.0	54.5		38.0
W.	W.	260 58.0 55.5	56.7	107 33.8	36.0
"	E.	368 31.0 30.0	30.5		34.0
				Means 107 57.5	36.0

Experiments of deflections. Distance 1.3 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
E.	E.	331° 33′.0 31.0	32′.0	30° 58′.5	34°.5
"	W.	300 34.0 33.0	33.5		34.3
W.	W.	301 01.0 00.0	00.5	31 35.5	35.8
"	E.	332 37.0 35.0	36.0		35.0
				Means 31 17.0	34.9

These two sets of deflections were observed between the second and third set of the preceding vibrations.

June 8, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	3h 16m 20s.0	41	3h 26m 40s.4	10m 20s.4
2	35.5	42	56.0	20.5
3	50.9	43	27 11.5	20.6
4	17 06.5	44	27.2	20.7
5	22.2	45	42.6	20.4
6	37.8	46	58.1	20.3
7	53.3	47	28 13.5	20.2
8	18 08.8	48	29.1	20.3
9	24.3	49	44.6	20.3
10	39.8	50	29 00.5	20.7
11	55.2	51	15.5	20.3
				10 20.43

Arcs 5° 36′. Temp. 35°. Time of 2 vibrations 15s.511.
3 20

June 8, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	3h 16m 27s.3	41	3h 26m 48s.0	10m 20s.7
2	43.2	42	27 03.5	20.3
3	58.6	43	19.0	20.4
4	17 14.2	44	34.6	20.4
5	29.7	45	50.0	20.3
6	45.3	46	28 05.6	20.3
7	18 00.8	47	21.1	20.3
8	16.2	48	36.5	20.3
9	31.8	49	52.2	20.4
10	47.3	50	29 07.6	20.3
11	19 02.9	51	23.3	20.4
				10 20.37

Arcs and temp. as before. Time of 2 vibrations 15s.509.

June 8, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	3h 31m 33s.3	41	3h 41m 53s.9	10m 20s.6
2	49.0	42	42 09.2	20.2
3	32 04.5	43	24.7	20.2
4	20.0	44	40.2	20.2
5	35.6	45	55.8	20.2
6	51.2	46	43 11.2	20.0
7	33 06.7	47	26.7	20.0
8	22.1	48	42.1	20.0
9	37.6	49	57.7	20.1
10	53.1	50	44 13.0	19.9
11	34 08.3	51	28.5	20.2
				10 20.15

Arcs 6° 8′. Temp. 35°.2. Time of 2 vibrations 15s.503.
and 3 12

June 8, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	$3^h\ 31^m\ 40^s.8$	41	$3^h\ 42^m\ 01^s.2$	$10^m\ 20^s.4$
2	56.4	42	16.5	20.1
3	32 11.9	43	32.2	20.3
4	27.3	44	47.5	20.2
5	43.1	45	43 03.0	19.9
6	58.6	46	18.4	19.8
7	33 14.1	47	33.9	19.8
8	29.6	48	49.4	19.8
9	45.1	49	44 04.9	19.8
10	34 00.7	50	20.3	19.6
11	16.2	51	35.8	19.6
				10 19.93

Arcs and temp. as before. Time of 2 vibrations $15^s.498$.

(4 sets of deflections were taken after the above, for which see below.)

June 8, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	$8^h\ 31^m\ 54^s.3$	41	$8^h\ 42^m\ 09^s.5$	$10^m\ 15^s.2$
2	32 10.2	42	24.9	14.7
3	25.3	43	40.2	14.9
4	40.8	44	55.5	14.7
5	56.2	45	43 10.9	14.7
6	33 11.4	46	26.2	14.8
7	27.0	47	41.7	14.7
8	42.3	48	56.9	14.6
9	57.4	49	12.3	14.9
10	34 13.1	50	27.5	14.4
11	28.3	51	42.9	14.6
				10 14.75

Arcs 6° 48′. Temp. 35°. Time of 2 vibrations $15^s.369$.
and 2 08

June 8, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	$8^h\ 32^m\ 02^s.3$	41	$8^h\ 42^m\ 18^s.3$	10^m 16.0
2	17.8	42	33.6	15.8
3	33.2	43	49.0	15.8
4	48.7	44	43 04.4	15.7
5	33 04.0	45	19.9	15.9
6	19.3	46	35.2	15.9
7	34.8	47	50.6	15.8
8	50.2	48	44 06.0	15.8
9	34 05.5	49	21.4	15.9
10	21.2	50	36.9	15.7
11	36.8	51	52.3	15.5
				10 15.80

Arcs and temp. as before. Time of 2 vibrations $15^s.395$.

