Dr. Asa Gray

With the Author's compliments.

"On the Structure, the Occurrence in Lancashire, and the Source of Origin of *Naias graminea*, Del., var. *Delilei*, Magnus."

BY

CHARLES BAILEY, *F.L.S.*

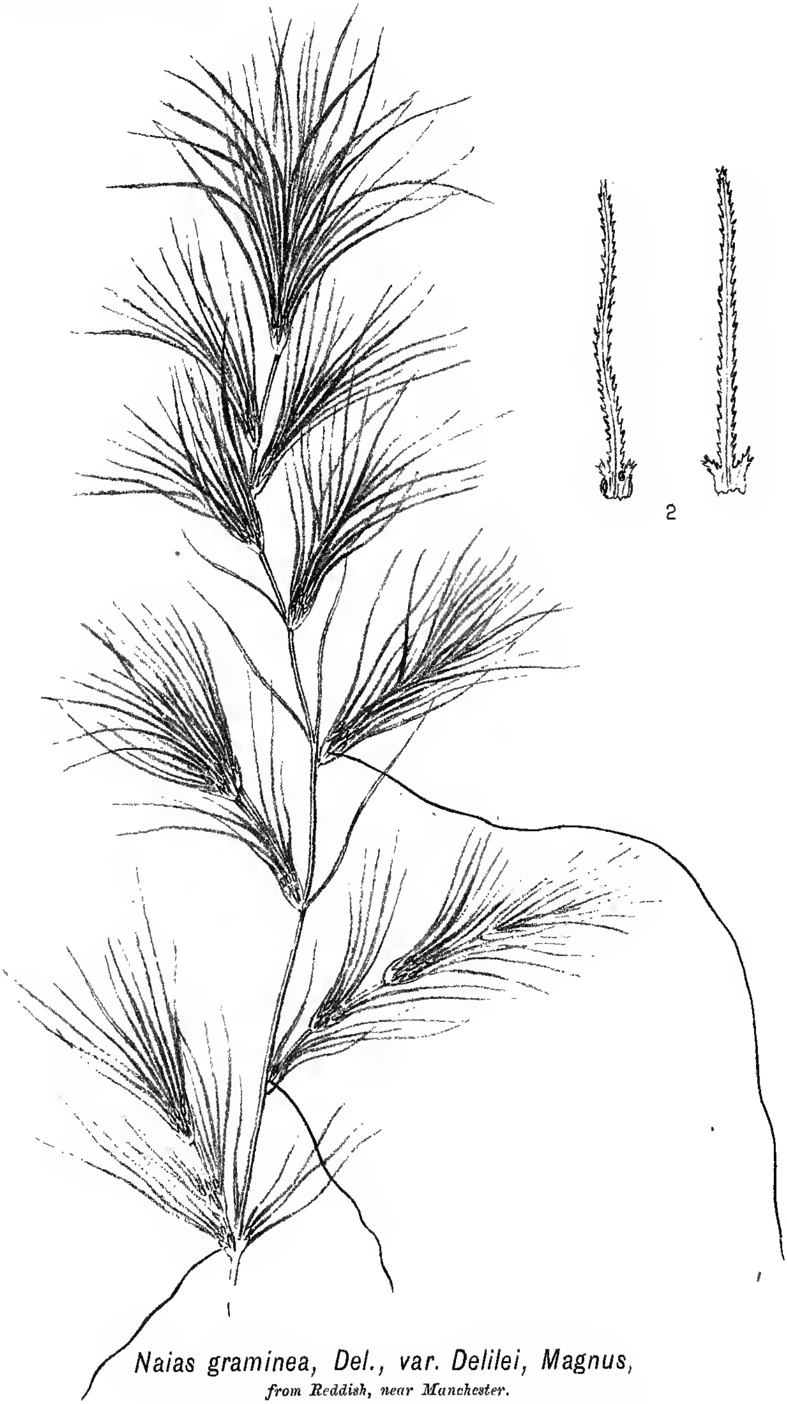
A RÉSUMÉ OF COMMUNICATIONS MADE TO

THE LEEUWENHOEK MICROSCOPICAL CLUB,

AND TO

THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Reprinted from the 'JOURNAL OF BOTANY,' Nos. 262 and 263, Vol. XXII., for October and November 1884.



Naias graminea, Del., var. Delilei, Magnus,
from Reddish, near Manchester.
To illustrate Paper by Mr. Charles Bailey.

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Naias graminea, Delile,

from Lower Egypt.

TO ILLUSTRATE PAPER BY MR. CHARLES BAILEY.

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I DEDICATE THESE PAGES TO THE MEMORY OF

AN OLD AND VALUED FRIEND—

THE LATE JOHN HARDY,

OF 118 EMBDEN STREET, HULME, MANCHESTER;

WHO DIED, SUDDENLY, 15TH SEPTEMBER, 1884.

HE WAS THE FIRST PRESIDENT OF

THE LEEUWENHOEK MICROSCOPICAL CLUB,

AND A FORMER VICE-PRESIDENT OF

THE MANCHESTER SCIENTIFIC STUDENTS' ASSOCIATION.

CHARLES BAILEY.

Ashfield, College Road,
Whalley Range, Manchester,
20th September, 1884.

NOTES ON THE STRUCTURE, THE OCCURRENCE IN LANCASHIRE, AND THE SOURCE OF ORIGIN, OF *NAIAS GRAMINEA* Delile, var. *DELILEI* Magnus.

(Plates 249—252.)

I.—Introduction.

Naias graminea Del., Plate 249, fig. 1, and *Chara Braunii* Gmel. were first reported as occurring in a natural state in England at the Meeting of the British Association at Southport in September, 1883. Their addition to the flora of South Lancashire and of Britain is due to the Biological Society of Ashton, and to Mr. John Whitehead, of Dukinfield. They were discovered during the exploration of the Ashton-under-Lyne district in acquiring the necessary material for the compilation of a fauna and flora of the neighbourhood, for presentation to the Biological Section of the British Association. An abstract of this communication, made by Mr. J. R. Byrom, of Ashton, is printed on pp. 541–543 of the 'Report of the Fifty-third Meeting of the British Association.'

Few portions of Great Britain are so well known, botanically, as most of the northern counties of England, and yet a concerted systematic examination of so well-worked a district as Ashton has brought to light many novelties, besides two, if not three, plants not previously known to be British. To those who know what a large number of practical botanists there are in the North of England, and with what zest so many of their number pursue botanical studies in their hard-earned leisure, it has always seemed a matter for regret that so little of their accumulated knowledge finds its way into print; and the instance of what has been done by the Ashton botanists should stimulate other local societies to make similar efforts.

The actual discoverer of the *Naias* was Mr. James Lee, of Denton; he brought it to Mr. Whitehead, who sent it to me early in September of last year as a possible *Naias*, and, from plants which I afterwards gathered *in situ* with the discoverer and Messrs. Whitehead and Byrom, it was finally determined by Mr. H. N. Ridley, of the British Museum, to be *Naias graminea* Del. or *Caulinia alagnensis* Pollini. Subsequently Dr. Magnus, of Berlin, has given it the varietal name of *Delilei*, on account of a structural peculiarity which will appear further on.

II.—The Genus and its Divisions.

The genus gives its name to the natural order *Naiadaceæ*, which is allied to the *Potamogetonaceæ*, but systematists are by no means agreed as to the respective limits of either family. Willdenow separated the group to which *N. graminea* belongs from *Naias* proper, under the generic name of *Caulinia*,* on account of the male flowers not having the quadrifid perianth of *Naias* proper; but Robert Brown reunited the two groups of *Naias* and *Caulinia* into *Naias* Linn. There is no doubt, however, that each of these divisions forms a very natural group sharply separated from the other by well-marked characters drawn from the leaf, stem, and fruit. All these points have been carefully worked out by Dr. P. Magnus in a work which he modestly entitled 'Beitrage zur Kenntniss der Gattung Najas, L.' (Berlin, 1870); and no one can investigate the morphology and anatomy of a plant of this genus without admiring the minute and conscientious investigations of this author. In preparing the following notes I have referred again and again to this memoir, and I cannot speak too highly of the help derived from it.

Dr. Magnus gives the following diagnoses of the two subdivisions of the genus, *viz.*:—

"§ Eunajas Asch.—Spine-teeth chiefly on the stem and backs of the leaves. Flowers diœcious (? in all). Anther four-chambered (? always). Seed-shell consisting of a many-layered stony parenchyma. Conducting bundles of the stem divided from the intercellular spaces by two to three layers of parenchyma-cells. Leaf furnished with a small-celled epiderm, which rises very sharply from the large parenchyma-cells of the leaf.

"§ Caulinia Willd. — Spine-teeth absent from the stem and backs of leaves. Flowers in most species monœcious (? in all). Anther one- to four-chambered. Seed-shell formed of three layers of cellular tissue. Conducting bundles of the stem divided from the intercellular spaces by a layer of parenchyma-cells; leaf without the small-celled epiderm."—'Beitrage,' pp. 55, 56.

The plant which forms the subject of this notice belongs to the section *Caulinia*, and its synonymy and principal book-references are the following:—

III.—Synonymy of the Plant.

Najas graminea Delile, Flore de l'Egypte. Mémoire sur les plantes qui croissent spontanément en Egypte; par Alire Raffeneau Delile, p. 1. Floræ Ægyptiacæ illustratio No. 874, p. 75. Explication des planches, p. 282, pl. 50, fig. 3.

Chamisso, Aquaticæ quædam diversæ affinitatis. Linnæa, vol. iv., 1829, pp. 502–3.

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* 'Mémoires de l'Académie Royale des Sciences de Berlin, 1798, classe de Philosophie Expérimentale,' page 87.

Kunth, Enumeratio Plantarum, &c., Tom. iii., p. 115.
Boissier, Flora Orientalis, vol. v., p. 28.
Compendio della Flora Italiana compilato per cura dei Professori V. Cesati, G. Passerini, e G. Gibelli. Par. i., p. 205.

Najas alagnensis Pollini, Hort. et provinc. Veron. pl. nov. vel. min. cogn., p. 26. Flora Veronensis quam in prodromum Floræ Italiæ septentrionalis exhibit Cyrus Pollinius; Tom. iii., p. 49 (1824).
L. Reichenbach, Flora Germanica Excursoria, No. 920, p. 151.
Chamisso, Aquaticæ quædam diversæ affinitatis in Linnæa, vol. iv., p. 502 (1829).
Antonii Bertolonii, M.D., Flora Italica sistens plantas in Italia et in insulis circumstantibus sponte nascentes. Tomo x., fasc. iii., p. 296.

Naias serristipula Nocc. et Balb., Ic. Fl. Ticin., Tab. 15 ex specim. sicc. delineata.

Naias tenuifolia Aschers., Atti della Societa Italiana di Scienze naturali, pp. 267 & 268. Non R. Br.

Najas graminea Del., var. *Delilei* Magnus, Berichte der deutschen botanischen Gesellschaft; Band i., Heft 10, Jahr. 1883, pp. 522 & 523.

