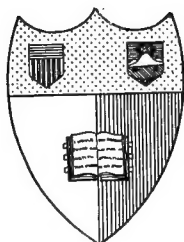




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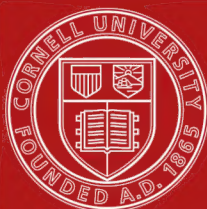


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LONDON

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Made and Printed in Great Britain.



CHARA VULGARIS.

THE
BRITISH CHAROPHYTA

BY
JAMES GROVES, F.L.S.

AND
GEORGE RUSSELL BULLOCK-WEBSTER
M.A., F.L.S.

RECTOR OF ST. MICHAEL ROYAL, LONDON, AND HON. CANON
OF ELY CATHEDRAL

VOLUME II

CHAREÆ

WITH PLATES, CONCLUDING ARTICLES, GEOLOGICAL SKETCH,
BIBLIOGRAPHY AND INDEX

LONDON
PRINTED FOR THE RAY SOCIETY

1924

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PRINTED BY
ADLARD AND SON AND WEST NEWMAN, LTD.,
LONDON AND DORKING.

PREFACE TO VOL. II.

THIS volume, dealing with the section *Chareæ*, completes the survey of the British Charophyta. It includes the new species *Chara muscosa* (8a), which had not been described when the first volume was issued, and does not therefore appear in the key to the British species in that volume.

The present volume contains twenty-five plates. Three of these (24, 34, and 40) have been reproduced (with slight alterations in one of them) from drawings by the late Henry Groves originally published in the 'Journal of Botany.' Two others (26 and 37) from his hand, and published in the same journal, have been partly re-drawn by Miss Mary Groves with alterations and additions. The rest have been specially prepared for this work, No. 35 having, however, also appeared in the 'Journal of Botany.' All the drawings showing the plants in their natural size, as well as several of the magnifications, are from Miss Groves's pencil, and we have again to express our indebtedness and warm thanks to the artist for her very painstaking and skilful work. The very successful reproduction of the drawings by Messrs. Whittingham & Griggs reflects great credit on that firm.

The chapter on the fossil Charophyta does not claim to be more than an introductory sketch pointing the way to an interesting field of study well worth further investigation. The plate relating to the fossil species is taken from photographs made by the late Clement Reid and reproduced by permission from the publications of the Royal and Geological Societies.

We have added a chapter on the collection and preservation of specimens in the hope that it may prove

of service to field botanists, and may perhaps encourage others to interest themselves in these somewhat neglected plants, by removing some of the difficulties encountered in dealing with them.

A bibliography has been compiled to assist those wishing to pursue the study of the group. We have tried to make this as complete as possible, but cannot hope to have included all the many and various detached papers bearing on the subject which have appeared in serial publications and in the journals of societies and academies, some of them not readily accessible.

In addition to the many friends and correspondents mentioned in the first volume as having rendered us assistance in the preparation of the work, we have to acknowledge with grateful thanks the kind help afforded us by Mr. Anthony Gepp, of the Department of Botany of the British Museum, in connexion with the list of exsiccata, and to the geologists whose names we mention in the geological sketch.

JAMES GROVES.

G. R. BULLOCK-WEBSTER.

July, 1924.

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BRITISH CHAROPHYTA.

CHAREÆ.

LEONHARDI in *Lotos*, XIII, p. 72 (1863).

Charæ pleurogynæ et hypogynæ BRAUN in *Ann. Sc. Nat.* ser. 2, I, p. 353 (1834).

Stem and branchlets with or without cortex. Branches normally one at a stem-node. Branchlets simple, producing bract-cells at their nodes. Coronula of oogonium composed of 5 cells in one tier. Oospore terete. Antheridium lateral.

The important character distinguishing this division of the group from the Nitelleæ consists in the construction of the coronula formed of five cells only, arranged in a single tier. The oogonium and oospore are never laterally compressed. In a considerable number of the species the oogonium develops a lime-shell, the production of which in the Nitelleæ is confined to the genus *Tolypella*. With the exception of *Nitellopsis*, all the species produce at the base of the branchlets one or two rings of cells, usually small, and in most cases more or less elongated, the stipulodes, which are absent in the Nitelleæ. The segments of the branchlets always exhibit a sympodial arrangement.

A reference to the plates illustrating the marking of the membranes will show that all the British Chareæ possess either a granulate or a tuberculate decoration of the oospore, and that in many cases the decorations are so much alike in the various species as scarcely to be distinguished. In some fruits of a plant the markings are obscure and difficult to determine, while in other fruits of the same plant they are clear and well defined. The markings show themselves most conspicuously within the pentagonal base of the oospore; here in many instances the characters of the decoration, which cannot well be determined in

other parts of the membrane, are seen clearly defined. No British species has a reticulate decoration, nor a smooth undecorated surface.

Distinguishing as granulate the decoration where the granules are all contiguous, and as tuberculate where they are non-contiguous, there appear to be three species having a tuberculate decoration—*Lamprothamnium papulosum*, *C. vulgaris* and *C. connivens*.

In *C. vulgaris* this is well marked and serves as a valuable test for distinguishing it from *C. contraria*, which is often very similar in general appearance.

In the rest of the Chareæ the markings are all granulate and in many cases very similar in their character. It is quite possible that an exhaustive microscopical investigation may reveal sufficiently marked characteristics in the decoration of the membranes as will clearly differentiate each species.

Genus 1. **NITELLOPSIS** Hy.

Chara sub-gen. *Tolypellopsis* LEONHARDI in Lotos, XIII, p. 73 (1863).

Chara sect. *Astephanæ* BRAUN in Cohn, Krypt. Fl. Schles. I, p. 402 (1876).

Nitellopsis HY in Bull. Soc. bot. France, XXXVI, p. 397 (1889).

Tolypellopsis MIGULA Die Characeen, p. 94 (1890).

Stem and *branchlets* ecorticate. *Stipulodes* none. *Branchlets* with 1–2 nodes, usually producing 1–2 very long bract-cells almost equalling the branchlets in diameter. *Bracteoles* absent. *Oogonia* and *antheridia* arising as direct outgrowths from the peripheral cells of the branchlet-nodes. *Coronula* small. The only known species dioecious.

In the position of the reproductive organs *Nitellopsis* resembles *Lychnothamnus*, to which genus the one known species was finally referred by Braun. Although the principal characters which serve to distinguish it are only vegetative, it is so remarkably distinct from any other Charophyte that we have followed Hy and Migula in placing it in a separate genus. Braun has suggested an affinity with the large-fruited Charophytes of the lower Tertiary series, and there is something simple and archaic-seeming about *N. obtusa*, which may point to its being a surviving representative of an ancient type.

Fruits closely resembling those of *N. obtusa* were found as fossils in the Cromer Forest Bed by the late Clement Reid. The bract-cells seem more important members than those of the other Chareæ, being much broader and almost equalling the ultimate segment of the branchlet.

1. *Nitellopsis obtusa* J. Groves.

(PLATE XXIV.)

- Chara obtusa* DESVAUX in Loiseleur, Notice aj. Fl. France, p. 136 (1810).
GROVES in Journ. Bot. XIX, p. 1, t. 216 (1881).
- C. vulgaris* var. *elongata* WALLROTH Ann. Bot. p. 182 (1815).
- C. ulvoides* BERTOLONI in Bruni, Nuov. Collez. d'Opusc. Scient. p. 113 (1825); Fl. Ital. X, p. 21 (1854).
AMICI in Mem. Accad. Modena I, p. 217, t. 4, f. 7-9 (1827).
- C. translucens* and var. *stelligera* REICHENBACH Iconogr. t. 804-5 & Comm. ix, p. 2 (1830-1), non Persoon.
- C. stelligera* REICHENB. in Mössler, Handb. d. Gewächs. ed. 2, III, p. 1595 (1829).
BRAUN in Ann. sc. Nat. ser. 2, I, p. 352 (1834); in Flora, XVIII, i, p. 55 (1835); in Cohn, Krypt. Fl. Schles. p. 402 (1876).
BISCHOFF Handb. Bot. Term. & Syst. t. 57, f. 2805 (1842).
RUPRECHT Symb. Hist. Pl. Ross. p. 77 (1845).
MONTAGNE in Ann. sc. Nat. ser. 3, (Bot.) XVIII, t. 2 (1852).
CRÉPIN in Bull. Soc. Bot. Belg. II, p. 127 (1863).
LEONHARDI in Lotos, XIII, p. 73 (1863); in Verh. Nat. Ver. Brunn, II, p. 177 (1864).
WAHLSTEDT Mon. Sver. & Norg. Charac. p. 24 (1875).
NORDSTEDT in Flora Danica, 2927 (1877).
BABINGTON Man. Brit. Bot. ed. 8, p. 470 (1881).
BOSWELL Engl. Bot. ed. 3, p. 195, t. 1910 (1885).
GIESENHAGEN in Flora, LXXXII, p. 419, f. 21-25 (1896); LXXXV, p. 48, f. 52-5, 57-9, t. 4, f. 1-3 (1898).
- C. stelligera* & *C. ulvoides* GANTERER Österr. Char. p. 11, t. 1, f. 4-5 (1847).
- Nitella ulvoides* & *N. stelligera* KÜTZING Phyc. Gen. p. 318 (1843).
WALLMAN Försök Charac. pp. 39, 40 (1853); Transl. pp. 33, 34 (1856).
- N. stelligera* KÜTZING Sp. Alg. p. 518 (1849); Tab. Phyc. VII, t. 27, f. 1 (1857).
COSSON & GERMAIN Fl. Par. p. 681 & Atl. t. 41, f. G (1845); ed. 2, t. 47, f. H (1882).
CLAVAUD in Act. Soc. Linn. Bordeaux, XXV, p. 348, t. 3 (1865).
RABENHORST Deutsch. Krypt. Fl. II, p. 196 (1847).
- N. Bertolonii* KÜTZING Tab. Phyc. VII, p. 11, t. 26, f. 2 (1857).
- Lychnothamnus stelliger* BRAUN in Braun & Nordstedt, Fragm. Mon. Charac. p. 102, t. 6, f. 189 (1882).
SYDOW Europ. Charac. p. 45 (1882).
- Nitellopsis stelligera* HY in Revue de Botanique, VIII, p. 46 (1890); in Bull. Soc. Bot. France, LX, Mém. 26, p. 22 (1913).