June 8, 1854. Experiments of vibrations. (Left to right.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	8^h 48^m $52^s.0$	41	8^h 59^m $04^s.6$	10^m $12^s.6$
2	49 07.3	42	19.7	12.4
3	23.0	43	35.3	12.3
4	38.2	44	50.5	12.3
5	53.4	45	9 00 05.8	12.4
6	50 08.9	46	21.1	12.2
7	24.3	47	36.3	12.0
8	39.6	48	51.6	12.0
9	54.7	49	1 07.0	12.3
10	51 10.1	50	22.2	12.1
11	25.3	51	37.5	12.2
				10 12.25

Arcs 6° 56′. Temp. 35°. Time of 2 vibrations $15^s.306$.
and 3 20

June 8, 1854. Experiments of vibrations. (Right to left.)

No.	Time by chronometer 2721.	No.	Time by chronometer 2721.	Time of 40 double vibrations.
1	8^h 48^m $59^s.8$	41	8^h 59^m $12^s.0$	10^m $12^s.2$
2	49 15.1	42	27.5	12.4
3	30.3	43	42.8	12.5
4	45.8	44	58.0	12.2
5	50 01.1	45	9 00 13.4	12.3
6	16.3	46	28.6	12.3
7	31.8	47	43.9	12.1
8	47.2	48	59.3	12.1
9	51 02.2	49	01 14.6	12.4
10	17.8	50	29.9	12.1
11	33.0	51	45.3	12.3
				10 12.26

Arcs and temp. as before. Time of 2 vibrations $15^s.306$.
Daily rate of chronometer 2721, losing $1^s.0$.

Recapitulation of Results, June 8, 1854.

Set No. 1.	Time of 2 vibrations	$15^s.511$	Temp. 35°
		15.509	" 35
Set No. 2.	" "	15.503	" 35.2
		15.498	" 35.2
Set No. 3.	" "	15.369	" 35
		15.395	" 35
Set No. 4.	" "	15.306	" 35
		15.306	" 35
	Means	15.425	35.0
	Time of 1 vibration	7.712	

The following deflections correspond in time to the middle of the above vibration results.

June 8, 1854. Experiments of deflections.

Deflecting magnet A. 67. Deflected magnet I. 10. Distance 1.3 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
W.	E.	329° 46′	45′.5		36°.7
		45		31° 10′.5	
"	W.	298 36	35.0		37.7
		34			
E.	W.	298 08	07.0		37.0
		06		31 33.5	
"	E.	329 41	40.5		36.2
		40			
				Means 31 22.0	36.9

Experiments of deflections. Distance 0.9 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
E.	E.	365° 52′.5	51′.7		37°.2
		51.0		110° 58′.2	
"	W.	254 54	53.5		36.6
		53			
W.	W.	262 30	29.0		37.0
		28		106 38.0	
"	E.	369 08	07.0		37.0
		06			
				Means 108 48.1	36.9

Experiments of deflections. Distance 0.9 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
W.	E.	369° 08′.0	07′.2		37°.2
		06.5		106° 48′.2	
"	W.	262 20	19.0		37.0
		18			
E.	W.	254 41	40.5		37.6
		40		110 06.7	
"	E.	364 48.0	47.2		36.6
		46.5			
				Means 108 27.4	37.1

Experiments of deflections. Distance 1.3 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
E.	E.	328° 52′	52′.0		36°.0
		52		31° 29′.5	
"	W.	297 23	22.5		35.2
		22			
W.	W.	298 03	02.5		36.3
		02		31 10.5	
"	E.	329 13	13.0		37.0
		13			
				Means 31 20.0	36.1

June 19, 1854. Experiments of deflections.