Caulinia alagnensis Pollini, Plant. Veron., 26.
Diar. Brugnatelli Giorn. ann. 1816, T. ix., p. 175.
Bluff et Fingerhuth, Compendium Floræ Germaniæ, Sectio i., ed. alt. ii., p. 585.
Flora Italiana, ... di Filippo Parlatore, vol. iii., pp. 665, 666.

Caulinia intermedia Balb., Elench. recentium stirpium, quas Pedemontanæ floræ addendas censet., &c.; in Mem. della R. Accad. di Tor. Ann. 1818, Tom. 23, p. 105.
Balb. et Nocca, Flor. Ticin., Tom. ii., p. 163, tab. 15.
Nocca, Clav., ii., p. 91.

Caulinia microphylla Nocc. et Balb., Flor. Ticin., Tom. ii., p. 163, tab. 16.

It still remains a question whether this plant should bear Delile's name, or Pollini's name, according as the one or the other had priority in publication, as has been pointed out by Prof. Ascherson in 'Atti della Societa Italiana,' vol. x., p. 267, where he shows that the description of the plant of Pollini was certainly published in 1814; whilst the Memoir of Delile, although perhaps printed in 1813, was not published until some later year. I cannot elucidate this point further, as my copy of Delile has no title-page, and my edition of Pollini's 'Flora Veronensis' is that of 1824. Pollini's herbarium-specimen of the Italian plant is preserved among the possessions of the Society of Naturalists of Rhenish Westphalia, in Bonn.

The Italian plant is not the same as Robert Brown's *Naias tenuifolia*, Prodr. Fl. Nov. Holland., p. 545, published in 1810, on account of the entirely different structure of the male flower (see Plate 251, fig. 15); otherwise the name would have taken precedence of Pollini's and Delile's.

Whether the plant found in Japan, at Yokohama, is identical with *Naias graminea* Del. is uncertain, but the description of it by Herr C. J. Maximowicz may stand for the Lancashire plant:—"Mollis elongata, foliis verticillatis patentibus rectis argute spinoso-serrulatis, apice 2–3 cuspidatis, dentibus incurvis 1-cellulosis minutis; stipulis distinctimus lanceolatis foliaceis folii ad instar serrulatis; fructu lineari-oblongo, granulato. Nippon, in fossis circa Yokohamam semel inveni fructiferam."*

IV.—The Stem.

The stems vary in length from a few inches to upwards of two feet, and they have many branches. Considering the large number of leaves which they support, the stems are comparatively weak; they do not vary much in diameter from the base to the summit; vertical sections of the upper internodes are not quite so circular as those of the lower internodes.

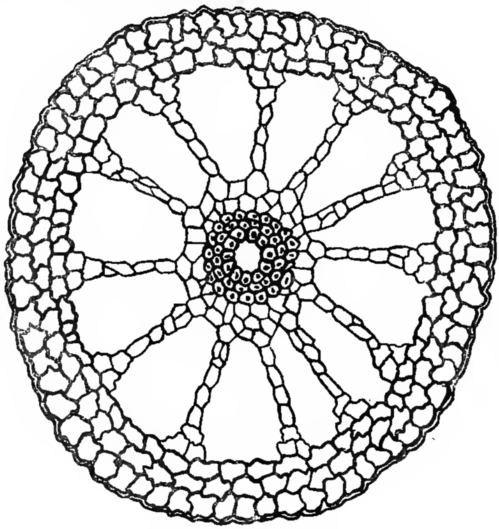

Fig. 42.

If we examine one of these internodes we find that the centre of the shaft consists of a small channel, surrounded by two or three layers of elongate cells somewhat closely aggregated; surrounding these is a layer of much larger cells, hexagonal in outline, and having thinner walls than those which protect the central channel. From this central mass radiates a series of from eight to twelve prolongations of the central hexagonal cells, meeting as many outgrowths from the tissue which forms the circumference of the internode, and arranged like the spokes of a wheel. See fig. 42.

* Diagnoses breves plantarum novarum Japoniæ et Mandschuriæ; in Bulletin de l'Acad. Imp. des Sciences de St. Petersburgh. Vol. ii., pp. 71, 72. 1867.

The rays enclose an equal number of large intercellular cavities, each cavity being bounded by the central and peripheral parenchyma at either end. The cavities occur in every internode, whatever its age, but they are limited in the direction of the axis by the node. The rays consist of a single row of cells, except at the points where they join the circumference and centre; they are not always as regular as they are drawn in fig. 42, as they occasionally branch at each end so as to enclose a smaller intercellular cavity.

The circumferential tissue of each internode consists of three or four rows of elongate cells having a hexagonal outline, with sinuous edges. The cells are all uniform in size, the outermost layer not being smaller than the rest, as it is in *Naias flexilis*. The external edge of the outer row of cells is slightly thickened, but I cannot detect any epidermal cells.

In the posthumous work of Prof. Parlatore, entitled 'Tavole per una "Anatomia delle piante aquatiche,"' a drawing is given of the transverse section of the Italian *Naias graminea*, but it differs from my drawing (fig. 42) in showing an epidermis of distinct square-shaped cells. The central bundle is also made to consist of about half a dozen rows of cells, smaller in size than I find them in the Reddish plant. I reproduce Parlatore's figure on Plate 252, fig. 36.

Chatin, in his valuable but incomplete work, 'Anatomie comparée des Végétaux,' did not quite reach the *Naiadaceæ* in the volume devoted to aquatic plants, or his drawings would have been useful for comparison; it is much to be desired that this fine work had been completed, as well for the parasitic plants as for the aquatic. The *Naiadæ* are not yet figured by Reichenbach in his 'Icones Floræ Germanicæ et Helveticæ,' &c.

V.—The Leaves.

Fig. 43.

The leaves grow in tufts at the side of each internode, and they are rather more lateral than they are represented in Delile's figure, reproduced two-thirds the original size in Plate 250, fig. 3. In the living state, as seen in the water from above, they have a light olive-green shade, much duller than that of the bright green leaves of *Naias flexilis*. In the dried state they become much darker, particularly in the older leaves, but the younger tufts retain the light green colour of the living plant.

In shape the leaves are linear, broadly channelled in their lower portion (figs. 64 & 65), thickened in the region of the midrib (figs. 60 to 63), and slightly keeled on their lower surface; in length they vary from ½ in. to 1¾ in., and they are 1-24th in. broad or less (see Plate 249, fig. 2). The sides of the fully-developed leaf are parallel for the greater portion of their length, but at their base they widen out into a broad sheath bearing two upright auricles applied to

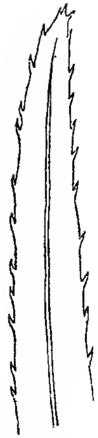

FIG. 44.

the stem and half-clasping it (figs. 52 to 55). The extremity of the leaf is gradually attenuated, and ends in from one to three spines (fig. 43); the extremities are frequently truncate, so that the spines give it a cuspidate character (fig. 44).

The margins of the sides, sheath, and free extremity are studded with erect, unicellular, yellowish brown spines (figs. 47 to 49), whose colour presents a contrast to the transparent marginal cell-walls, and to the green contents of the cells of the lamina of the leaf. The spines are acuminate, slightly curved, and gradually narrowed from the base to the sharp point.

VI.—The Leaf-spines.

The form of the spine, or tooth, on the margin of the leaf furnishes good discriminating characters between the various species of *Naias*, as was long ago pointed out by the late Al. Braun in one of the earlier numbers of this Journal (vol. ii., 1864, pp. 274–279). The simplest form of tooth is that of *N. flexilis*, where, in Dr. Boswell's Loch Cluny specimens, the base of the spine is in the same plane as the leaf-margin. The spine springs from a dilatation between two of the marginal leaf-cells (fig. 45), each of which nearly equally supports the spine to the extent of one-third its length, rarely more. Sometimes the two marginal cells are separated from each other by the spine (see fig. 46).

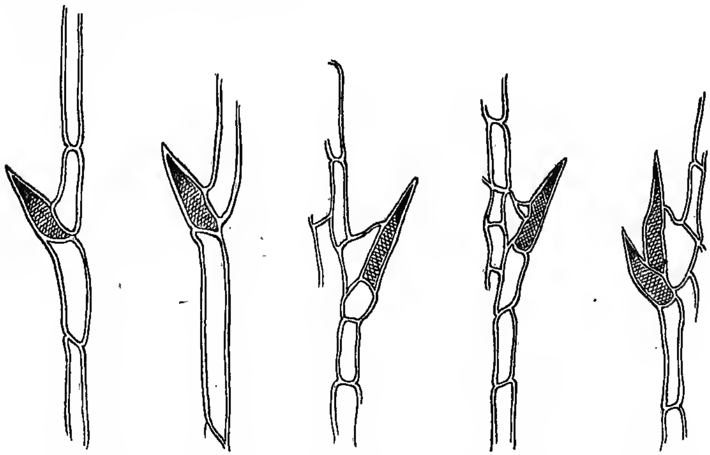

FIG. 45. FIG. 46. FIG. 47. FIG. 48. FIG. 49.

In *Naias graminea* the type of spine is similar, but it differs from that of *N. flexilis* in having a bi-celled base whose sides unequally support the spine. The lowermost of the two basal cells diverges, at its upper end, from the line of the leaf-margin, so as to wholly support the lower end of the spine (see fig. 47). The uppermost cell, on the other hand, acts as a support to the inner side of the spine for fully one-half its length; it also partially underlies the upper end of the lowermost basal cell, and thus its three-sided profile fills up the axil of the spine and adds considerably to its rigidity, as compared with the arrangement in *N. flexilis* (comp. fig. 45). Occasionally a third cell makes its appearance, as shown in fig. 48, and not infrequently there is an auxiliary spine between the upper supporting cell and the original spine (see fig. 49). In all these cases, however, the axillary, or uppermost, basal cell distinguishes the type of tooth from the characteristic tooth of *N. flexilis*. Cesati gives figures of the dentition of these two species in Plate II. of 'Linnæa,' vol. xxxvi.; but he makes that of *N. alaganensis* much nearer to that of *N. flexilis* than I find it to be in the Manchester plant.

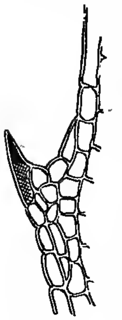
Fig. 50.

A third type of spine is furnished by *Naias minor* All. (*Caulinia fragilis* W.). This shows an advance upon the basal arrangement of the spines of *N. flexilis* and *N. graminea*, in being formed of more than three cells (see fig. 50). The entire tooth stands much above the line of cells which forms the margin of the leaf.

Upon comparing these figures (which I have carefully made from typical specimens) with those given by Braun on p. 275, vol. ii. of this Journal, it will be seen that my drawings present considerable variation from his, particularly in *N. flexilis*. It is possible that Braun's figures were meant to be diagramatic, and representative of groups rather than of species; for convenience of reference I have reproduced them in Plate 251, figs. 6 to 8.

The other end of the series of types of spines is represented by the tooth of *N. major*, where there is not only a multicellular base, but the spine itself is compound; one terminal dark brown cell resting upon several elongate dark brown cells, the whole forming a very conspicuous tooth standing well out from the plane of the leaf-margin. Fig. 51 gives a tooth of this species from one of the late Dr. Wirtgen's specimens from the mouth of the Moselle, near Coblentz.