Tolytellopsis stelligera MIGULA Die Characeen, p. 255, f. 70-3 (1890);

Syn. Charac. Europ. p. 63, f. 58-60 (1898).

HOLTZ Charac. Mark-Brandenb. p. 40, f. 1-3, pp. 84-5 (1903).

PRÓSPER Carofit. Españ. p. 87, f. 15B (1910).

T. obtusa BEGUINOT & FORMIGGINI, Bull. Soc. Bot. Ital. 1907, p. 102.

T. ulvoides WILLE in Engler & Prantl, Nat. Pfl.-fam. I, ii, p. 174 (1891).

Nitellopsis obtusa J. GROVES in Journ. Bot. LVII, p. 127 (1919).

EXSICCATA:—Areschoug 397; Braun, Rabenh. & Stiz. 1, 34; Groves 20; Lloyd 406, 407; Migula, Syd. & Wahlst. 10, 54, 55; Nordstedt & Wahlst. 49 *a* & *b*; Rabenhorst 479.

Dicecious. *Stem* stout, producing at the lowest nodes rhizoid-like branches, bearing large white much thickened star-shaped nodes, the rays of which resemble modified branchlets. *Internodes* usually equalling or not much exceeding the branchlets. *Whorls* of 5-7 straight or slightly incurved branchlets. *Stipulodes* absent; lower peripheral cells of the stem-nodes regular, almost always three times as numerous as the branchlets. *Branchlets* very long, of 2-3 segments, the ultimate segment elongated, acuminate or mucronate. *Bract-cells* 1-2, very long and thick, acuminate or mucronate, almost as large as the ultimate branchlet-segment, sometimes absent. *Oogonia* and *antheridia* solitary or geminate. *Oogonia* nearly globular, c. 1200-1400 μ long, 1000-1200 μ thick; spiral-cells showing about 9 convolutions; *coronula* small, apparently deciduous, c. 65 μ high, 150 μ broad, strongly connivent. *Oospore* bitruncate-ellipsoid, c. 775 μ long, 600 μ thick, golden-brown showing about 7 low but well-defined ridges, terminating at the base in very short claws; *outer membrane* thin, flexible, translucent, dull yellow-brown, faintly and very finely decorated with granulations, more or less linearly arranged. *Antheridium* very large, c. 1000 μ in diameter.

HABITAT.—In deep water, usually near the coast, plentiful in several of the Norfolk Broads and in some of the channels connecting them, extremely rare elsewhere.

DISTRIBUTION.—*England*: Devon, S., Slapton Ley (*H. Groves*, 1884, once found); Hants, S., Sowley Pond (*G. R. B.-W.*, 1900, once found); Surrey, pool by R.

Thames, Walton Bridge (*H. Groves*, 1885, once found); Norfolk, E., Filby, Hickling, Blackfleet, Rockland, Somerton, and Barton Broads, Heigham Sound, Old Meadow Dyke, Hundred Stream, etc.; Northamptonsh., canal, Northampton (*H. N. Dixon & A. B. Jackson*, 1905).

First record: 'Journ. Bot.' 1881. (From Filby Broad, Arthur Bennett.)

Outside the British Isles, recorded from Sweden, Finland, Russia, France, Belgium, Germany, Bohemia, Italy and Northern India.

A large, rather straggling plant, almost attaining to the size of *Nitella translucens*, with which it was confused by some early authors. The ecorticate stem and branchlets, the small number of the latter, each having but one or two nodes, the one or two long thick bract-cells, and the long ultimate segments, combine to produce a *Nitella*-like appearance, though the plant when living has a distinct facies of its own. In the small size of the coronula there is also a resemblance to the *Nitellæ*, but the single tier of five cells places it among the *Chareæ*. The large white star-like nodes which form the most outstanding feature of the plant are singularly beautiful objects. They are usually if not always produced on colourless lateral branches which arise from the enlarged lower stem-nodes and are immersed in the soft thick mud in which the plant luxuriates. They evidently represent metamorphosed whorls of branchlets, the equivalents of the various parts of which are traceable. The "stars" vary considerably in the length of their rays, see vol. i, p. 42, fig. 15. Many of the stem-nodes and sometimes the branchlet-nodes are also thickened and whitish owing to accumulations of starch. Giesenhagen has carefully investigated the development of the stem- and branchlet-nodes, and has elicited the fact that the former are not, as Migula had tentatively suggested, less complicated in structure than those of other *Chareæ*.

Through the kindness of the late Prof. Hy, we have had the opportunity of examining ripe fruits, which we had not been able to obtain from any of the British localities. The walls of the spiral-cells are thicker and tougher than those of the other British charophytes; and the inner portions do not break down

as the fruit matures, the posterior wall remaining distinct from the membrane of the oospore, while the lateral walls form between the cells what appears to be an extended flange to the ridges. When the whole integument is removed the oospore exhibits sharp low ridges.

There is an element of doubt as to the status of the plant in the Surrey locality, other water plants having appeared suddenly in the pool below Walton Bridge, suggesting the possibility of intentional introduction.

It is with regret that we have been obliged to surrender the very appropriate specific name *stelligera*, by which the plant is generally known, in favour of the first of the two earlier names.

[**Lychnothamnus barbatus** Leonhardi, having an imperfect haplostichous stem-cortex, ecorticate few-segmented branchlets, long stipulodes, and oogonia and antheridia situated side by side, arising from different peripheral cells of the branchlet-node, one oogonium usually between two antheridia, has been found in a few localities in France, Germany, Italy, and India.]

Genus 2. **LAMPROTHAMNIUM** J. Groves.

Lamprothamnus BRAUN in Braun & Nordstedt, Fragm. Mon. Charac. pp. 16 & 100 (1882), *non* Hiern.

Lamprothamniium J. GROVES in Journ. Bot. LIV, p. 336 (1916).

Stem and *branchlets* ecorticate. *Stipulodes* present. *Oogonium* normally situated below the antheridium, both arising from the central anterior peripheral cell of the branchlet-node.

A small genus occurring in the Western half of Europe and in North-Western and Southern Africa, in brackish water, usually quite near the coast. The relative position of the reproductive organs, which is the reverse of that found in *Chara*, serves to distinguish it from that genus, to which it is closely allied. Species described, four.*

* *Lamprothamnus montevidensis* Spegazzini does not appear, from the author's description, to belong to this genus.

1. *Lamprothamnium papulosum* J. Groves.

(PLATE XXV.)

- Chara papulosa* WALLROTH Fl. Crypt. Germ. II, p. 107 (1833).
C. Pouzolsii BRAUN in Flora, XVIII, i, p. 58 (1835).
C. Wallrothii RUPRECHT, Distr. Crypt. Vasc. Ross, p. 11 (1845).
 NORDSTEDT in Bot. Notiser for 1863, p. 41.
C. alopecuroidea BRAUN in Neue Denks. Schweiz. Ges. Naturw. X,
 p. 13 (1849).
 KÜTZING Sp. Alg. p. 518 (1849); Tab. Phyc. VII, t. 45, f. 2 (1857).
 BOSWELL Engl. Bot. ed. 3, XII, p. 193, t. 1909 (1885).
C. alopecuroides WALLMAN Försök Syst. Charac. p. 53 (1853);
 Transl. p. 45 (1856).
 BABINGTON in Journ. Bot. I, p. 193, t. 7 (1863).
 LANGE in Fl. Danica, t. 2745 (1867).
 BRAUN in Monatsb. Akad. Berl. for 1867, p. 896 (1868).
Lychnothamnus alopecuroides BRAUN in Monatsb. Akad. Berl. for 1867,
 p. 798 (1868), misprinted *alopecoroides*.
 GROVES in Journ. Bot. XVIII, p. 161, t. 209, f. 10 (1880).
 MANSSEL-PLEYDELL in Proc. Dorset Nat. Hist. Club, XIII, p. 163
 (1892), with plate.
Lychnothamnus Wallrothii WAHLSTEDT Mon. Sver. & Norg. Charac.
 p. 23 (1875).
Lamprothamnus alopecuroides BRAUN in Braun & Nordstedt, Fragm.
 Mon. Charac. p. 100, t. 6, f. 185-8 (1882).
 SYDOW Europ. Charac. p. 41 (1882).
 MIGULA Die Characeen, p. 274, f. 74-6 (1890); Syn. Charac. Europ.
 p. 67, f. 61-3 (1898).
 GIESENHAGEN in Flora, LXXXV, pp. 31-48, f. 45-51 (1898).
 HOLTZ Characeen in Krypt.-fl. Mark Brandenb. IV, p. 40, f. 4 (1903).
 PRÓSPER Carofit. Españ. p. 92, f. 16B (1910).
 HY in Bull. Soc. Bot. France, LX, Mém. 26, p. 24 (1913).
Lamprothamnus papulosus BEGUINOT & FORMIGGINI in Bull. Soc. Bot.
 Ital. XIV, p. 108 (1908).
Lamprothamnium papulosum J. GROVES in Journ. Bot. LIV, p. 337
 (1916).
 EXSICCATA:—Areschoug 243, 396; Braun, Rabenh. & Stiz. 62, 63, 81;
 Fries XV. 99 (*vide* Wahlst.); Groves 21, 46; Lloyd 412; Migula, Syd. &
 Wahlst. 11, 12; Niessen 15 (*vide* Wahlst.), 16; Nordstedt & Wahlst. 20,
 21, 21b, 22a & b; Schultz 1200.