Deflecting magnet A. 67. Deflected magnet I. 7. Distance 0.9 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
W.	W.	268° 50′	49′.5		40°.6
		49		107° 33′.0	
"	E.	376 23	22.5		41.6
		22			
E.	E.	373 05	04.5		41.2
		04		106 05.0	
"	W.	267 00	59.5		41.2
		266 59			
				Means 106 49.0	41.1

Experiments of deflections. Distance 1.3 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
E.	W.	303° 38′	37′.5		40°.8
		37		30° 43′.0	
"	E.	334 21	20.5		41.0
		20			
W.	E.	334 46	46.0		43.5
		46		30 42.5	
"	W.	304 04	03.5		43.0
		03			
				Means 30 42.7	42.1

June 19, 1854. Experiments of vibrations. (Left to right.)

No.	Time.[1]	No.	Time.[1]	Time of 40 double vibrations.
1	4h 33m 20s.1	41	4h 43m 38s.6	10m 18s.5
2	35.3	42	54.0	18.7
3	51.0	43	44 09.5	18.5
4	34 06.5	44	25.0	18.5
5	21.9	45	40.4	18.5
6	37.3	46	55.9	18.6
7	52.8	47	45 11.2	18.4
8	35 08.3	48	26.6	18.3
9	23.8	49	42.1	18.3
10	39.3	50	57.7	18.4
11	54.9	51	46 13.0	18.1
				10 18.44

Arcs 7° 28′. Temp. 43°. Time of 2 vibrations 15s.461.
and 3 44

[1] Number of chronometer not stated.

June 19, 1854. Experiments of vibrations. (Right to left.)

No.	Time.	No.	Time.	Time of 40 double vibrations.
1	$4^h\ 33^m\ 28^s.2$	41	$4^h\ 43^m\ 46^s.8$	$10^m\ 18^s.6$
2	43.4	42	44 02.3	18.9
3	59.0	43	17.8	18.8
4	34 14.3	44	33.2	18.9
5	29.9	45	48.6	18.7
6	45.3	46	45 04.2	18.9
7	35 00.9	47	19.5	18.6
8	16.3	48	35.1	18.8
9	31.9	49	50.4	18.5
10	47.2	50	46 05.8	18.6
11	36 02.8	51	21.4	18.6
				10 18.72

Arcs and temp. as before. Time of 2 vibrations $15^s.463$.

Experiments of vibrations. (Left to right.)

No.	Time.	No.	Time.	Time of 40 double vibrations.
1	$4^h\ 50^m\ 26^s.2$	41	$5^h\ 00^m\ 44^s.0$	$10^m\ 17^s.8$
2	41.8	42	59.3	17.5
3	57.3	43	01 14.8	17.5
4	51 12.9	44	30.3	17.4
5	28.2	45	45.9	17.7
6	43.5	46	02 01.3	17.8
7	59.1	47	16.7	17.6
8	52 14.5	48	32.2	17.7
9	29.9	49	47.7	17.8
10	45.4	50	03 03.2	17.8
11	53 01.0	51	18.8	17.8
				10 17.67

Arcs 6° 56′. Temp. 43°. Time of 2 vibrations $15^s.442$.
and 4 00

Experiments of vibrations. (Right to left.)

No.	Time.	No.	Time.	Time of 40 double vibrations.
1	$4^h\ 50^m\ 34^s.1$	41	$5^h\ 00^m\ 51^s.6$	$10^m\ 17^s.5$
2	49.5	42	01 07.1	17.6
3	51 04.9	43	22.4	17.5
4	20.3	44	37.9	17.6
5	35.9	45	53.4	17.5
6	51.2	46	02 08.9	17.7
7	52 06.9	47	24.3	17.4
8	22.2	48	39.6	17.4
9	37.8	49	55.0	17.2
10	53.1	50	03 10.3	17.2
11	53 08.6	51	25.8	17.2
				10 17.44

Arcs and temp. as before. Time of 2 vibrations $15^s.436$.

June 19, 1854. Experiments of vibrations. (Left to right.)