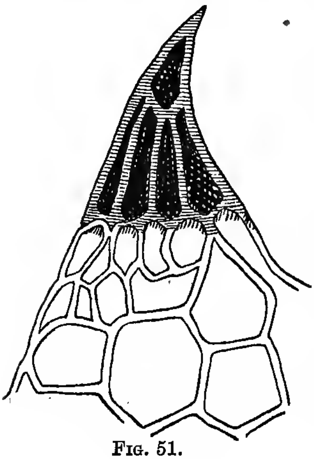
Fig. 51.

In *N. graminea* the spines are situated on the leaf-margins only (never on the midrib) at intervals equal to from one-half to the whole breadth of the leaf. Figs. 47 to 49 have been drawn from spines on the edge of the middle portion of the leaf. Their shape is constant on the sides of the lamina, but they become longer on the sheath, and at the apex of the leaf.

VII.—The Leaf-sheath.

The leaf-sheath is another important character in distinguishing the species of *Naiadæ*, the extent of the dilatation, and the form of the auricle, when present, furnishing useful marks of discrimination. The types given by Braun in the 'Journal of Botany,' vol. ii., p. 274, are re-drawn on Plate 251. figs. 10 to 14, but, as will be seen from what follows, the Reddish plant differs considerably from Braun's figure of *N. graminea*, unless he meant it to serve as a general figure of the type of sheath in his super-species *N. tenuifolia*.

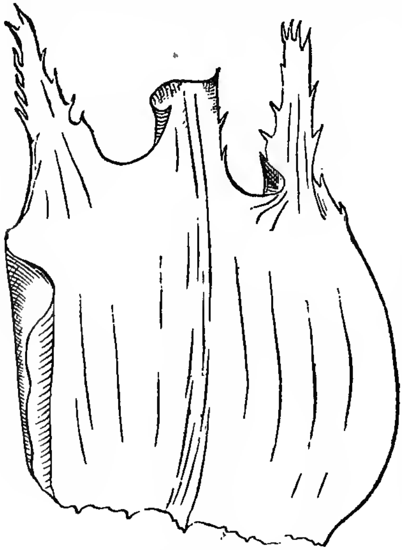

Fig. 52.

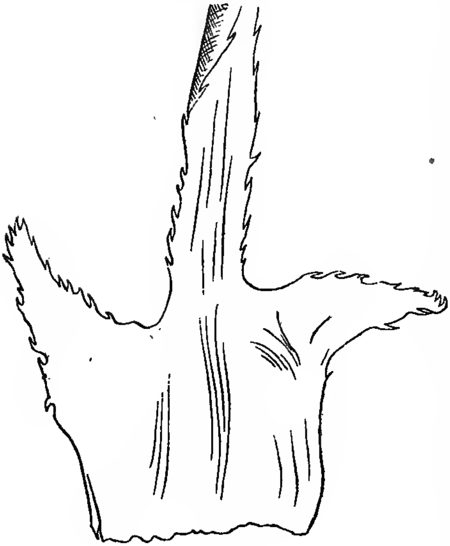

Fig. 53.

In the English *Naias graminea* the base of the lamina of the outermost pair of leaves suddenly dilates into a pair of upright auricles, or ears, which are continued below so as to form a more or less ample sheath (see fig. 52); the size of the sheath presents considerable variations, according to the age and the position of the leaf to which it belongs (see figs. 52 to 55). I see no trace of any intravaginal scales (squamulæ) at the base of the leaf-sheath, such as are found in *Naias major* and in the allied genus *Phucagrostis*. Fig. 29, Plate 251, shows the scales of *Naias major in situ*; one of the scales is drawn separately in fig. 30 on the same plate.

The auricles in their turn vary in shape and size, but I have not met with them so regularly oval nor so acute as they are represented in Braun's figure (fig. 14, Plate 251); on the contrary, I never find them acute, and, though somewhat parallel-sided, they gradually taper from their base to their elongate truncate apex (see figs. 52 and 54). More often than not the auricle is larger on one side than the other, as in figs. 54 and 55. The auricles are confined principally to the first

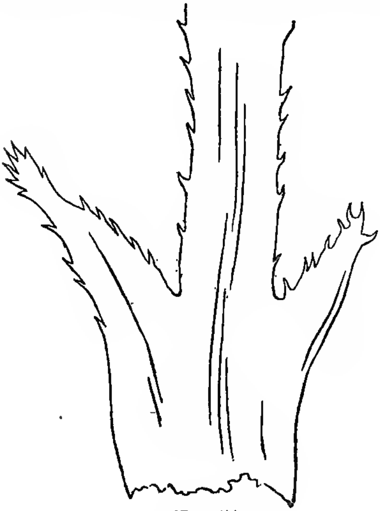

FIG. 54.

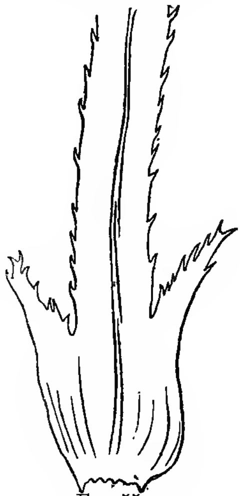

FIG. 55.

pair of leaves of each fascicle, and the sheaths of the pair embrace the leaf; most often these are the only leaves in the fascicle which possess auricles (see Delile's figure on Plate 250, fig. 4). The next pair of leaves has auricles which, when present, form a more acute sinus with the lamina (fig. 55); but as we approach the centre of each fascicle the leaves are destitute of auricles, and pass into short lanceolate bracts, in the midst of which we find the flowers.

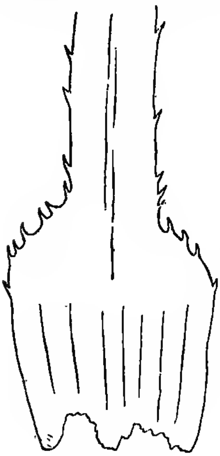

FIG. 56.

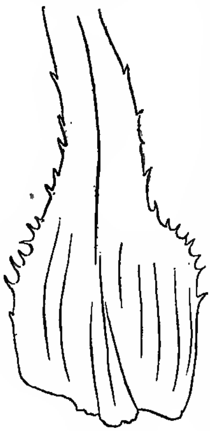

FIG. 57.

In Scotch specimens of *Naias flexilis* the leaf-sheath is of another type; the base of the limb widens out into a sheath more than twice the breadth of the limb, and at an angle of about 45°; but there is no approach to an auricle on either side. The shoulders of the sheath are crowded with teeth, but they are infrequent on the sides. See figs. 56 and 57, and compare them with the slightly different figure of Braun on Plate 251, fig. 10.

For drawings of the leaf-sheaths of *Naias minor* and *N. major* see Plate 251, figs. 9 & 29, and compare the former with Braun's figure, Plate 251, fig. 11.

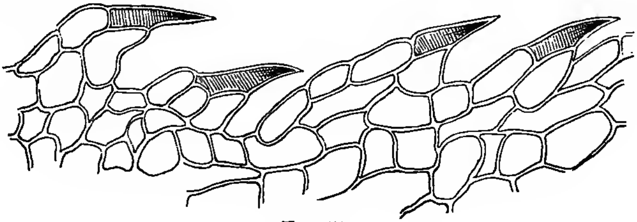

Fig. 58.

The margins of the auricles of *N. graminea*, and more particularly their free extremities and inner sides, are crowded with strong, spiny, tawny-brown cells, similar to those on the lamina; but they occur at much shorter intervals, and the cells at the base of the spines are more loosely aggregated (see fig. 58), so that there is no well-defined series of marginal cells as in the lamina. The basal cells which support the spines have their longest diameter in the direction of the spine.

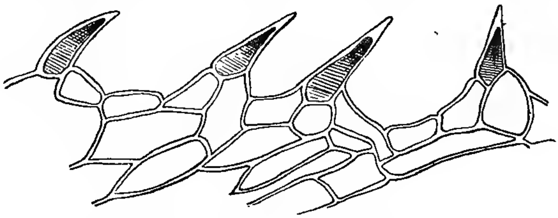

Fig. 59.

In *N. flexilis* (fig. 59) the cells are more loosely aggregated also, but the line of marginal cells, though not so well-defined as in the lamina, is more clearly apparent than it is in *N. graminea*. The cells of the sheath, as well as the marginal cells of the lamina, of *N. flexilis* are larger and longer than they are in *N. graminea;* but the two species may be distinguished by the length of the imbedded portion of the spine, which in *N. flexilis* is less, and in *N. graminea* is more, than one-third of its free length. The leaf-cells of *N. flexilis* generally are larger than those of *N. graminea* (compare figs. 45 and 46 with figs. 47 to 49, and fig. 58 with fig. 59, all of which are drawn to the same scale).

VIII.—Leaf-structure.

The anatomy of the leaves of *N. graminea* is simple. The margins of the lamina to the extent of one-third the breadth are composed of two layers of cells (see figs. 63 and 65), which in the Reddish specimens do not present that contrast in the size of the cells of the superior and inferior layers which Dr. Magnus mentions on p. 51 of his 'Beitrage.' No doubt the cells of the convex side of the lamina are slightly the smaller, but the difference is not so marked as they are represented in Plate 252, figs. 31 to 33, which are copied from the figures given by Dr. Magnus.

FIG. 60.

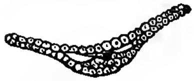

FIG. 61.

FIG. 62.

FIG. 63.

FIG. 64.

FIG. 65.

There are no stomata on the leaves, and no epidermis; but the surface-cells in all parts of the plant have intermixed with them reddish pink pigment-cells, which become brown with age. They are probably resinous, as they are the last to decay; similar cells occur in other species of *Naias*.

The central portion of the leaf is much thicker than the sides, because at this point the two layers of the lamina diverge from each other so as to enclose a central bundle of small-sized cells, surrounded by a layer of six or eight larger-sized cells. On either side of this central tissue are two intercellular cavities, which greatly exceed in size the cells which bound them (see figs. 60 to 65).

In his 'Beitrage,' pp. 51 and 52, Magnus describes *Naias graminea* as possessing bast-cells in certain fixed positions in the leaf, namely, close to the margin, and immediately above and below the central bundle on the upper and lower surfaces of the leaf (see figs. 31 to 33 on Plate 252). These bast-cells I cannot discover, after prolonged search, in any portion of the Reddish plants; but as Magnus states (p. 52) that Damietta specimens collected by Ehrenberg, and Cairo specimens collected by Schweinfurth, also have these bast-cells wanting, it is clear that the Reddish plant corresponds in this particular with the plants from Lower Egypt.

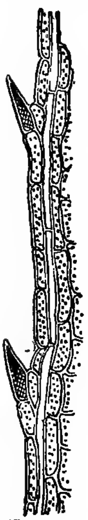

FIG. 66.

On the other hand, the plant from the Italian stations possesses bast-cells. I found them clearly marked in specimens in my herbarium collected by Signor Malinverni, "In stagnis fossis et oryzetis circa Quinto Vercellensis ditionis pago æstate 1875"; the accompanying figure has been drawn from the leaf of one of these plants (fig. 66).