Monœcious. *Stem* slender to moderately stout, lower nodes often distant, the internodes sometimes four times the length of the branchlets, upper whorls crowded, forming long dense heads. *Root-nodes* producing whitish spherical or elongated simple clustered bulbils. *Whorls* of usually 6-8 branchlets. *Stipulodes* normally in a single circle, corresponding in number and produced opposite the bases of the branchlets, but occasionally

with accessory ones alternating, long, acute or acuminate, declining. *Branchlets* straight, or slightly incurved, of 4–5 more or less turgid segments, the ultimate segment acute and often very short. Sterile branchlets often with long turgid segments and undeveloped bract-cells. *Bract-cells* produced at all, or all but one of the joints, normally 5*, all developed, the posterior nearly as long as the anterior, spreading, usually long and slender with an acuminate apex, and exceeding the oogonium, sometimes shorter and stouter. *Bracteoles* thinner and shorter than the bract-cells, often shorter than the oogonium, usually single, often absent. *Oogonia* and *antheridia* almost always solitary, occurring at the lowest 1–2 nodes of the branchlets, and rarely also at their base. *Oogonium* produced at the base of the antheridium, usually growing downwards, and therefore situated below the antheridium, but occasionally by the side of, or very rarely above it, subcylindrical-ellipsoid or ellipsoid, c. 750–950 μ long (excl. coronula), c. 400–575 μ broad; *spiral-cells* showing 12–15 convolutions; *coronula* c. 90 μ high, 200–250 μ broad, straight, the cells often almost spherical. *Oospore* cylindrical-ellipsoid, truncate at the apex, c. 600–750 μ long, 275–375 μ broad, becoming black when ripe, showing about 11 low ridges; *outer membrane* thick, brittle, opaque, very dark red, very finely granulated. *Antheridium* c. 400–500 μ in diameter.

HABITAT.—In one lagoon and in a few brackish-water pits close to the coast in the extreme south of England; very rare.

DISTRIBUTION.—Dorset, The Fleet, near Langton Herring (*W. Bowles Barrett*, 1889); clay pit, near Hamworthy Junction (*E. F. Linton*, 1899); I. of Wight, in some of the pits of the disused salterns, near Newtown, where it was discovered in 1862, by *A. G. More*, but is now apparently extinct.

* In this and the following descriptions the number of bract-cells given is that on a fertile branchlet, at the lowest node; on the higher nodes the number usually diminishes.

First record : Babington, 1863.

Outside the British Isles *L. papulosum* occurs in Norway, Sweden, Denmark, Northern Germany (Baltic Coast), Spain, France, Italy, N.W. Africa (Algiers) and S. Africa (Port Elizabeth).

Extremely variable in stature, but usually a small or medium-sized plant. In France, where it is widely distributed, Prof. Hy states that it ranges in height from 3 to 40 cm. The English forms are without incrustation.

It is remarkably distinct in facies from any other British Charophyte; the long fox-tail-like heads, from which the happily chosen specific name *alopecuroides* was taken, and the long slender graceful stipulodes, attaining to a length of about 3 mm. and conspicuously spreading downwards, serve to distinguish it at once in the field. An important characteristic is the production of simple whitish usually spherical root-bulbils, attaining a diameter of about 1 mm., and occurring in clusters. Miss Mary McNicol, *Annals of Botany* XXI, pp. 61-70, t. 8 (1907), has given a careful account with illustrations of the structure and development of the bulbils and pro-embryo of the South African plant, an extremely vigorous form, the branchlets often exceeding ten in number and a circle of stipulodes produced above as well as below the branchlets. Miss McNicol finds, in the terminal process of the pro-embryo, that the middle of the three cells of which it is composed is often so much swollen as to be almost spherical. In Dr. Giesenhagen's valuable paper (*l.c.*), the structure of the stem- and branchlet-nodes is fully described and figured. The terminal segments of the branchlets, the bract-cells and the stipulodes have often long hyaline tips owing to a thickening of the cell-wall. The bract-cells are occasionally short and stout with mucronate tips. Minute accessory bract-cells are sometimes developed.

The oogonia with lime-shell, which are very numerous in this species, exhibit a peculiar feature, not, as far as we know, observable in any other Charophyte. The spiral-cells at the point where they near the apex and close in to form the neck cease to secrete lime, with the result that the deposit stops short at this point, leaving the lime-shell with a truncated top (see fig. 9), out of which the oospore protrudes.

The British examples present a wide range of variation of form, from a robust broad-headed state, such as that from the

Isle of Wight, from which our plate is taken, to a narrow attenuate form with tapering heads and distant lower whorls found in Dorset. In specimens from the Hamworthy locality collected in April by G. R. B.-W., the branchlets of the lower whorls are much elongated, attaining a length of 5 cm., and resembling in appearance those of *Chara Braunii*. Several varieties have been described, but the differences are not very appreciable. Some forms from the Mediterranean coast have shorter fruits and the spiral-cells show fewer convolutions than those of the British plant.

It is with regret that we have felt obliged to adopt the specific name *papulosum*, instead of the more generally used and much more appropriate name *alopecuroides*, especially as the former was given by Wallroth under a misapprehension, but the accepted rules of nomenclature do not seem to allow of any other course. See 'Journ. Bot.' liv, p. 336 (1916).

[**Lamprothamnus Hansenii** Sonder, from Schleswig-Holstein, apparently differs from *L. papulosum* in not producing the long dense fruiting heads, in having somewhat stouter branchlets, and in the oogonium and oospore being comparatively much broader. The measurements of the former given by Dr. Migula are 700 μ long, 600 μ broad, of the latter 500–550 μ long, 420–460 μ broad, and the colour of the oospore is stated to be brown. We have not seen a specimen, but the plant is described and figured by Dr. Migula ('Die Characeen,' p. 756, f. 149; 'Syn.' p. 67, f. 64). Of *Lamprothamnus aragonensis* and *L. toletanus* Prósper also we have not had the opportunity of examining specimens. Judging from the descriptions and illustrations ('Carofit. Españ.' pp. 91, 95, f. 16A, 17), both would appear to be closely allied to *L. papulosum*, if not merely extreme forms of that species.]

Genus 3. **CHARA** Linnæus.

'Gen. Plant.' ed. 5, p. 491.

(Emend. Agardh, Leonhardi & Braun.)

Stem and *branchlets* with or without cortex. *Stipulodes* present though sometimes rudimentary. *Oogonium*

and *antheridium* in the monœcious species arising from the same peripheral cell of the branchlet-node, the oogonium normally above the antheridium.

The parent genus of the group first discriminated in 1719 by Vaillant, to whom we are indebted for the name. As now restricted the genus is apparently quite a natural one; it comprises about 80 species, and is distributed throughout the world. The distinguishing character is found in the relative position of the gametangia, the oogonium being normally always situated above the antheridium. In by far the larger number of species the stem and branchlets possess a cortex. The varying degrees of complexity of this supply a secondary character for purposes of classification. The stipulodes being in a single or double row affords the basis for the main divisions of the genus. In some species these organs are quite rudimentary.

Section 1. *HAPLOSTEPHANÆ* BRAUN 'Consp. Char. Europ.' p. 4, 1867 (*Stenartrea* Ganterer; Sect. *Charopsis*, Leonhardi).

Circle of stipulodes in a single row.

1. *Chara Braunii* Gmelin.

(PLATE XXVI.)

- Chara translucens minor flexilis* CORTI Osserv. Microsc. p. 133, t. 3 (1774).
- C. Braunii* GMELIN Fl. Bad. Alsat. IV (suppl.), p. 646 (1826).
 BISCHOFF Krypt. Gewächse, p. 26, t. 1, f. 5 (1828).
 WALLMANN Försök Syst. Charac. p. 58 (1853); Transl. p. 49 (1856).
 NORDSTEDT in Bot. Notiser for 1863, p. 41.
 WAHLSTEDT Mon. Sver. & Norg. Charac. p. 24 (1875).
 GROVES in Journ. Bot. XXII, p. 3, t. 242 (1884); in Babington Man. Brit. Bot. ed. 9, p. 540 (1904).
 BOSWELL Engl. Bot. ed. 3, XII, p. 197, t. 1911 (1885).
- C. flexilis* AMICI in Mem. Soc. Ital. (Modena) ii, p. 247, t. 10, f. 12-15 (1823), non Linn.
- C. Cortiana* BERTOLONI in Amici in Mem. Acad. Modena, I, p. 204 (1827); Fl. Ital. X, p. 16 (1854).
- C. coronata* BISCHOFF Krypt. Gewächse, t. 1, f. 7 (1828); Handb. bot. term. & syst. II, t. 57, f. 2817 (1842).
 BRAUN in Ann. sc. Nat. ser. 2, I, p. 353 (1834); in Flora, XVIII, i, p. 59 (1835); Consp. Charac. Europ. p. 4 (1867); in Monatsb. Akad. Berl. for 1867, p. 897 (1868); in Cohn, Kryp. Fl. Schles. p. 403 (1877).