No.	Time.	No.	Time.	Time of 40 double vibrations.
1	$5^h\ 13^m\ 12^s.2$	41	$5^h\ 23^m\ 30^s.3$	$10^m\ 18^s.1$
2	27.9	42	45.7	17.8
3	43.3	43	24 01.2	17.9
4	58.9	44	16.8	17.9
5	14 14.2	45	32.3	18.1
6	29.5	46	47.9	18.4
7	45.1	47	25 03.4	18.3
8	15 00.3	48	18.9	18.6
9	16.1	49	34.1	18.0
10	31.3	50	49.7	18.4
11	46.9	51	26 05.1	18.2
				10 18.15

Arcs 6° 48′. Temp. 42°.4. Time of 2 vibrations $15^s.454$.
3 36

Experiments of vibrations. (Right to left.)

No.	Time.	No.	Time.	Time of 40 double vibrations.
1	$5^h\ 13^m\ 20^s.2$	41	$5^h\ 23^m\ 37^s.6$	$10^m\ 17^s.4$
2	35.7	42	52.9	17.2
3	51.2	43	24 08.3	17.1
4	14 06.5	44	24.0	17.5
5	22.1	45	39.5	17.4
6	37.5	46	54.9	17.4
7	53.2	47	25 10.2	17.0
8	15 08.4	48	25.2	16.8
9	23.7	49	40.8	17.1
10	39.2	50	56.5	17.3
11	54.8	51	26 11.7	16.9
				10 17.19

Arcs and temp. as before. Time of 2 vibrations $15^s.430$.

Experiments of vibrations. (Left to right.)

No.	Time.	No.	Time.	Time of 40 double vibrations.
1	$5^h\ 33^m\ 23^s.3$	41	$5^h\ 43^m\ 39^s.5$	$10^m\ 16^s.2$
2	38.9	42	54.9	16.0
3	54.2	43	44 10.3	16.1
4	34 09.5	44	25.8	16.3
5	25.2	45	41.3	16.1
6	40.4	46	56.7	16.3
7	55.9	47	45 11.9	16.0
8	35 11.2	48	27.4	16.2
9	26.8	49	42.8	16.0
10	42.2	50	58.2	16.0
11	57.6	51	46 13.6	16.0
				10 16.11

Arcs 7° 04′. Temp. 42°.4. Time of two vibrations $15^s.403$.
3 28

Experiments of vibrations. (Right to left.)

No.	Time.	No.	Time.	Time of 40 double vibrations.
1	5^h 33^m $31^s.2$	41	5^h 43^m $47^s.2$	10^m $16^s.0$
2	46.5	42	44 02.8	16.3
3	34 02.1	43	18.1	16.0
4	17.4	44	33.5	16.1
5	33.0	45	49.0	16.0
6	48.4	46	45 04.5	16.1
7	35 03.7	47	19.8	16.1
8	19.0	48	35.2	16.2
9	34.3	49	50.6	16.3
10	49.5	50	46 05.9	16.4
11	36 05.2	51	21.3	16.1
				10 16.15

Arcs and temp. as before. Time of 2 vibrations $15^s.404$.

Recapitulation of Results, June 19, 1854.

Set No. 1.	Time of 2 vibrations	$15^s.461$	Temp. 43°
		15.463	" 43
Set No. 2.	" "	15.442	" 43
		15.436	" 43
Set No. 3.	" "	15.454	" 42.4
		15.430	" 42.4
Set No. 4.	" "	15.403	" 42.4
		15.404	" 42.4
	Means	15.437	42.7
	Time of 1 vibration . .	7.718	

June 19, 1854. Experiments of deflections.

Deflecting magnet A. 67. Deflected magnet I. 7. Distance 1.3 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
W.	W.	298° 54′	53′.5	30° 53′.0	42°.0
		53			
"	E.	329 47	46.5		42.2
		46			
E.	E.	329 20	19.5	30 50.0	43.2
		19			
"	W.	298 30	29.5		42.0
		29			
				Means 30 51.5	42.4

Experiments of deflection. Distance 0.9 feet.

Magnet.	North pole.	Circle reads.	Mean.	2 u.	Temp.
E.	W.	259° 19′	18′.5	106° 11′.5	42°.2
		18			
"	E.	365 31	30.0		42.0
		29			
W.	E.	369 39	38.5	106 30.5	43.2
		38			
"	W.	263 09	08.0		41.8
		07			
				Means 106 21.0	42.3