The line of libriform cells is the central one of the three series which I have drawn; it is most clearly apparent when viewed as a transparent object, from the circumstance that its cells do not contain chlorophyll, and hence it is visible as a transparent colourless line in the midst of green tissue.

An isolated bast-cell is given in fig. 34 on Plate 252, and their position in the leaf is shown in figs. 31 to 33 on the same Plate at the points marked *b*. In the upper part of fig. 32 the single cell seems to have been multiplied into three, but, as Dr. Magnus explains in his memoir, these long Y-shaped cells are arranged in a single linear series at the edge of the leaf; the bifurcating end of one cell encloses the solitary attenuated end of the one next to it; a section at such a junction severs the three interlocked ends of two contiguous cells.

The absence of this libriform tissue in the Lancashire plant has a bearing in determining its source of origin, as will be noticed further on.

Between the Italian and the Lancashire plants I notice one other point of difference, which may be due to the period of growth. Above and below the central bundle of the leaf, but particularly on the lower surface, the external cells are densely packed with starch-grains, very similar to what is met with in the external membrane of the fruit. Although starch-granules are present in the membrane of the fruits of the Lancashire plant, I have failed to discover a single instance of their occurring in quantity in the leaves.

All the cells of the leaf exhibit a very striking circulation of their contents against the cell-walls; the chlorophyllean granules and other protoplasmic bodies being very large, and the cell-walls being very transparent, the plant furnishes a splendid illustration of circulation, more so than in any plant which I have examined.

IX.—The Inflorescence.

The construction of the flowers of the genus *Naias* and their morphology have been minutely studied by Dr. Magnus, and the results given in his 'Beitrage,' pp. 26 to 33. In referring to the development of a side-shoot of *N. graminea* he says that many of the internodes are suppressed, and that from three to five pairs of leaves spring from the axis before we reach the flowers, which occur to the number of from two to four all in one node. He adds that it is worthy of notice that the male flowers are found on those parts of the shoots which have long internodes, while the female flowers occur only on those shoots where the internodes are suppressed.

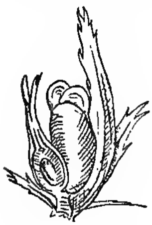

Fig. 67.

This was not the structure in the Lancashire plant. Quite as often as not pistilliferous flowers were found in the axil of the first pair of leaves of the tuft. Antheriferous and pistilliferous flowers are found side by side (see figs. 67 and 68) in the axil of the same leaf. Both kinds of flowers are also found in all stages of development, quite young ones lying side-by-side with those more developed.

The great majority of the plants produced fully-developed flowers, both male and female, the latter being much the more numerous. The species is monœcious; even in those instances in which I found only female flowers on the individual plant, I could not be sure that male flowers had not been produced, or would not have been produced later on. It was not usual, though by no means infrequent, to find both sexes in the same fascicle, at equal stages of development (figs. 67 and 68), and mature and immature flowers enclosed by the same bract (see figs. 81 and 86).

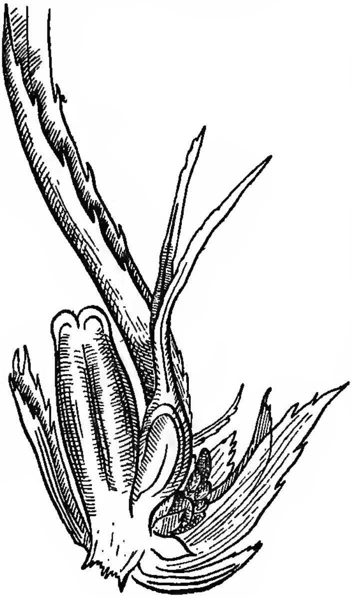

Fig. 68.

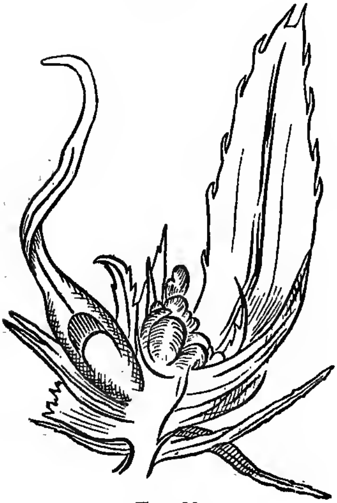

Fig. 69.

The flowers begin to occur immediately within the axil of the first pair of leaves in each fascicle, but there is frequently an outlying pair of leaves below the fascicle which does not contain flowers. The oldest flowers are always at the base of the fascicle. When mature, the fruits are plainly visible to the naked eye (see Delile's figure on Plate 250, fig. 4), but they can be detected, when present, by the touch. The female flowers are rarely solitary, but occur in twos, threes, or fours; in the earlier stages of development they are sometimes more numerous. The male flowers are more often solitary. In the centre of the fascicle are the youngest flowers (see figs. 68 and 69).

In appearance the flowers look as if they were ordinary anthers and pistils, *i.e.*, that they possess no perianth; but Dr. Magnus has shown that their outermost covering is really a perianth which more or less closely invests the anthers and pistils. In fig. 16 on Plate 251 the perianth has been drawn back from the exposed anther of *N. major*. Figs. 22, 24, 25, and 28 show the natural reflexion of the perianth-leaves in the male flower of *N. major*.

All the flowers are sessile, and I have endeavoured to convey, in the accompanying figures, accurate representations of each.

X.—The Pistilliferous Flower.

The female flower consists of an elongate flask-shaped body, with a long neck which bifurcates at its free end (figs. 68 and 70), like the bifid stigma of a *Carex*, such as *C. ovalis*. The outer covering is the perianth; the body which it encloses is the pistil.

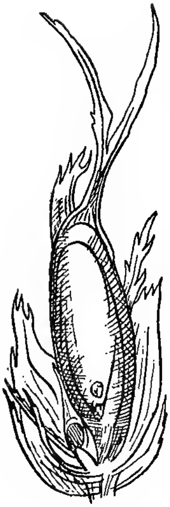

FIG. 70.

In its early stage the lower, or flask-shaped, portion consists of a globose or ovate body, surmounted by a flat parallel-sided band, of nearly the same breadth as the lower portion (fig. 67). The upper portion or neck of the flask divides about half-way up into two divisions, like the stigma of an ordinary flowering plant (see fig. 71). This stigmatoid portion attains its maximum length very early. The basal portion contains a single anatropous ovule, and it enlarges both outwards and upwards until it is twice the length of the style-like portion (see fig. 70).

The investing membrane (fig. 88)—which can be removed like the calyptra of a *Polytrichum*—is made up of one or two layers of cells, which vary in shape according to their position. The portion which covers the ovule consists of elongate cells with truncate ends, and these cells are densely packed with rounded grains of starch very uniform in size. The starch makes its appearance in the later stages of the growth of the membrane. The portion which covers the long neck of the flask-shaped body is also mostly composed of long cells; but the cells which occur on the margins of the stigmatoid divisions of the free ends are only one-third the length of the central cells, and their outer ends are somewhat enlarged so as to make the edge of the stigmatoid divisions minutely papillate, as if to afford better attachment for the grains of pollen (fig. 72). The cells of the base of the neck are much broader than any of those in other parts of the investing membrane, and they are also more loosely aggregated at that point.

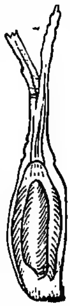

FIG. 71. FIG. 72. FIG. 73.

A central canal runs throughout the narrow portion which simulates the style, and at the point where it reaches the chamber which contains the ovule it becomes slightly constricted (fig. 71); but immediately below the constriction it widens out into a cupola-shaped cavity, whose upper portion or roof is lined with a few unicellular hairs (figs. 72 and 73). Below this cavity is the ovule. The accompanying drawings (figs. 67 to 73) illustrate the female flower in some of its stages of development.

No portion of the pistilliferous flower bears any spines similar to those which occur on the bracts and leaves; such spines are present in some of the species of *Naias*.

XI.—The Antheriferous Flower.

The male flowers are not so numerous as the female flowers, and they grow intermixed with them. Although I have frequently found plants of *Naias graminea* in which none but pistilliferous flowers could be detected at the period of examination, such tendency towards diœcism never showed itself when anther-bearing flowers were present. When the latter occurred on a plant pistilliferous flowers were invariably present, and oftener than not side by side with them (see figs. 67 and 68).

My observations of the anther do not quite coincide with the descriptions and figure given by Dr. Magnus; I have consequently given a larger number of illustrative drawings of these organs. The drawing of Dr. Magnus is reproduced on Plate 252 in fig. 35.

Fig. 74.

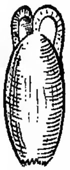

Fig. 75.

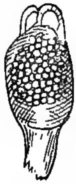

Fig. 76.

When young they are oval-shaped bodies borné upon a very short stalk (see figs. 74 and 76). So much do they resemble the anther of an ordinary flowering-plant that I was a long time in realising that the outer body which I was examining was the membrane which formed the perianth. The perianth closely invests the anther throughout all its stages of growth, and, from all that I have seen, it keeps pace uniformly with the growth of the membrane of the anther.

The anthers of this genus, according to Dr. Magnus, are axis-growths which, when ripening, are pushed through the perianth, rupturing that membrane somewhat irregularly, and they finally dehisce at their apex. That the anthers of the Reddish plant dehisce at the apex there is no doubt, but I have seen no trace of the rupturing of the outer perianth-membrane through the emergence of the anther proper; on the contrary, the summit of the flower presents a regularity of parts for which Dr. Magnus's observations did not prepare me. The rupturing of the perianth in *N. major* is shown in figs. 22 and 28 on Plate 251.

In an early stage the antheriferous flower of *N. graminea* has its outer membrane prolonged into two erect rounded ears, which are continued down the sides as keels or ridges (figs. 67 and 75). The young pollen at this stage is distinctly seen through the membranes of the flower and of the anther (fig. 76). The anther then becomes more elongate by its upward growth; a slight groove makes its appearance longitudinally, corresponding with the principal dissepiment of the anther (fig. 68); the upright ears and the keels lose their prominence, and the separate pollen-grains are not so distinguishable (fig. 77). Finally, the mature quadrilocular anther is an ovoid cylindrical body having two narrow ridges covering the summit, and descending about half-way down the covering of the flower (fig. 78). For comparison, see an antheriferous flower of *N. minor* in Plate 251, fig. 17; a transverse section of *N. major* in fig. 18; a vertical section of *N. major* in

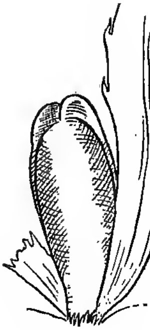

FIG. 77.

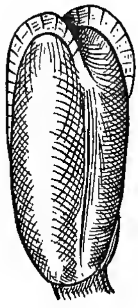

FIG. 78.

fig. 23; a vertical section of *N. minor* in fig. 27; and a vertical section of *N. major.* in fig. 21.

The membrane which invests the anther is formed of close-ranked, elongate, translucent cells, six to twelve times as long as broad, and tinged with a beautiful rose-colour; the superposition of this rosy membrane over the lemon-coloured pollen of the anther gives the flower a tawny-orange appearance, which readily attracts notice, even without the aid of a lens. The cells which compose the ridges in the upper half of the flower are larger and broader than those of the rest of the membrane.