- GANTERER Österr. Char. p. 13, t. 1, f. 6 (1847).
 KÜTZING Sp. Alg. p. 520 (1849); Tab. Phyc. VII, t. 43, f. 1 (1857).
 LEONHARDI in Verh. naturf. ver. Brünn, II, p. 179 (1864).
 MÜLLER in Bull. Soc. Bot. Genève, II, p. 59 (1881).
 BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 108 (1882).
 SYDOW Europ. Charac. p. 48 (1882).
 COSSON & GERMAIN Atl. Fl. Par. ed. 2, t. 44 (1882).
 MIGULA Die Characeen, p. 321, f. 81-3 (1890); Syn. Charac. Europ.
 p. 72, f. 68-9 (1898).
 FILARSKY-NANDOR Charac. Ungarn, pp. 53 & 121 (1893).
 PRÓSPER Carófit. Españ. p. 100, t. 18A (1910).
Charopsis Braunii KÜTZING Phyc. Gen. p. 319 (1843); Phyc. Germ.
 p. 257 (1845).
 HY in Bull. Soc. bot. France, LX, Mém. 26, p. 25 (1913).
Chara Stalii MENEGHINI in Atti Sc. Ital. Genov. 1846, p. 553.
 VISIANI Fl. Dalm. III, p. 334 (1852).
Nitella Braunii RABENHORST Deutsch. Krypt.-fl. II, p. 197 (1847).

In addition to the synonyms above quoted, several specific names have been given to extra-European forms of this species.

EXSICCATA:—Billot 2995; Braun, Rabenh. & Stiz. 10, 64; Erbar. Critt. Ital. 604; Groves 45; Lloyd 413; Migula, Sydow & Wahlst. 129; Nordstedt & Wahlst. 87; Rabenhorst 279; Schultz 600 & 600 bis.

Monœcious. *Stem* moderately stout, the *internodes* usually about the same length as the branchlets. *Cortex* entirely absent. *Whorls* of 8-10 branchlets. *Stipulodes* corresponding in number and alternating with the branchlets, spreading, variable in size, usually well-developed, strongly acuminate. *Branchlets* nearly straight or somewhat incurved, of 4-5 segments, the lower 3-4 elongated, the uppermost very short, hardly longer than the surrounding bract-cells, acuminate. *Bract-cells* variable in number, but apparently normally 5, sometimes all well-developed, sometimes only the anterior pair, usually falling short of the oogonium. *Bracteoles* usually resembling the anterior bract-cells. *Oogonia* and *antheridia* produced at the two or three lowest nodes, frequently geminate, occasionally three together. *Oogonium* c. 525-650 μ long, 400-450 μ thick; spiral-cells showing about 9-10 convolutions; coronula c. 150 μ high, 200 μ broad at the base, somewhat spreading, the cells ovoid conical with rounded apex. *Oospore* ellipsoid-cylindrical, c. 450-550 μ long, 275-300 μ thick, becoming almost black, showing about 7-9 inconspicuous

ridges terminating in short basal claws; *outer membrane* thick, brittle, semi-rigid, semi-opaque, dull brown to black, finely and faintly granulated. *Antheridium* c. 250–275 μ in diameter.

HABITAT.—In a canal in tepid water.

DISTRIBUTION.—*England*: South Lancashire, near Reddish (*C. Bailey*, 1883); still there in 1920 (*F. J. Stubbs*).

First record: 'Journ. Bot.' 1884.

Outside the British Isles *C. Braunii* is very widely distributed, occurring in Norway, Sweden, Finland, Russia, Spain, Portugal, France, Belgium, Germany, Austria, Italy and Greece, also in many parts of Asia, North and South Africa, North and South America, Australia, New Zealand, and the Sandwich Islands.

A medium-sized plant, often tufted in growth, sometimes slightly incrustated, the incrustation tending to become annular. Readily distinguished from any other British species by the entire absence of cortex, the clear transparent green flexible stems and branchlets and the long segments of the latter, which combine to give the plant a close resemblance to a *Nitella*. The small conical terminal segment, similar to and but little larger than the two or three developed bract-cells at the ultimate node, form with them a distinctive corona-like termination to the branchlets. The frequent production of a pair of oogonia and a pair of antheridia at the same node is also characteristic; occasionally there are even three of each of these organs together. The shape and dimensions of the oogonium and oospore and the number of convolutions shown are very variable; those given here are taken from the British plant. Dr. Allen, in his paper on the American forms ('*American Naturalist*,' XVI, pp. 358–369, t. 4, 1882), gives an excellent account of the variation.

C. Braunii is the only representative in this country of the group *Haplostephanæ*, of which there are many species, especially in warmer latitudes. In the British Isles it has been found in the one locality only, occurring in a canal, the water of which is raised to an abnormal temperature by the discharge of hot water from adjacent mills. *Naias graminea*, a native of Egypt, has been found in the same neighbourhood, and as its introduc-

tion is ascribed to the use of Egyptian cotton in the mills, there seems a probability that *C. Braunii*, which also occurs in Egypt, has been introduced by the same means, although the distribution of the species is such as to make its occurrence in this country not improbable.

Many continental botanists have followed Braun in using the name *C. coronata* for this species, but such a course is at variance with the "Rules," and we are glad to be able to retain the earlier published name given by Gmelin in honour of the illustrious Alexander Braun, by far the greatest authority on the Charophyta.

[There are two other European species belonging to the section *Haplostephanæ*, **C. scoparia** Braun, found in Prussia, which closely resembles *C. Braunii*, but has a triplostichous cortex to the stem, and **C. Pelosiana** Avetta, found in Northern Italy, which has a diplostichous cortex to the stem, and is apparently allied to the extra-European *C. flaccida*. Of *C. Pelosiana* we have not seen a specimen or figure.]

Section 2. *DIPLOSTEPHANÆ* BRAUN, 'Consp. Char. Europ.' p. 4, 1867.

Circle of stipulodes in a double row.

Subsection 1. *Haplostichæ* Braun, 'Consp. Char. Europ.' p. 4, 1867.

Rows of cortical-cells of the stem equalling the branchlets in number, no secondary rows being produced.

2. **Chara canescens** Loiseleur.

(PLATE XXVII.)

Chara hispida var. *microphylla* SCHUMACHER Enum. Pl. Saell. I, p. 260 (1801).

C. canescens LOISELEUR Notice aj. Fl. France, p. 139 (1810).

DE CANDOLLE Fl. Franc. tome 5 (or vol. 6) p. 246 (1815).

REICHENBACH in Mössl. Handb. d. Gew. ed. 2, p. 1599 (1829)
Fl. Germ. Exc. p. 150 (1830).

GROVES in Journ. Bot. XVIII, p. 134, t. 208, f. 9 (1880); in
Babington Man. ed. 9, p. 541 (1904).

- C. crinita* WALLROTH *Annus Botanicus*, p. 190, t. 3 (1815).
 BRUZELIUS *Obs. Char.* pp. 10, 19 (1824).
 AGARDH *Syst. Alg.* p. 126 (1824).
 BRAUN in *Ann. sc. Nat. ser. 2, I*, p. 356 (1834); in *Flora*, XVIII, i, p. 70 (1835); in *Abh. Berl. Akad. Wiss.* 1856, p. 338, &c.; *Consp. Char. Europ.* p. 5 (1867); in *Monatsb. Akad. Berl.* for 1867, p. 901 (1868); in *Cohn, Krypt. Fl. Schles. I*, p. 404 (1876).
 KÜTZING *Phyc. Germ.* p. 259 (1845); *Sp. Alg.* p. 525 (1849); *Tab. Phyc. VII*, t. 69, f. 1 (1857).
 GANTERER *Österr. Char.* p. 14, t. 2, f. 8 (1847).
 BABINGTON in *Ann. & Mag. Nat. Hist. ser. 2, V*, p. 88 (1850).
 RUPRECHT *Symb. Hist. Pl. Ross.* p. 86 (1845).
 WALLMAN *Försök Syst. Charac.* p. 91 (1853); *Transl.* p. 76 (1856).
 WAHLSTEDT *Bidr. Skand. Charac.* p. 31 (1862); *Mon. Sver. & Norg. Charac.* p. 25 (1875).
 NORDSTEDT in *Bot. Notiser*, 1863, p. 41; 1871, p. 152.
 RABENHORST *Krypt.-fl. Sachsen, I*, p. 290 (1863).
 CRÉPIN in *Bull. Soc. Bot. Belg. II*, p. 126 (1863).
 LEONHARDI in *Verh. Naturf. ver. Brunn, II*, p. 180 (1864).
 LANGE in *Flora Danica*, t. 2747 (1867).
 DE BARY in *Bot. Zeit. XXXIII*, t. 5, f. 7-20 (1875).
 BRAUN & NORDSTEDT *Fragm. Mon. Charac.* p. 137, f. 221-2 (1882).
 SYDOW *Europ. Charac.* p. 52 (1882).
 BOSWELL *Engl. Bot. ed. 3, XII*, p. 198, t. 1912 (1885).
 MIGULA *Die Characeen*, p. 348, f. 87-90 (1891); *Syn. Charac. Europ.* p. 83, f. 73-5 (1898).
 WILLE in *Engler & Prantl Nat. Pfl.-fam. I, ii*, p. 175, f. 128A (1891).
 HOLTZ in *Krypt. Mark Brandenb. IV, i*, p. 91 (1903).
 PRÓSPER *Carofit. Españ.* p. 104, f. 19, 20A (1910).
 HY in *Bull. Soc. Bot. France, LX*, *Mém.* 26, p. 28 (1913).
- C. hispida* var. *crinita* WAHLENBERG *Fl. Suec. II*, p. 692 (1826).
C. horridula RABENHORST *Deutsch. Krypt. Fl. II, ii*, p. 198 (1847).
C. condensata WALLMANN *Försök Syst. Charac.* p. 92; *Transl.* p. 77 (1856).
C. pusilla KÜTZING *Tab. Phyc. VII*, t. 69, f. 2b (1857).
- EXSICCATA:—Areschoug 42, 398, 399; Braun, Rab. & Stiz. 6, 65-8, 80, 118; Desmazières II, 336; Fries VIII, 100; Groves 18, 19; Hansen 1100; Heldreich 996 (♀ only), 996b; *Krypt. Exsicc.* 89, 1015; Lloyd 420; Migula, *Syd. & Wahlst.* 13, 14, 38, 62-5, 91-4, 131-2; Nielsen 17, 18, 49 (*vide* Wahlst.); Nordstedt & Wahlst. 23-9; Rabenhorst 69; Gr. & B.-W. 27-9.

Dioecious. *Stem* moderately stout; internodes 2-4 times the length of the branchlets. *Cortex* regularly 1-ranked, rarely with any trace of lateral cells; *spine-cells* persistent, some solitary, but mostly in clusters of 2-5, spreading, once to three times as long as the diameter of the stem, usually slender and acuminate, occasionally shorter and blunter. *Whorls* of 8-10 branchlets. *Stipulodes* of both series well developed,

the upper usually very long, slender and acuminate, the lower usually similar, but sometimes shorter and blunter. *Branchlets* short, slightly incurved, of 5–8 segments, all but the last usually corticate, the cortex 1-ranked, ultimate segment often scarcely exceeding the subtending bract-cells. *Bract-cells* usually 5–6, all well-developed and exceeding the oogonium, slender acuminate; *bracteoles* usually very short, but occasionally longer than the fruit; *bractlet** minute, sometimes rudimentary. *Oogonium* ellipsoid to ellipsoid-elongate, c. 600–750 μ long, 400–500 μ thick; *spiral-cells* showing 13–15 convolutions; *coronula* short, c. 50–80 μ high, 100–150 μ broad, straight or slightly connivent. *Oospore* ellipsoid-obovoid or ellipsoid-cylindrical, c. 450–625 μ long, 275–400 μ thick, black, showing 10–13 low inconspicuous ridges terminating in short basal claws; outer membrane thick, brittle, opaque, very dark red, very finely granulated. [*Antheridium* c. 600–650 μ in diameter. The male plant has not hitherto been found in the British Isles.]

HABITAT.—Lakes and pools near the sea, rare, occurring in a few scattered localities in the South and East of England and the West and South-East of Ireland, and in one locality in the extreme North of Scotland.

DISTRIBUTION.—*England*: Cornwall, W., Budock Pool, near Falmouth, *W. L. P. Garnons*, 1841; small pool near Kynance Cove, *J. Guardia & H. Groves*. Dorset, Little Sea, Studland, *Bolton King*; clay-pit, near Hamworthy, *E. F. Linton*. Kent, E., Birchington, *G. O. Allen*. Suffolk, E., Easton and Benacre Broads, *E. S. & C. E. Salmon*. Norfolk, E., Hickling Broad, *G. R. B.-W.*

Scotland: Orkney, Loch of Stenness, Mainland, *H. H. Johnston & G. C. Druce*.

Ireland: Kerry, S., Castle Gregory Lake, *R. W. Scully*. Wexford, lagoon North of Wexford Harbour, *E. S. Marshall*. Galway, N. E., Saltmarsh-pool East

* The term *bractlet* is applied to the small central elongated cell below the oogonium, which, in dioecious species, takes the place of the antheridium.

of Galway, *R. A. Phillips*. Galway, S.E., small lake near Kinvarra, *R. A. Phillips*.

First record : Babington, 1850.

Outside the British Isles *C. canescens* is recorded from Sweden, Denmark, Russia, Belgium, Holland, Germany, Austria, Hungary, Roumania, Bulgaria, Spain, France, Italy and Greece, also from Asia, N. Africa and N. America. It occurs in the Baltic Sea.

A small to medium-sized plant, usually with rather rigid stem and branchlets, often growing in dense tufts. The long numerous persistent spine-cells and the sharp stipulodes and whorled bract-cells combine to render it the most bristly-looking of our Charas. It often happens that adjacent internodal cells of the cortex nearly correspond in length, so that the spine-cells appear to be partially whorled. It is readily distinguished from any other European species by the absence of secondary cortical-cells, so that the number of cortical series is equal to that of the branchlets. It is also the only European species with one-ranked cortex to the branchlets, the number of sheathing tubes corresponding with that of the bract-cells.

Another remarkable characteristic, shared, so far as we know, by no other species, is its parthenogenetic reproduction. The male plant has been found in very few localities throughout the world; ripe oospores which germinate freely are nevertheless produced in great quantity. In the specimens of the male plant which we have examined, collected in Hungary, the spine-cells are frequently solitary. Dr. Migula records it from France, Greece, and the Caspian Sea, and Dr. Petkoff from Bulgaria. As regards the Greek plant in the specimen in Heldreich's 'Herb. Graec. Norm.,' No. 996, which we have examined, the female plant is correctly identified, but the male belongs to a triplostichous species, *C. galioides*, with which it is frequently found, and which it superficially resembles. There is therefore an element of doubt as to the record for Greece.

C. canescens, though so widely distributed, is a compact species, the principal variation being in the length of the internodes, the length and number of the spine-cells, the size of the stipulodes and bract-cells, and the size and shape of the oogonia and oospores. In the plant from the Orkney I. the latter are exceptionally stout and broad. An extreme form described by Dr. Migula, under the name of var. *thermalis*, from mineral springs at

St. Nectaire in France, has very small sparse spine-cells and much shorter bract-cells than in the normal forms.

Braun rejected the earlier specific name, *canescens*, in favour of that of *crinita*, on the ground that the former was given under a misapprehension by its author, the specimens described owing their appearance to having been bleached by the sun, but this objection is invalid under Art. 50 of the International Rules. Loiseleur's description is admittedly an inadequate one, but we do not think there is any reasonable doubt as to the identity of the species intended, especially in view of the description of the very characteristic armature of the stem given in 'Flore Française,' VI, p. 246, by De Candolle, who was evidently acquainted with Loiseleur's plant.

Monœcious species belonging to the same section are: *C. hirsuta* Allen, from California, and *C. sibirica* Migula, from Tomsk Province, Siberia.

[**C. imperfecta** Braun, a dioecious species with haplostichous cortex to the stem, the cortical-cells in non-contiguous rows, and with imperfectly corticate branchlets, but closely resembling *C. vulgaris* in habit and appearance, occurs in a very few localities in Spain, France and Algiers. The gametangia at the lowest branchlet-nodes are geminate or even three together.]

Subsection 2. *Diplostichæ* Braun, 'Consp. Char. Europ.' p. 5, 1867.

Rows of cortical cells of the stem double the number of the branchlets, a single row of secondary cells alternating with the primary.

1. *Aulacanthæ* Braun in Cohn 'Krypt Fl. Schles.' I, p. 406 (1876).

Secondary cortical-cells larger and more prominent than the primary, so that the spine-cells appear to be situated in grooves.

3. *Chara vulgaris* Linn.

(PLATE XXVIII.)

Equisetum olidum C. BAUHIN Phytopinax, p. 33 (1596).