Robert Brown's *N. tenuifolia* has considerable affinity with the Manchester plant, but, independent of other differences, the anther is very dissimilar on account of its external tunic terminating in a narrow elongate beak, which bears a number of brown spiny teeth at its free end (see fig. 15, Plate 251). At the period of dehiscence the internal tunic which contains the pollen separates itself from the external membrane, but, instead of its emerging through the summit of the beak of the perianth, it is thrust through a rupture in the side.

In *N. graminea* the external membrane closely invests the inner membrane, but it is not projected beyond it in the form of a beak; and I have not seen a vestige of a brown spiny cell on any portion of the male flower.

XII.—The Pollen.

The pollen of the various species of *Naias* does not seem to have been much noticed by observers. Magnus does not allude to it, nor give any figures of pollen-grains for any of the species; and contradictory statements are made by some authors. Thus the drawings of Braun, engraved in fasc. x., plate i., of the 'Genera plantarum floræ germanicæ' of Nees ab Esenbeck, show a globose pollen for *Naias minor* (*Caulinia fragilis*) *in situ*, and for *Naias major* in separate grains (see Pl. 251, fig. 19), and in his diagnosis of the genus (*Caulinia*) he specifies "pollen globosum, magnum." This statement seems to be the foundation for the similar statement in the works of later authors, one of the most recent being given in the 'Genera plantarum' of Bentham and Hooker, vol. iii., p. 1018, *viz.*, "pollen globosum." In the 'Compendio della Flora Italiana' of Cesati, Passerini, and Gibelli, part 1, p. 204, tab. xxvii., fig. 1, the pollen of *N. major* is elliptico-cylindrical like a grain of rice, say from two to three times longer than broad (see Pl. 251, fig. 26). In the 'Flora Danica,' Plate 2121, the pollen of *Najas marina* (*Caulinia fragilis*) is of an elliptical form, not quite twice as long as broad.

This divergence of form in the pollen-grain of *Naias major* suggests at first sight inaccuracy of observation, but I have found both globose and elongate pollen in the anthers of the Lancashire *Naias graminea*. The globular form is represented in fig. 79, and the elliptical form is given in fig. 80, both drawn to the same scale.

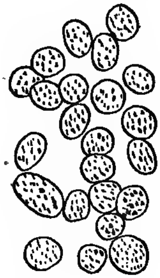

FIG. 79.

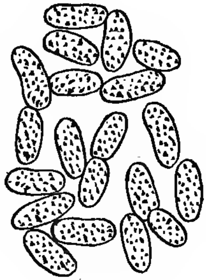

FIG. 80.

Undoubtedly the pollen is globular in its early stages, but, after selecting what appeared to be perfectly mature anthers just at the period of dehiscence, the pollen which emerged was found to be globose, as drawn, in one anther, and elliptico-cylindrical in another anther. Whether the globose pollen ultimately passes into the elliptical form, and that the latter represents the mature pollen, or whether there is a dimorphism in the pollen-grain, I cannot pronounce; I can only certify to the occurrence of both forms in plants from the same station, and that the globose form is much the rarer of the two.

In its fresh state the pollen-grain is of a pale yellow colour, and its contents are granular. It must be produced in great abundance, as I have frequently found it in a free state in the water of the glass jars which have held the living plant during these investigations; grains also occur floating about in the chloride of sodium solution, which I use for mounting the dissections of the plant for permanent microscopic examination.

XIII.—FERTILIZATION.

The pollination of *Naias graminea* is entirely effected in the water, as there is no provision for an elongation of the peduncle to raise the pistilliferous flowers up to the surface of the water, as in *Potamogeton Zizii*, *Valisneria*, *Anacharis*, and other aquatic plants. The structure of the inflorescence forbids its being considered a cleistogamous flower; whether it is an aquatic type of an anemophilous or an entomophilous plant I cannot determine.

Some observations I have noted for recording here are of some interest, as they suggest that pollination is effected in two ways. In the station in which the *Naias* occurs near Manchester the very slight natural flow of the water in the canal towards the locks is quite sufficient for the transport of the pollen, and, though I have not purposely taken some of the canal water to see if it contained free pollen, my home observations leave me no doubt that pollen is carried to the pistilliferous flowers by the current; in such case the plant would be hydrophilous. While, however, examining portions of a living plant on which were ripe anthers, I noticed a colony of *Vorticellidæ* attached to one of the fascicles of leaves; the grace and activity of its movements led me to watch it for a considerable time, and whilst so watching it I witnessed grains of pollen whirled in all directions, or drawn into the vortex of the animal by its marginal cilia. The alternate contraction and elongation of the elastic and thread-like pedicles of the colony kept the pollen-grains in constant motion, which left me no doubt that at times the grains would be directly borne to the stigmatoid appendages of the pistilliferous flowers.

The canal-water is most prolific in animal life; beetles, molluscs, leeches, rotifers, polyps, larvæ of insects, &c., must surely prove potent factors in transporting pollen not only in the tepid water of the Reddish canal, but in the still water of pools and ditches. If we carefully look for instances of their intervention we cannot fail to find distinctive protozophilous plants, dependent for their fertilisation upon animal life in the aqueous world, in much the same way as we find entomophilous plants in the aërial world.

It is a very happy circumstance that Sir Joseph Hooker should have indicated the forms of pollination which prevail in many of our native plants, where known. Sprengel, Darwin, Müller, Lubbock, Kerner, and many others have largely increased our knowledge of this subject for terrestrial plants, but its extent after all is very limited; we have but ascended a few steps leading up to the vestibule, whilst the great temple of truth is beyond. While, as regards aquatic plants, and particularly those which are wholly submersed throughout their lives, like *Naias graminea*, *Stratiotes*, &c., our knowledge is even more and more limited. Hence Sir Joseph Hooker has earned the thanks of British botanists by bringing into prominence, in his 'Student's Flora,' this important feature in the economy of our native plants.

XIV.—The Fruit.

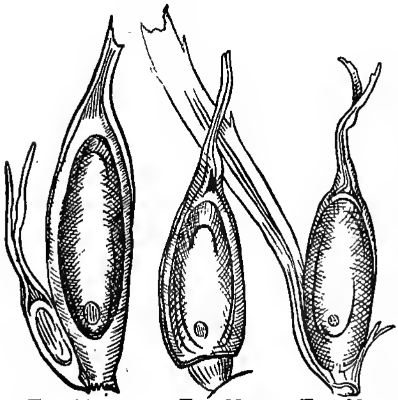

Fig. 81. Fig. 83. Fig. 82.

Up to the time of the fertilization of the ovule the outer membrane of the flower—the perianth, and the investing membrane of the ovule contained within the perianth, both remain transparent or semi-transparent. After pollination has taken place the membrane of the ovule becomes turbid and thickens, while the ovule itself enlarges and becomes a mature fruit, covered with a testa formed of thick-walled cells (figs. 81 to 83).

The fruit is sculptured with a network of raised ridges which thus produce depressions in the shell; this sculpture seems to have its seat in one of the inner membranes of the shell, since it cannot always be distinguished through the most external layer. As far as I have been able to make it out, it is somewhat after the character of the accompanying fig. 84; but this must be looked upon as a diagramatic interpretation of what is supposed to be seen, rather than an actual repre-

FIG. 84.

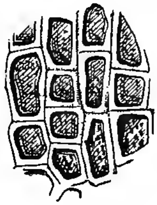

FIG. 85.

sentation of fact. In the same way I have drawn the testa of *Naias flexilis* in fig. 85 from a single mature fruit in one of Dr. Boswell's Loch Cluny specimens; I am more sure of the correctness of this figure than of that of *N. graminea*, but it represents what is seen in a single fruit only. It would therefore appear that the sculpture of *N. flexilis* is quadrangular, while that of *N. graminea* is hexagonal; but too much must not be made of observations founded on such a limited basis.

According to the observations of Cesati* the fruits of the Italian *N. alaganensis* are granulose-punctate, which fairly well describes the appearance of the outer covering of the Manchester plant; but Cesati's figure in 'Linnæa,' *l. c.*, Table ii., fig. 2 *d*, makes the fruit much more papillate than I find it in the Lancashire form. On the other hand, this same observer makes the fruit of *N. flexilis* shining and obscurely angular, and he so draws it in his plate.

The explanation of this difference in the form of sculpturing is probably due to the fact that the external membrane more or less obscures the underlying layer, and thus the latter is seen by observers according as the transparency of the outer layer admits of it. For the further elucidation of this point I have reproduced the figures of Dr. Magnus in Plate 252, where figs. 40 and 41 show the arrangment of the coats of the fruit of *N. graminea* from Cairo, and figs. 37 to 39 those of *N. flexilis*.

At Reddish mature fruits of *N. graminea* are produced in great abundance; scarcely a plant occurred without fruits. In the many hundred plants which I have examined I have not seen a single instance where the beak of the fruit was other than bifid, unless it had broken off altogether, as represented in figs. 81 and 83,

* "Die Pflanzwelt im Gebiete zwischen dem Tessin, dem Po, der Sesia und den Alpen," ('Linnæa,' vol. xxxii., 1863, pages 259 and 260).

and in the middle fruit of figure 86. This division of the beak into two branches is a constant character, and very clearly distinguishes it from the four-rayed beak of *Naias flexilis* (fig. 87).

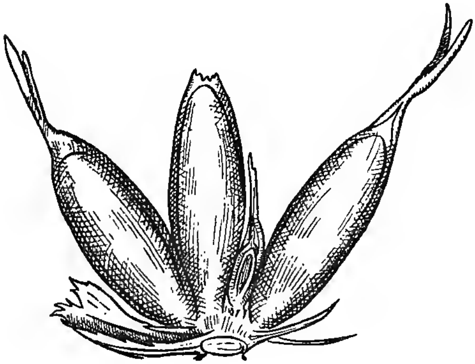

FIG. 86.

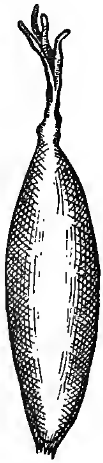

FIG. 87.

One other point of differentiation between *Naias graminea* and *N. flexilis* rests in the shape of the fruit. In the former the ends are more abruptly narrowed into the base and the beak than they are in the latter, which has gradually narrowing ends; compare figs. 86 and 87. Cesati's figures in 'Linnæa' xxxii., Plate 2, confirm this conclusion.

The perianth easily separates from the fruit; it is represented in fig. 88. The portion which covers the body of the fruit consists of a single layer of cells.

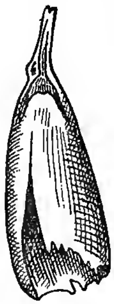

FIG. 88.

XV.—THE ROOTS.

The roots are of great length, creeping in the soft black mud of the bed of the canal; they are given off from the nodes in verticils. They are capillary, uniform in diameter, even when nine inches long, tawny-orange in colour, and I have not seem them branch.