E. fetidum sub aqua repens C. BAUHIN Prodr. Theat. Bot. p. 250 (1620).

- Chara vulgaris foetida* VAILLANT in Mém. Acad. Sc. 1719, p. 17, t. 3, f. 1.
- C. vulgaris* LINNÆUS Sp. Plant. p. 1156 (1753), *emend.* Wallroth.
SMITH Engl. Bot. 336 (1796).
WALLROTH Annus Botanicus, p. 179, t. 1 (1815).
HARTMAN Handb. Skand. Fl. p. 377 (1820).
BRUZELIUS Obs. Char. pp. 6 & 21 (1824).
AGARDH Syst. Alg. p. 128 (1824).
KÜTZING Phyc. Gen. p. 319, t. 38, 39 (1843); Phyc. Germ. p. 258 (1845); Sp. Alg. p. 523 (1849); Tab. Phyc. VII, t. 58, f. 1 (1857).
RUPRECHT Symb. Hist. Pl. Ross. p. 80 (1845).
BABINGTON in Ann. & Mag. Nat. Hist. ser. 2, V, p. 89 (1850).
BERTOLONI Fl. Ital. X, p. 12 (1854).
GROVES in Journ. Bot. XVIII, p. 133, t. 208, f. 8 (1880).
GREEN Fl. Liverpool, f. 800-1 (1902).
HY in Bull. Soc. Bot. France, LX, Mém. 26, p. 30 (1913).
- C. funicularis* & *C. batrachosperma* THUILLIER Fl. Par. ed. 2, p. 473 (1799), *vide* Braun.
- C. hispida* var. *gracilis* HOOKER Brit. Fl. II, p. 247 (1833).
- C. foetida* BRAUN in Ann. sc. Nat. ser. 2, I, p. 354 (1834); in Flora, XVIII, i, p. 63 (1835); in N. Denks. Schweiz. Ges. Naturw. X, p. 14 (1849); Consp. Charac. Europ. p. 5 (1867); in Monatsb. Akad. Wiss. Berl. for 1867, p. 910 (1868); in Cohn, Krypt. Fl. Schles. I, p. 406 (1876).
COSSON & GERMAIN Atl. Fl. Par. t. 37, f. 1-4, 6-7 (1845); ed. 2, t. 41, f. 1-7 (1862).
RABENHORST Deutsch. Krypt. Fl. II, p. 197 (1847).
GANTERER Österr. Char. p. 18, f. 12-13 (1847).
WALLMAN Försök Syst. Charac. p. 76 (1853); Transl. p. 63 (1856).
BRÉBISSON Fl. Normand. ed. 3, p. 380 (1859).
WAHLSTEDT Bidr. Skand. Charac. p. 11 (1862); Mon. Sver. & Norg. Charac. p. 26 (1875).
NORDSTEDT in Bot. Notiser for 1863, p. 45.
CRÉPIN in Bull. Soc. Bot. Belg. II, p. 125 (1863).
BABINGTON Man. Brit. Bot. ed. 7, p. 461 (1874).
J. MÜLLER in Bull. Soc. Bot. Genève, II, p. 70 (1881).
BRAUN & NORDSTEDT, Fragm. Mon. Charac. p. 159 (1882).
SYDOW Europ. Charac. p. 72 (1882).
BOSWELL Engl. Bot. ed. 3, XII, p. 202, t. 1914 (1885) *ex parte*.
MIGULA Die Characeen, p. 554, f. 121, 122 (*pro parte*), 124 (1894); Krypt.-Fl. Deutsch. II, ii, p. 316, t. 73 (1907); Syn. Charac. Europ. p. 122, f. 106, 107 (p.p.) 109 (1898).
HOLTZ Charac. Mark-Brandenb. p. 102, 104, f. 2 (1903).
PRÓSPER Carofit. Españ. p. 128, t. 23 (1910).
- EXSICCATA:—Areschoug 147, 245; Braun, Rabenh. & Stiz. 7, 39-41, 82, 91, 110; Desmazières II, 333; Jack, Lein. & Stiz. 209-11; Krypt. Exsicc. 1212; Migula, Sydow & Wahlst. 39-43, 66-70, 103-8, 112-15, 142-4; Mougeot & Nestl 590; Nordstedt & Wahlst. 90-2, 94; Rabenhorst 149, 170; Reichenbach, 2143; Wagner 24; G. & B.-W. 7, 30.

Monœcious. *Stem* moderately stout. *Cortex* diplostichous, usually regular, the primary series of cells less prominent than the secondary. *Spine-cells* solitary,

appressed or slightly spreading, variable in length, stout, more or less obtuse, often papilliform. *Whorls* of 7–9 branchlets. *Stipulodes* of both series well-developed, usually equal short stout and more or less obtuse. *Branchlets* incurved, spreading or recurved, of 6–8 segments, of which 2–3 are usually ecorticate. *Bract-cells* usually 5, of which one or two pairs are usually elongated, extremely variable in length, the anterior pair often much exceeding the oogonium, the posterior 1–3 rudimentary, sometimes all bract-cells developed, the posterior much the shorter. *Bracteoles* similar to the anterior bract-cells, sometimes exceeding them in length. *Oogonia* and *antheridia* almost always solitary produced at the 3–4 lowest nodes. *Oogonium* varying from broadly ellipsoid to cylindrical-ellipsoid, but usually tapering slightly upwards, usually c. 525–800 μ long (excl. coronula), 350–475 μ broad; *spiral-cells* showing 14–16 convolutions; *coronula* very variable in size and shape, 75–125 μ high, 200–325 μ broad, usually more or less spreading. *Oospore* ellipsoid or ellipsoid-cylindrical, c. 425–675 μ long (excl. cage), c. 225–400 μ broad, pale golden brown to dark brown, showing about 12–15 low thin ridges, often prolonged downwards into a cage*; *outer membrane* thin, flexible, very translucent light yellow-brown, sometimes conspicuously, sometimes obscurely granulated, granules non-contiguous, varying in size and prominence. *Antheridium* c. 325–500 μ in diameter.

HABITAT.—In lakes, ponds, pools, pits and ditches, distributed all over the British Isles, but less common in Scotland and Wales.

DISTRIBUTION.—*England*: Recorded from all counties except the Isle of Man.

Wales: Glamorgan, Carmarthen, Pembroke, Cardigan, Carnarvon, Flint, Anglesea.

* It would seem that prolongation of the ridges of the oospore to form a cage takes place in the strongly developed fruits. We have referred to their presence in species where we have observed them, but they may well occur in others.

Scotland : Wigton, Kirkcudbright, Selkirk, Roxburgh, Haddington, Edinburgh, Fife, E., Perth, E., Forfar, Aberdeen, N., Elgin, Easternness, Main Argyll, Clyde, S., Ebudes, S. & M., Sutherland, W., Caithness, Hebrides, Orkney, Shetland.

Ireland : All counties except Waterford and Tyrone.

Channel I. : Guernsey, Alderney, Sark, Herm.

Outside the British Isles *C. vulgaris* has, next to *C. fragilis*, the widest range, occurring practically all over Europe except the extreme north, in Asia, North and South Africa, North and South America, and Australasia.

First record: Probably Johnson's edition of 'Gerard's Herbal,' 1633.

A medium-sized plant, normal forms ranging from about 9-18 inches in height, with moderately stout stem; it is usually conspicuously incrustated, but entirely unincrustated states occasionally occur. We have seen no root-bulbils, and there is less tendency towards thickened stem-nodes than in many species. The coronula is extremely variable in size and shape, the cells being sometimes almost spherical, sometimes so elongated as to be twice as long as broad, and quite spreading.

It may be distinguished from the other British species of the section *Aulacanthæ* by all the spine-cells being solitary and obtuse, by the short obtuse stipulodes, the bract-cells being more obtuse and the back pair being but little developed, and by the smaller fruits and antheridia. In facies it more closely resembles *C. contraria*, from some forms of which it is not always easy to distinguish it when the cortical-cells are of about equal prominence. The points of difference will be discussed under *C. contraria*.

C. vulgaris is our most variable species, the forms and states which it presents being almost unlimited in number. Many of these have been described and named. In Dr. Migula's 'Die Characeen' no less than sixty-nine "forms" are discriminated by name, but most of these appear to us too trivial to be worth distinguishing. The principal lines of variation, not including var. *crassicaulis*, are well indicated in the following analysis by Braun, in "Die Characeen Afrikas" ('Monatsb. Akad. Wiss. Berl.' for 1867, pp. 911-2).

- I. Subinermis, papillis brevioribus parum conspicuis.
1. Macroptila (vulgo longibracteata), foliolis sporangia longe (duplo-sextuplo) superantibus, plerumque simul macroteles, foliorum articulis ecorticatis elongatis.
 - (a) condensata, verticillis approximatis, dense implexis. (H. l. *Ch. montana* Schleich, *Ch. coarctata* Wallm.)
Capitato-condensata.
 - (b) laxior, verticillorum foliis nunc divergentibus, rectis vel arcuatim recurvis, nunc convergentibus. (Forma vulgatissima, quasi centralis, *Ch. divergens* Koch et Zis; si munda: *Ch. atrovirens* Lowe.)
 - (c) elongata, verticillis longe remotis, foliis foliolisque valde elongatis. (*Ch. longibracteata* Kütz.)
 - (d) stricta, verticillis remotis erectis, foliis foliolisque brevioribus. (*Ch. funicularis* Thuill. ex p., *Ch. seminuda* Kütz.)
 2. microptila (vulgo brevibracteata), foliolis sporangia parum vel vix superantibus, plerumque simul brachyteles. Articuli foliorum corticati et fertiles plerumque numerosiores.
 - (a) contracta, verticillis approximatis, foliis arcuatoconniventibus. (Munda: *Ch. batrachosperma* Thuill.)
 - (b) expansa vel subexpansa, magis elongata. (*Ch. polysperma* Kütz.; *Ch. pleiospora* Ganter. et munda: *Ch. punctata* Lebel.)
 - (c) clausa, brachyphylla (articulis paucioribus) submacroteles, verticillis remotis arcte conniventibus (*Ch. squamosa* Salle, non Desf.).
- II. Subhispidata (*Ch. vulg. papillata* Wallr.), papillis longioribus aculeiformibus, caulis diametrum sæpe æquantibus, rarissime superantibus. Cellularum corticis series secundariæ plerumque valde prominentes.
1. macroptila (et macroteles).
 - (a) condensata.
Capitato-condensata.
 - (b) laxior, divergens vel connivens. (*Ch. decipiens* Desv., *Ch. tuberculata* Opiz.)
 - (c) elongata. (*Ch. collabens* Ag.)
 - (d) stricta. (*Ch. funicularis* Thuill. ex p., *Ch. stricta* Kzg.)
 2. microptila (et brachyteles).
 - (a) contracta. (b) subexpansa, expansa vel refracta. (*Ch. refracta* Kütz.) (c) clausa, brachyphylla.
- β. melanopyrena. Nucleus sporangii ater.