In internal structure they bear some resemblance to the stems. There is a central channel surrounded by a mass of elongate cells hexagonal in outline, smaller in size, and with thinner walls than those of the rest of the cells within the cylinder. Outside this area is a row of cells whose walls are darker coloured than any of the others (except the cells which form the exterior of the cylinder), and they so arrange themselves as to form a sheath round the central cells; from this row of cells numerous short branches are given off which enclose intra-cellular cavities, similar to those in the stem, but much smaller and more circular (see fig. 89). These cavities are regularly arranged in one series round the central mass, as in the stem, but there are occasionally outlying cavities in the neighbourhood of the external orange-coloured cells, as shown in fig. 89. Enclosing the whole is a layer of larger-sized cells, of a dark brown colour, and more angular in outline than any of the other cells. In the midst of these cells, but on the outermost side, are a few cells filled with a rich tawny brown pigment. The walls of the circumferential cells are all very thin, and they have the rich colour of the pigment cells.

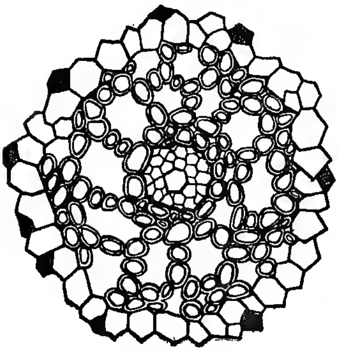

FIG. 89.

In addition to the roots proper the plant gives off adventitious roots from the stem-nodes, as represented in Plate 249. These are generally given off singly from between the first pair of leaves of the fascicle; occasionally two proceed from the same node, but in such case the second root emerges on the opposite side of the node. In the lower portions of the stem the adventitious roots become more numerous from each node, and they begin to acquire the orange colour of the roots proper. They attain a length of from half an inch to six inches or more, and they have a similar internal structure to that of the roots proper; the peripheral cells, however, do not possess the angular character nor the tawny colour of the outer layer in the lower roots. The tissue is more loosely aggregated; the intra-cellular cavities are fewer in number and smaller, scarcely exceeding the size of the cells which surround them. The central cavity is present, as well as the surrounding sheath, but the cells of the latter are fewer than they are in the root proper. The external cells do not differ much from the inner cells either in shape or in colour, the rich pigment of the corresponding layer in the root being absent.

XVI.—THE LANCASHIRE LOCALITY.

The occurrence of a *Naias* in Lancashire was so unexpected a circumstance that I was pleased, through Mr. Whitehead's kindness, to have the opportunity of seeing the plant in its station in the canal at Reddish, near Manchester. The precise locality was not intended to be published, but as the station seems to be well known to so many local botanists there is no further need to suppress it.

When I first visited the canal, on the 14th September, 1883, the *Naias* grew in an area of about a quarter of a mile in length; in some portions of this space it was the prevailing plant, wholly covering the canal-bed, while in other portions it was intermixed with *Potamogeton rufescens*, *P. obtusifolius*, *P. crispus*, *P. pusillus*, *Myriophyllum*, and *Anacharis*. Except in so far that the station, like most canals, was an artificial one artificially supported, there seemed nothing in the accompanying vegetation to suggest that the *Naias* was not aboriginal. All the other plants were of the prevailing canal character, the non-native *Anacharis* being as much at home as any of them.

The temperature of the canal water is, however, artificially raised by the discharge of hot water from boilers and condensing tanks attached to the cotton-mills and other works, which are erected on the banks of the canal. In the declining evening of my first visit the water was quite warm, say about 90° Fahr. This abnormal temperature must be looked upon as the important factor in the struggle for existence maintained by this plant. In subsequent visits to the canal the temperature of the water was not met with so high as it was found on the first occasion; still, with the fitful discharge of hot water into the canal at many points, its average temperature must be many degrees above the normal point for the neighbourhood. It might have been expected that the vegetation which grows in this tepid body of water would have shown signs of luxuriance, but such does not appear to be the case. The most striking variation is met with in *Potamogeton crispus*, which becomes dwarfed, particularly in stations where there is an inflowing stream of warm water.

Two other plants which grow in the same canal ought to be noticed in this connexion. The first of these is the *Chara Braunii* Gmel., which the Messrs. Groves figured and described in the 'Journal of Botany' for January, 1884, t. 242, p. 3. This plant affects the edges of the canal, but it also occurs in the deeper water of the centre, where it is more liable to be cut down by the passing barges. Another interesting plant grows with the *Chara*, whose identity is by no means settled, and it may prove worthy of a more detailed notice *viz.*, a species of *Zannichellia*.

Mr. Whitehead had mentioned to me, on the occasion of our joint visit, that *Z. palustris* had been recently found in the canal, and as it was an infrequent plant in the district surrounding Manchester, I was anxious to procure specimens, although it involved a moonlight search. It was while hunting for this plant that, unknown to myself or to my companions, I collected the *Chara* in the darkness; the specimens were very fragmentary, but from them Mr. Arthur Bennett determined the plant to be the *Chara Braunii*, new to the British Flora. In justice to Mr. Whitehead it ought to be stated that he and Mr. Armitage had collected it in the same station a fortnight or so prior to my visit.

The *Zannichellia* grows in the soft mud in the shallower parts of the canal, with *Chara Braunii* and *Potamogeton pusillus;* it also occurs in places where the water scarcely covers it. It would appear to flower and fruit in the mud as well as in the water, but the fruits which are produced in mud are of a very pale yellow-green, on account of their imperfect exposure to the light. From the dwarf, creeping, habit of the plant it seems to have an affinity with the form of *Z. palustris*, named *Z. repens* Bœnningh. The characters of the Reddish plant agree with the description of *Z. repens* in essential points, but the stigma is not usually more enlarged than in *Z. palustris*, whereas this feature is a decided character, both in the diagnosis and in Reichenbach's plate.* In the spring and early summer it has large reserve-buds, of the size of peas, from which the shoots take their rise.

One of its peculiarities is, that it has four or five rows of spines or protuberances on the dorsal and ventral edges of many of its carpels, and much more prominent than they are in *Z. pedunculata*, *Z. gibberosa*, and *Z. polycarpa*.

Delile reports † finding *Zannichellia palustris* in a lake near to Fâreskour in Lower Egypt, along with *Naias muricata*. It would be interesting to determine whether the form is the same as that which occurs in the canal at Reddish. Local botanists also ought to keep an eye upon the possible occurrence of the rare *Naias muricata*, figured and described by Delile; so far it has only been recorded for Egypt and Arabia.

The locality which produces such an extra-anglican species as *Naias graminea* must be worth exploring for the animal life which is fostered by the same high temperature which has sustained the *Chara* and the *Naias*.

XVII.—Geographical Distribution.

Naias graminea is distributed over a wide area. It occurs in a natural state in the northern and central parts of Africa, in Syria (Plain of Sharon: 'Memoirs of the Palestine Exploration Fund,' Fauna and Flora, p. 416), and Persia, in the Indian Archipelago and other warm regions of Asia, and probably in Japan. It does not occur in Europe except as a colonist, it having been introduced (according to the Italian botanists) with East Indian rice, into districts where that cereal is cultivated, as in the plains of Lombardy and Venice; the Italian localities are given in Cesati's 'Compendio della Flora Italiana,' as Alagna in Novara, Balzola between Vercelli and Casale, Merlato near Milan, Upper Vercellese, Strasoldo nel Friuli near Palmanavo. It has also been reported from the extreme north-eastern portion of Austria; but it is not native in any of its European stations, and it is an introduction in Lancashire. It becomes, therefore, an interesting question to account for its appearance in a country which does not grow the rice which it consumes.

XVIII.—Its probable Source of Origin.

When this plant was exhibited at the British Association at Southport, in September last year, I expressed the opinion in the Biological Section, that it had probably been introduced into the Reddish locality with Egyptian cotton. This class of cotton is not one of the staple articles of consumption in the Stockport district,

* Icones Floræ Germanicæ, &c., vol. vii., fig. 20, pl. xvi.

† 'Flore de l'Egypte,' vol. ii., p. 281; and also on page 75 under No. 872.

but there is one mill on the banks of the canal (Houldsworth's) which consumes Egyptian cotton largely, and from it, if not from others, the fruits of the *Naias* may have been transported to the canal. Last autumn, Mr. J. Cosmo Melvill and myself carefully examined the large condensing tank in the yard of this mill, but we could not find a trace of the plant; the water was of a high temperature and little vegetation was found in it, but its depth was beyond our means of properly exploring it.

Alire Raffenau Delile * gives an account of the culture of rice in Egypt, and shows that the water used for the young plants is drawn fron the Nile by fixed machines during the principal part of the year; but in times of inundation, during the rising of the river, the water is naturally distributed, its particular course being regulated by the embankments which protect the fields. He states that the plant grows in the canals of the rice-fields at Rosetta and in the Delta, but he considered it only a variety of *Naias fragilis*, which grows in the same waters.

The irrigation of modern Egyptian cotton plantations will be effected by much the same means, the Nile, with its artificial ramifications, being the chief water supply of the country. Fruits of the *Naias* may reach Egypt from Abyssinia, or from the great lakes of Equatorial Africa; the Nile water supplied to the growing cotton-plant will be accompanied by these fruits, some of which would be left dry upon the surface after the water had percolated through the upper soil, but they would not germinate there. Either by the agency of the wind, or through accidental contact with the soil, they become mixed with the cotton exported to England. When the bales of cotton reach the Lancashire mills, the fruits of the *Naias* would be removed in the blowing-room, or by the carding-engines. The refuse is turned out of the mill into the yard, whence the wind and other agencies transport the fruits into the tepid water of the canal; here they meet with a suitable nidus for germination and growth, and the result is the appearance of an alien in our flora.

If these surmises have any substratum of truth, the *Naias* may occur in any mill-pond connected with works where Egyptian cotton is used, and where the water is raised to a permanently high temperature by the condensation of steam from the boiler. As Egyptian cotton is largely used in Bolton, the mill-ponds and canals of that neighbourhood may be expected to contain *Naias graminea* and other Egyptain aquatic plants, as *Naias muricata* Del., *Chara Braunii* Gmel., &c.

The Egyptian origin of the plant is to some extent confirmed by the form of *Chara Braunii* which grows at Reddish being very near the form of that species which occurs in Northern Africa. Whether there is anything showing an affinity to the Egyptian plant in the peculiar form of *Zannichellia* which grows in the same canal, I have not the means of determining; but both it and the

* 'Mémoire sur les plantes qui croissent spontanément en Egypte,' vol. ii., pp. 16, 17.

Chara Braunii are so often associated together as to give a strong colour to the surmise of their common origin. There is nothing in the recorded distribution of *Chara Braunii* to forbid its being ultimately shown to be aboriginal, but until it is recorded from other British stations, with fewer doubtful surroundings than it has in the Manchester station, it can only be looked upon as a colonist.

XIX.—A Histological Peculiarity.