The relative size of the cortical-cells is very variable, those of the primary and secondary rows being in some forms almost equal in diameter and prominence, while in others the secondary are double the diameter of the primary. The size of the spine-cells is also variable, ranging from mere papillæ to well-developed spines, sometimes even considerably longer than the diameter of the stem. The bract-cells and bracteoles also vary much in length. The stipulodes are normally rather short and particularly regular. The stipulodes, spine-cells and bract-cells are all more or less obtuse.

The plant often occurs in bogs and in very shallow running water, when it presents a tufted state (*C. foetida* var. *condensata*, Breb., *C. coarctata* Wallman), through the shortening of the internodes.

C. atrovirens Lowe, in 'Trans. Camb. Phil. Soc.' VI, p. 551 (1838), an unincrusted form with several elongated ecorticate segments to the branchlets, has been found in a few localities in this country.

We have not seen any specimens with black oospores (var. *melanopyrena* Braun), the membranes of those from East Bridge-rule, Cornwall, previously referred to this variety, being found upon examination by transmitted light to be brown, as in other forms, although appearing black to the naked eye.

In a few instances the variations are obviously due to conditions of growth, but in most cases the causes are not apparent. For instance, it not infrequently happens that when this species occurs in several pits close together, of approximately equal depth and size, so that the conditions are apparently precisely similar, while the individual plants of a pit will be almost identical, those of each of the pits will present a slightly different facies.

The four forms which we have characterized and figured as varieties appear to us the most noteworthy, but it cannot be claimed that these are always stable nor that a definite line can be drawn between them. They may well be regarded merely as extremes of variation.

Braun used the name *C. foetida* for this species, and his example has been widely followed on the Continent, but we have thought it right to retain the Linnean name. Although probably what we now know as *C. fragilis* and *C. delicatula* were also originally included in the name by Linnæus, owing to his not distinguishing them, there can be no doubt that he was familiar with the present plant, it being the most conspicuously common species in Europe, and Vaillant's figure, which is quoted in 'Species Plantarum,'

being an excellent representation of it. Moreover, the earlier post-Linnean authors identified the Linnean name with it, when other species were beginning to be made out. In the Linnean herbarium *C. vulgaris* is represented by one specimen of the present species and one of *C. fragilis*. If it be contended that Linnæus's name ought to be set aside, because it included two or more species, the same argument would apply to Braun's *C. fœtida*. We have not quoted *C. montana* Schleich as a synonym, that name having been published without description.

Var. b. *longibracteata*.

KÜTZING Sp. Alg. p. 523 (1849).

(PLATES XXI & XXIX, FIG. 3).

C. longibracteata KÜTZING in Reichenbach, Fl. Germ. Excurs. II, p. 843 (1832); Tab. Phyc. VII, t. 60, f. 1 (1857).

C. fœtida var. *longibracteata* COSSON & GERMAIN, Atl. Flor. Par. t. 37, f. 7 (1845).

EXSICCATA:—Areschoug 46; Braun, Rabenh. & Stiz. 83; Groves 14; Krypt. Exsicc. 1213; Migula, Syd. & Wahlst. 109–11; Rabenhorst 359.

Stem moderately stout. *Cortex* regular. *Spine-cells* short and appressed or rudimentary. *Branchlet* segments elongated, the ultimate 2–3 ecorticate, often forming whip-like ends. *Anterior bract-cells* and *bracteoles* very long, often 6 or more times the length of the oogonium.

Though well-marked in its extreme forms, intermediate states between this and the type are constantly found.

Var. c. *papillata*.

WALLROTH Annus Botanicus, p. 183 (1815).

(PLATE XXIX, FIG. 2.)

C. decipiens DESVAUX in Loiseleur, Notice aj. Fl. France, p. 138 (1810).

C. collabens AGARDH Syst. Alg. p. xxviii (1824), *fide* Braun.

C. fœtida var. *papillaris* BRAUN in Ann. sc. Nat. ser. 2, I, p. 355 (1834).
COSSON & GERMAIN Atl. Fl. Par. t. 37, f. 6 (1845).

C. fœtida var. *subhispida* BRAUN in Flora, XVIII, i, p. 64 (1835).

C. stricta KÜTZING in Flora, XVII, i, p. 707 (1834); Tab. Phyc. VII. t. 59, f. 1 (1857).

C. foetida II. *subhispidata*, 1. *macroptila* BRAUN in Monatsb. Akad. Berl. for 1867, p. 912 (1868).

C. foetida subsp. *subhispidata* BRAUN & NORDSTEDT, Fragm. Mon. Charac. p. 167 (1882).

EXSICCATA:—Groves 15; Migula, Sydow & Wahlst. 17; Nordstedt & Wahlst. 95.

Stem stout. *Cortex* irregular. *Secondary cortical-cells* much thicker than the primary. *Spine-cells* conspicuously long and more or less spreading, deciduous. *Branchlets* long or of medium length. *Bract-cells* rather long.

A large somewhat lax and untidy-looking plant, usually much incrustated.

Var. d. *refracta*.

(PLATE XXIX, FIG. 1.)

C. refracta KÜTZING in Flora, XVII, i, p. 707 (1834); Tab. Phyc. VII. t. 58, f. 2 (1857).

C. foetida var. *refracta* WAHLSTEDT Bidr. Skand. Charac. p. 13 (1862).

C. foetida II. *subhispidata*, 1. *microptila* BRAUN in Monatsb. Akad. Berl. for 1867, p. 912 (1868).

EXSICCATA:—Billot 3274; Groves 16; Nordstedt & Wahlst. 93, 96; Rabenhorst 440; Gr. & B.-W. 8.

Stem moderately stout. *Spine-cells* well-developed, but shorter than in the preceding. *Branchlets* short, often somewhat reflexed at the joints, the ultimate segments much abbreviated. *Bract-cells* short.

A conspicuously neat plant, usually but little incrustated, fruiting very freely, sometimes at 5 nodes of the branchlets.

Var. e. *crassicaulis*.

KÜTZING Sp. Alg. p. 523 (1849).

(PLATE XXIX, FIG. 4.)

C. foetida var. *crassicaulis* BRAUN in Ann. sc. Nat. ser. 2, I, p. 355 (1834); in Flora, XVIII, i, p. 64 (1835).

C. longibracteata var. *crassicaulis* WALLMAN Försök Syst. Charac. p. 8 (1853); Transl. p. 65 (1856).

- C. crassicaulis* KÜTZING Tab. Phyc. VII, p. 25, t. 60, f. 2 (1857).
 BRAUN in Monatsb. Akad. Wiss. Berl. for 1867, p. 921 (1868).
 MIGULA Die Characeen, p. 614, f. 128? (1895); Krypt.-Fl. Deutsch. II,
 ii, p. 330, t. 74, f. 1? (1907); Syn. Char. Europ. p. 133, f. 113? (1898).
C. fetida subsp. *crassicaulis* BRAUN & NORDSTEDT Fragm. Mon.
 Charac. p. 168 (1882).

EXSICCATA:—Groves 17.

Stem stout, firm. *Secondary cortical-cells* very thick. *Spine-cells* short, thick and rounded at the apex. *Stipulodes* very obtuse. *Branchlets* short, stout, incurved. *Posterior bract-cells* usually at least twice as long as broad.

This variety in its extreme form is a remarkably distinct-looking plant, characterized by the much stouter stem and branchlets, the latter being incurved, the long internodes, the well-developed posterior bract-cells and the botuliform stipulodes, spine-cells and bract-cells, but intermediates occur between this and other forms. Kützing's magnified figure shows the cortical-cells as of equal thickness, but this is probably a slip. Migula's figure may not belong to this variety, as the posterior bract-cells are shown as rudimentary, and the branchlets are not incurved. Our figure shows a rather slender form.

The vars. *longibracteata*, *papillata* and *refracta* occur in many counties; forms referable to var. *crassicaulis* we have seen from Hants, N., Cambs, Hunts, Warwick, Derby and Yorks, N.E.

[*C. gymnophylla* Braun, closely allied to, or a subspecies of, *C. vulgaris*, much resembles that species in habit and appearance, but is distinguished by having the branchlets entirely ecorticate, or with only one or two corticate segments, gametangia being produced at nodes from which no cortex arises. It occurs in the countries bordering on the Mediterranean. We have a small fragment of a plant collected by Mr. J. E. Nowers, at Kilronan, Aran, W. Galway, in 1890, which appears to belong to *C. gymnophylla*. It is desirable however that further specimens should be obtained to substantiate the record.]

[*C. Rabenhorstii* Braun, having larger antheridia (diam. c. 550 μ) and usually producing oogonia and antheridia at different nodes of the same branchlets, has

been found in one locality in Italy. Regarded as a subspecies of *C. foetida* (= *C. vulgaris*) by Braun & Nordstedt ('Fragmente,' p. 168).]

4. *Chara rudis* Leonhardi.

(PLATE XXX.)

- Chara hispida* var. *rudis* BRAUN in Braun, Rabenh. & Stiz. Charac. Exsicc. No. 4 (1857).
 GROVES in Journ. Bot. XVIII, p. 132, t. 208, f. 7a (1880).
 J. MÜLLER in Bull. Soc. Bot. Genève, II, p. 86 (1881).
*C. spinosa** *rudis* NORDSTEDT in Bot. Notiser, for 1863, p. 48.
C. rudis LEONHARDI in Verh. Naturf. ver. Brunn, II, p. 185 (1864).
 BRAUN Consp. Charac. Europ. p. 6 (1867); in Cohn, Krypt. Fl. Schles. I, p. 408 (1876).
 WAHLSTEDT Mon. Sver. and Norg. Charac. p. 29 (1875).
 SYDOW Europ. Charac. p. 83 (1882).
 MIGULA Die Characeen p. 619, f. 129 (1895); Krypt.-Fl. Deutsch. II, ii, p. 331, t. 74, f. 2 (1907); Syn. Charac. Europ. p. 133, f. 114 (1898).
 HOLTZ in Krypt. fl. Mark. Brandenb. IV, i, p. 107 and p. 104, f. 1 (1903).
C. hispida subsp. *rudis* BRAUN & NORDSTEDT, Fragm. Monog. Charac. p. 173 (1882).
C. major subsp. *rudis* HY in Bull. Soc. Bot. France, LX, mém. 26, p. 37 (1913).