A still stronger proof of its Egyptian extraction is furnished from the histological side. This part of the case has been dealt with by Dr. Magnus, in a paper read to the German Botanical Association at Berlin, December 11th, 1883, and I make no apology for reproducing here the substance of this interesting communication. In describing the structure of *Naias graminea* on page 13, I mentioned that there were two forms of the plant; one, possessing peculiar libriform cells near the margin of the leaf; the other, destitute of these bast-cells. This latter form Dr. Magnus names the var. *Delilei*, and he states that the English specimens belong to this variety, and indubitabty prove their Egyptian source. The following are some extracts from the paper of Dr. Magnus, published in the 'Berichte der deutsch. Botanischen Gesellschaft,' Jahrg. 1883, Band i., Heft 10:—

"I have examined the specimens of *Najas graminea* collected by Delile in the rice-fields near Rosetta, as also those obtained by Schweinfurth near Benha-el-assl in the Nile Delta, and have found them to be without bast-nerves. They are also wanting in a specimen collected by Gaillardet, near Saida in Syria, which has been kindly communicated to me by M. Boissier. I was further enabled, through the kind communication of Professor Ascherson, to examine specimens of *Najas graminea* Del., collected by him during his travels in the Libyan Desert, in the Oasis of Dachl, as also specimens collected by Schweinfurth in the Great Oasis (Chargeh). From this it would appear that the *Najas graminea* Del., collected in a brook at Aïn-Scherif near Kasr Dachl, as well as those collected by Ascherson near El Chargeh, likewise have leaves without libriform cells, like the plants of Lower Egypt. On the other hand, the *N. graminea* collected some weeks later in the same ditches in Aïn-Scherif by Ascherson, as well as from a warm spring-hole in Kasr Dachl, as also the specimens collected by Schweinfurth near Chargeh, have all well-developed bast-nerves, similar to the plants of Cordofan, Djur, Algeria, Celebes, &c. . . .

"The absence of these bast-nerves in a variety of *Najas graminea* is the more peculiar, as through the construction of the male flower of *N. tenuifolia* R. Br. [see fig. 15, Plate 251], from Australia, which differs so materially, has precisely the same bast-nerves in exactly the same shaped libriform cells on the leaves; consequently these bast-nerves represent the distinctive character of a group of allied species, but still subject to variations. . . . .

"I have mentioned above that the one set of specimens from Kasr-Dachl and Chargeh had leaves without bast-nerves, and that another set had them; that is, that the one set belong to the var. *Delilei*, while the other agrees with the form which appears in Cordofan, Djur, Algiers, &c. This would appear to be a clear proof that the oases of the Libyan Desert have received their flora from Egypt as well as from Central Africa. This agrees with the results of the investigations which Ascherson furnished to the 'Botanische Zeitung' for 1874, pages 641 to 644.

"These explanations would, however, seem to be somewhat contradictory, seeing that the English specimens are remarkable for their great length of leaf, whereas the leaves of *N. graminea* from Cairo and Damietta are very short. But a minute examination of form teaches us that we must not attach much importance to the question of the length of leaves, which is influenced, as in most water-plants, by the depth, current, bed, and temperature of the water. Thus we find that the specimens collected by Professor Ascherson in the Dachl Oasis, from the deeper pools (half a metre deep), have long leaves as well as bast-nerves, and yet the English specimens have longer leaves without bast-nerves; while the Egyptian specimens have shorter leaves without bast-nerves. Thus, again, we find the *N. graminea* Del., growing in the shallow ditches of the rice-fields of the plains of Lombardy, has short leaves with bast-nerves, whereas the *Najas graminea* from Celebes has very long leaves with bast-nerves. In short, we see that the length or shortness of the leaves has nothing whatever to do with the formation of the variety, and nothing to do with the histological formation of the leaf-tissue.

"It is nevertheless possible that the var. *Delilei*, deprived of the bast-nerves, has been developed in the quiet stagnant waters of the overflowed Nile, as in these stagnant waters the mechanical cells would become deprived of their functions. Thus we find Schwendener, in his exhaustive work, 'The Mechanical Principle in the Anatomical Construction of Monocotyledons,' Leipzig, 1874, page 122, remarking that *Potamogeton fluitans* in its customary habitat of running water has a developed system of bark-bundles, whereas the var. β *stagnalis* Koch is completely deprived of same.

"The var. *Delilei*, found in the stagnant waters of the overflowed Nile, is a most persistent and constant one, as during a period of a hundred years it has been indubitably collected by Delile, Schweinfurth, and Ehrenberg, in Lower Egypt. Its unaltered appearance in England and in the oases shows its constancy and total independence of habitats, whilst its formation has probably been caused by the same."

It now only remains to me to tender my acknowledgments to Mr. Ridley, Mr. Arthur Bennett, Dr. Magnus, Professor Ascherson, Mr. Beeby, and to the Editor of this Journal, for help rendered. The delay which has occurred in completing this paper has been unavoidable; it has had to take its turn in the intervals of a busy life.

XX.—Explanation of the Figures

Plate 249.

Fig. 1. The upper portion of a branch of *N. graminea,* from Reddish; nat. size.

2. Two of the leaves from same, drawn rather broader than the natural size, the sheaths and auricles flattened out.

Plate 250.

3. Upper portion of a branch of *N. graminea* from Lower Egypt. Copied from Delile's drawing in his 'Flore de l'Egypte,' but reduced to two-thirds original size.

4. Base of a leaf-fascicle, showing leaf-auricles, fruits, &c.; slightly enlarged. From Delile's 'Flore de l'Egypte.'

5. Section of fruit; enlarged. From Delile's 'Flore de l'Egypte.'

Plate 251.

6—8. Arrangement of the cells of the marginal spines on the leaf of (6), *N. flexilis;* (7), *N. graminea;* (8), *N. minor* and *N. arguta.* From Dr. Alexander Braun's sketches in 'Journal of Botany,' 1864, vol ii., p. 275.

9. Form of sheath at base of leaf of *N. minor;* from 'Compendio della Flora Italiana,' of Cesati, Passerini, and Gibelli, tav. xxviii, fig. 1 *n*.

10—14. Form of sheath at base of leaf of (10), *N. flexilis;* (11), *N. minor;* (12), *N. minor,* var. *setacea;* (13), *N. falciculata:* and (14), *N. graminea.* All copied from Dr. A. Braun's woodcuts in 'Journal of Botany,' 1864, vol. ii., p. 274.

15. Male flower of *N. tenuifolia* R. Br. Enlarged $\frac{16}{1}$. From Magnus's 'Beitrage,' plate iv., fig. 5.

16. Anther of *N. major,* with the perianth reflexed; enlarged. From 'Genera Plantarum Floræ Germanicæ,' Th. Fr. Lud. Nees ab Esenbeck, Fasc. vi., *Naias,* fig. 5.

17. Male flower of *N. minor;* enlarged. Nees ab Esenbeck, *l. c.*, fig. 24.

18. Transverse section of male flower of *N. major.* Nees ab Esenbeck, *l.c.*, fig. 7.

19. Pollen of *N. major;* enlarged. Nees ab Esenbeck, *l. c.*, fig. 8.

20. Male flower of *N. major,* with the perianth drawn back; enlarged. From 'Iconographia familiarum naturalium regni vegetabilis,' Dr. Adalbert Schnizlein, Heft v., pl. 71, fig. 4.

21. Vertical section of male flower of *N. major:* enlarged. Schnizlein, *l. c.*, fig. 6.

22. Male flower of *N. major,* showing the separation of the perianth from the anther; enlarged. Schnizlein, *l. c.* fig. 7.

23. Vertical section of a male flower of *N. major.* From 'Compendio della Flora Italiana,' *l. c.*, fig. 1 *b*.

24—25. Dehiscence of the perianth of *N. major,* after the observations of Braun; enlarged. Nees ab Esenbeok, *l. c.*, figs. 9 and 10.

26. Grains of pollen of *N. major,* with fovilla; enlarged $\frac{200}{1}$. From 'Compend. Fl. It.,' *l. c.*, fig. 1 *d*.

27. Vertical section of a male flower of *N. minor* All.; enlarged. 'Compend. Fl. It.,' *l. c.*, fig. 1 *e*.

28. Male flower of *N. major;* enlarged $\frac{4}{1}$. 'Compend. Fl. It.,' *l, c.*, fig. 1*a*.

29. Base of leaf of *N. major* with the sheath opened. Intravaginal scales at the base of the sheath, one on each side; enlarged $\frac{2}{1}$. 'Compend. Fl. It.,' *l.* c. fig. 1 *m*.

30. Intravaginal scale of *N. major*; enlarged $\frac{6}{1}$. 'Compend. Fl. It.,' *l. c.*, fig. 1 *o*.

Plate 252.

31. Transverse section of the middle of the leaf of *N. graminea,* Del.; enlarged $\frac{152}{1}$. Magnus, 'Beitrage,' pl. vi., fig. 3.

32. Transverse section of the side of the leaf of *N. graminea,* Del., from Celebes; enlarged $\frac{335}{1}$. Magnus, 'Beitrage,' pl. vi., fig. 2.

Fig. 33. Transverse section of the leaf of *N. graminea* Del., from Celebes; enlarged $\frac{130}{1}$. Magnus, 'Beitrage,' pl. vi., fig. 1.

In Figs. 31—33 the leading bundles are drawn schematically: i = intercellular spaces, b = bast-cells.

34. Isolated bast-cell from the leaf of *N. graminea* from Celebes; enlarged $\frac{152}{1}$. Magnus, 'Beitrage,' pl. vi., fig. 4 *b*.

35. Male flower of *N. graminea*; enlarged $\frac{36}{1}$. Magnus, 'Beitrage,' pl. iii., fig. 6.

36. Transverse section of the stem of *Caulinia alaganensis*. From 'Tavole per una Anatomia delle piante aquatiche,' Parlatore, pl. vi., fig. 3.

37. Surface-view of the outer cell-layer of the unripe seed of *N. flexilis*; $\frac{198}{1}$. Magnus, 'Beitrage,' pl. v., fig. 9.

38. Diagonal section of the nearly ripe seed-shell of *N. flexilis*: enlarged $\frac{198}{1}$. Magnus, 'Beitrage,' pl. v., fig. 8.

39—40. Diagonal sections of the still (? if not always) unripe seed-shell of *N. graminea* from Cairo; enlarged $\frac{198}{1}$.

41. Diagonal section of the quite ripe seed-shell of *N. graminea* from Cairo; enlarged $\frac{198}{1}$. Magnus, 'Beitrage,' pl. v., fig. 12.

FIGURES IN THE LETTERPRESS.

All the figures are drawn from Reddish specimens of *Naias graminea* Del., var. *Delilei* Magnus, except when stated otherwise.

42. *N. graminea.*—Transverse section of stem, drawn diagrammatically; enlarged $\frac{52}{1}$.

43 and 44. *N. graminea.*—Ends of leaves, showing dentition; enlarged $\frac{14}{1}$.

45 and 46. *N. flexilis.*—Spines on margins of leaves, from specimens collected by Dr. Boswell, in Loch Cluny, near Blairgowrie, Perthshire; enlarged $\frac{156}{1}$. See 'Journal of Botany,' No. 154, 1875, p. 297.

47 to 49. *N. graminea.*—Spines on margin of middle portion of leaf; enlarged $\frac{156}{1}$.

50. *N. minor.*—Tooth of leaf from one of Archbishop Haynald's specimens from ponds in his park at Kalocsa, Hungary; enlarged $\frac{156}{1}$.

51. *N. major.*—Tooth of leaf from plant collected near Coblentz, by Dr. Ph. Wirtgen; enlarged $\frac{156}{1}$.

52. *N. graminea.*—Large leaf-sheaf from leaf of first pair; enlarged $\frac{14}{1}$.

53. *N. graminea.*—Usual form of leaf-sheaf from leaf of first pair; enlarged $\frac{14}{1}$.

54. *N. graminea.*—Usual form of leaf-sheaf from leaf of first pair, with irregular-sized auricles; enlarged $\frac{14}{1}$.

55. *N. graminea.*—Leaf-sheaf from leaf of second pair; enlarged $\frac{14}{1}$.

56 and 57. *N. flexilis.*—Leaf-sheath from Scotch specimens; enlarged $\frac{14}{1}$.

58. *N. graminea*—Spines on margin of auricles; enlarged $\frac{148}{1}$.

59. *N. flexilis.*—Spines on margin of auricles from Loch Cluny. They are the first four which occur on the left shoulder of Fig. 57, above the minute spine, nearest the base of the sheath; enlarged $\frac{146}{1}$.

60 to 65. *N. graminea.*—Transverse sections of leaves, beginning near the summit; enlarged $\frac{32}{1}$.

66. *N. alaganensis.*—Libriform cells in margin of leaf, from Malinverni's Italian specimens; enlarged $\frac{146}{1}$. The libriform cells are the long cells without cell-contents.

67. *N. graminea.*—Young antheriferous and pistilliferous flowers growing side by side; enlarged $\frac{18}{1}$.

68. *N. graminea.*—Older antheriferous and pistilliferous flowers growing side by side; enlarged $\frac{18}{1}$.

69. *N. graminea.*—Portion of central infloresence; enlarged $\frac{36}{1}$.

70. *N. graminea.*—Pistilliferous flower with contiguous bracts; enlarged $\frac{18}{1}$.

71. *N. graminea.*—Young pistilliferous flower; enlarged $\frac{18}{1}$.

72 and 73. *N. graminea.*—Young pistilliferous flowers, showing the stigmatoid appendages; enlarged $\frac{18}{1}$.

74 and 75.—*N. graminea.*—Young antheriferous flowers; enlarged $\frac{23}{1}$.

76. *N. graminea.*—Young antheriferous flower, showing immature pollen; enlarged; $\frac{38}{1}$.

Fig. 77. *N. graminea.*—Antheriferous flower not fully ripe; enlarged $\frac{23}{1}$.
78. *N. graminea.*—Mature antheriferous flower; enlarged $\frac{29}{1}$.
79. *N. graminea.*—Globose pollen; enlarged $\frac{146}{1}$.
80. *N. graminea.*—Elliptico-cylindrical pollen; enlarged $\frac{146}{1}$.
81. *N. graminea.*—Fruit, with immature pistilliferous flower in the same bract; enlarged $\frac{18}{1}$.
82 and 83. *N. graminea*—Fruits nearly mature; enlarged $\frac{18}{1}$.
84. *N. graminea.*—Supposed ridges and pits, of hexagonal outline, on surface of fruit; as seen with a $\frac{4}{10}$ objective, Lieberkuhn and Kelner B eye-piece.
85. *N. flexilis.*—Ridges and pits, of quadrangular outline, on surface of fruit; as seen with a $\frac{4}{10}$ objective, Lieberkuhn, and a Kelner B eye-piece.
86. *N. graminea.*—Three mature fruits and an immature pistilliferous flower in the same verticil; enlarged $\frac{14}{1}$.
87. *N. flexilis.*—Mature fruit from Loch Cluny specimen; enlarged $\frac{14}{1}$.
88. *N. graminea.*—Perianth removed from fruit; enlarged $\frac{14}{1}$.
89. *N. graminea.*—Transverse section of the root; enlarged $\frac{85}{1}$.

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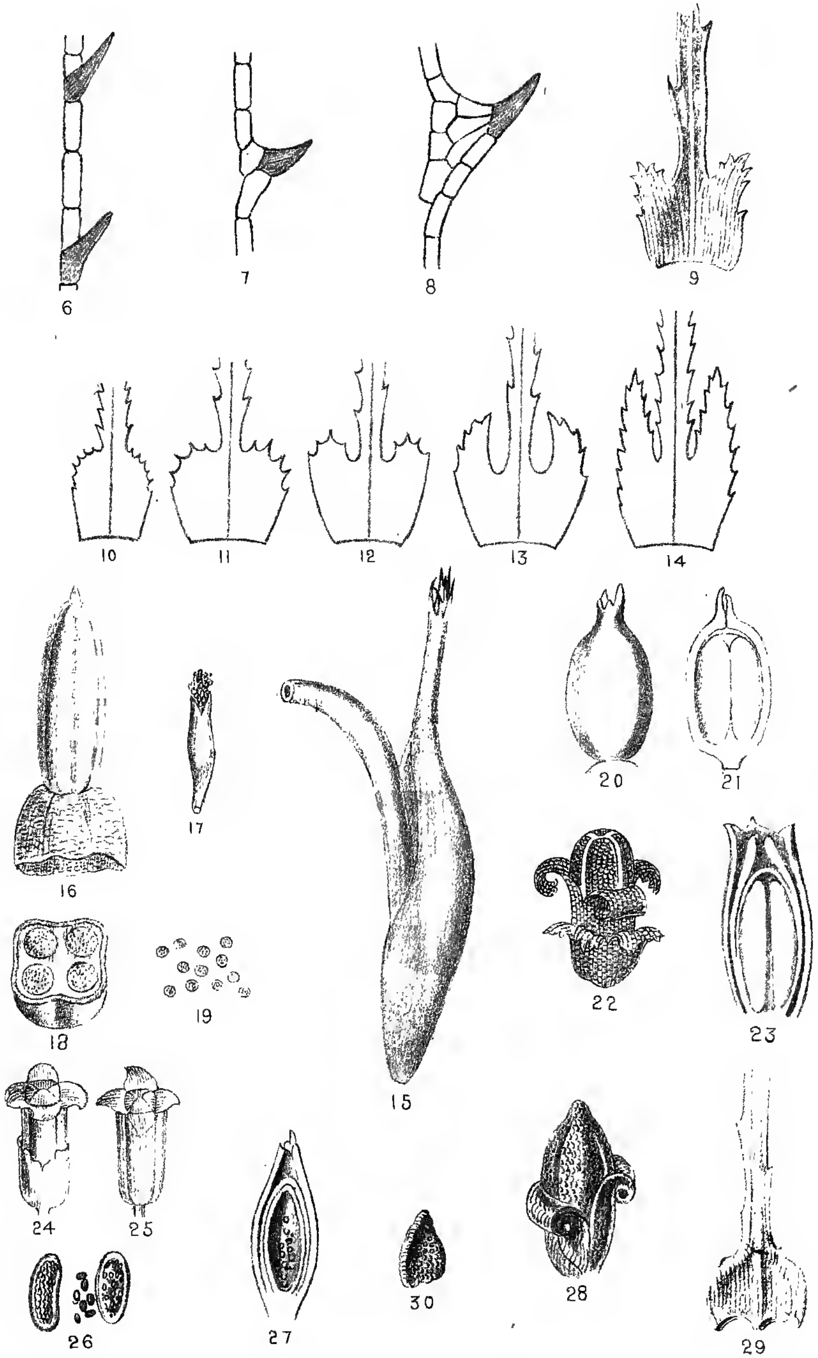
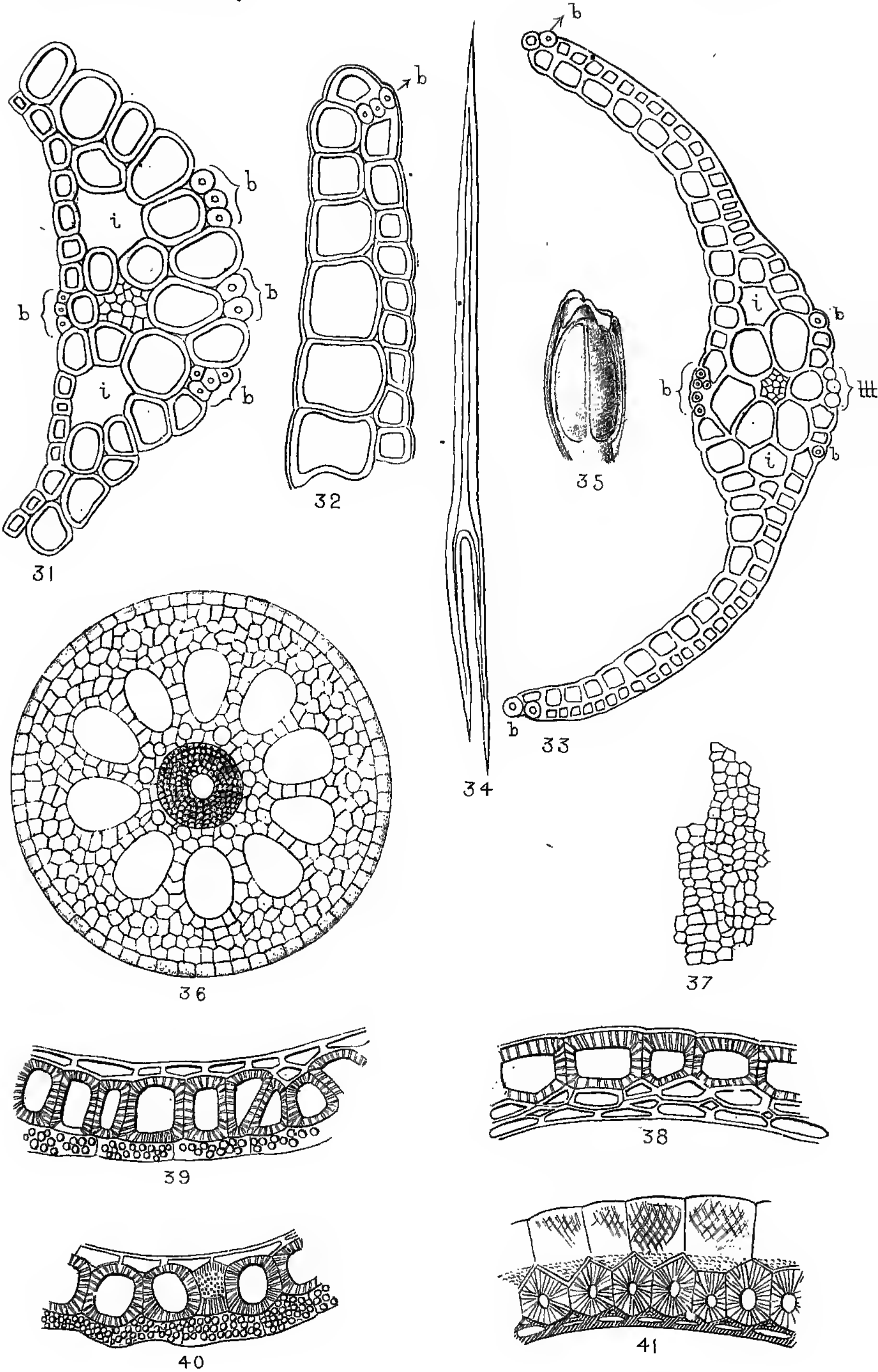


Organography of Naias.

To illustrate Paper by Mr. Charles Bailey.



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