EXSICCATA :—Areschoug 142; Braun Rabenh. & Stiz. 4, 86; Fl. Exsicc. Austr. Hung. 791; Groves 13; Jack, Lein & Stiz. 217; Krypt. Exsicc. 1214, 1215; Migula 130; Nielssen 32, 33 (*vide* Wahlstedt); Nordstedt & Wahlst. 62, 63, 64a, 64b, 65, 66; Gr. & B.-W. 9.

Monœcious. *Stem* of medium thickness or rather slender; *internodes* about $1\frac{1}{2}$ —twice as long as the branchlets. *Cortex* regularly diplostichous, the cells of the secondary series very much the broader and more prominent, often more than twice the diameter of the primary series, not tapering at the extremities. *Spine-cells* mostly geminate, some solitary, and a few three together, usually appressed except in the younger internodes, of medium length, cylindrical usually obtuse. *Stipulodes* of both series well-developed, of nearly equal length, sub-cylindrical, usually obtuse. *Whorls* of 6–8 branchlets. *Branchlets* usually rather long, slender, and not much curved, of 7–8 segments, the 3 upper usually ecorticate. *Bract-cells* normally 5, the posterior short,

the anterior usually shorter than the fruit; *bracteoles* usually longer. *Oogonia* and *antheridia* solitary, produced at the lowest 3-4 nodes. *Oogonium* (excl. cor.) c. 900-1000 μ long, 625-700 μ broad, *spiral-cells* showing about 13-14 convolutions, *coronula* spreading c. 180 μ high, 350 μ broad. *Oospore* c. 675-750 μ long (excl. basal appendage), 425-450 μ broad, rich chestnut-brown, showing about 12-13 fine ridges, prolonged downwards into a cage; *outer membrane* thin, flexible, translucent, light rich chestnut-brown faintly and finely granulated. *Antheridium* 400-500 μ in diameter.

HABITAT.—Usually occurring in lakes, but occasionally in running water, rare in England; known from one county only of Wales; in several counties of Scotland; much more widely distributed in Ireland.

DISTRIBUTION.—*England*: Cambridge, Salop, Lancs, W., Yorks, N.E., Durham.

Wales: Anglesea.

Scotland: Roxburgh, Haddington, Fife, Perth, E., Elgin, Easternness, Main Argyll, Orkney.

Ireland: Tipperary, S., Limerick, Clare, Tipperary, N., Kilkenny, Queen's Co., Galway, S.E., W. and N.E., King's Co., Kildare, Wicklow, Dublin, Meath, Westmeath, Longford, Roscommon, Mayo, E. & W., Sligo, Cavan, Monaghan, Fermanagh, Donegal. E., Armagh, Down.

First record: (as variety of *C. hispida*) 'Journ. Bot.' 1880.

Outside the British Isles *C. rudis* is recorded from Sweden, Russia, Denmark, Belgium, Holland, Germany, Austria, Hungary, Switzerland.

A large plant often 3 feet high, with moderately stout stem and long branchlets, usually much incrustated. It resembles the more common *C. hispida*, of which it is often regarded as a subspecies, but differs from it in having a more slender stem and branchlets, much larger secondary cortical-cells, often twice the diameter of the primary cells, almost hiding the latter, and in having a considerable proportion of the spine-cells geminate,

when they are placed one above another, not side by side, as is usual with *C. hispida*. From *C. vulgaris* it differs by its larger size and longer branchlets, by the production of geminate and clustered spine-cells, by the more acute stipulodes, spine-cells and bract-cells, the posterior bract-cells being longer, and the larger fruit and antheridia.

The difference in its distribution from that of *C. hispida* is very marked, the latter extending over most of England, being commoner in the East and South-East, while *C. rudis* is apparently confined to a few northern counties, with the exception of Cambridge and Salop. In Ireland the distribution of both is very similar.

C. subspinosa Ruprecht is apparently the oldest name given to this species. Braun evidently had no doubt as to the identity of Ruprecht's plant, having probably seen specimens, but the very meagre remarks in 'Symb. ad. hist. pl. Ross.' p. 255, cannot, we think, on the most liberal construction be accepted as a description within the meaning of the Rules, and the name would therefore be a "nomen nudum." For this reason we have not cited it among the synonyms.

5. *Chara hispida* Linn.

(PLATE XXXI.)

- C. major, caulibus spinosis* VAILLANT Mém. Acad. Sc. p. 18, t. 3, f. 3 (1719).
C. hispida LINN. Sp. Plant. II, p. 1156 (1753) *pro parte*.
 OEDER Flora Danica, I, t. 154 (1764).
 SMITH Engl. Bot. t. 463 (1798).
 WALLROTH Annus Botanicus, p. 187, t. 4 (1815); Fl. Crypt Germ. II, p. 112 (1833).
 BRUZELIUS Obs. Char. pp. 9 & 20 (1824).
 AGARDH Syst. Alg. p. 128 (1824).
 BRAUN in Ann. sc. Nat. ser. 2, I, p. 355 (excl. γ) (1834); in Flora XVIII, i, p. 67 excl. γ (1835); in N. Denks. Schweiz. Ges. Naturw. X, p. 17 (1849); Consp. Charac. Europ. p. 5 (1867); in Monatsb. Akad. Wiss. Berl. for 1867, p. 922; in Cohn's Krypt. Fl. Schles. I, p. 407 (1876).
 BISCHOFF Handb. bot. Term. II, t. 56, f. 2799-801, t. 57, f. 2813, 2824-7, 2829-33 (1842).
 COSSON & GERMAIN Atl. Fl. Par. t. 38, f. B, 1-2 (1845); ed. 2, t. 42, f. B. 1-2 (1882).
 KÜTZING Phyc. Germ. p. 259 (1845); Sp. Alg. p. 524 (1849); Tab. Phyc. VII, t. 65, 66, 67, f. 1, (1857).
 GANTERER Oesterr. Char. p. 17 (1847).
 RABENHORST Deutsch. Krypt. Fl. II, p. 198 (1847) *ex parte*.
 BABINGTON in Ann. and Mag. Nat. Hist. ser. 2, V, p. 89 (1850).

- WALLMANN Försök. syst. Charac. p. 80, excl. ζ (1853); Transl. p. 67 (1856).
 WAHLSTEDT Bidr. Skand. Charac. p. 25 (1862); Mon. Sver. & Norg. Charac. p. 28 (1875).
 CRÉPIN in Bull. Soc. Bot. Belg. II, p. 125 (1863).
 LEONHARDI in Verh. Naturf. ver. Brunn, II, p. 186 (1864).
 GROVES in Journ. Bot. XVIII, p. 131, t. 208, f. 7 (1880).
 J. MÜLLER in Bull. Soc. Bot. Genève, II, p. 83 (1881).
 BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 171 (1882).
 SYDOW Europ. Charac. p. 80 (1882).
 BOSWELL Engl. Bot. ed. 3, XII, p. 206 *pro parte*, t. 1916 (1885).
 MIGULA Die Characeen, p. 624, f. 130-2 (1895); Krypt.-Fl. Deutsch. II, ii, p. 332, t. 75 (1907); Syn. Charac. Europ. p. 137, f. 115-117 (1898).
 GREEN Fl. Liverpool, f. 799 (1902).
 HOLTZ Charac. Mark. Brandenb. p. 109 (1903).
 PRÓSPER Carofit. Españ. p. 142, t. 24 (1910).
C. spinosa Vaillantii RUPRECHT Symb. Hist. Ross, p. 83 (1845).
C. spinosa NORDSTEDT in Bot. Notiser for 1863, p. 47.
C. equisetina KÜTZING in Flora, XVII, i, p. 706 (1834); Tab. Phyc. VII, t. 68, f. 1 (1857).
C. major HY in Bull. Soc. Bot. France, LX, mém. 26, p. 37 (1913) *pro parte*.

EXSICCATA :—Areschoug 45, 143, 144, 400; Braun, Rabenh. & Stiz. 2, 3, 49, 70, 85, 117; Desmazières 334-5; Fries 14, 100, *vide* Sydow; Groves 12, 13, 43, 44; Hansen 1099; Jack, Leiner & Stiz. 215, 216; Lloyd 429, 430; Migula, Sydow & Wahlst. 18, 19, 49, 116-22; Nielsen 26-31, *vide* Wahlstedt; Nordstedt & Wahlst. 55 *a*, 55 *b*, 56, 57 *a*, 57 *b*, 58, 59, 59 *b*, 60 *a*, *b*, *c*, *d*; Rabenhorst 258; Reichenbach 93; Westendorp & Wall. 900, *vide* Sydow; Gr. & B.-W. 10, 31.

Monœcious. *Stem* usually very stout and firm; internodes usually $1\frac{1}{2}$ - $2\frac{1}{2}$ times the length of the branchlets. *Cortex* diplostichous, somewhat irregular, the secondary series rather more prominent than the primary, the cells often tapering at their extremities; *spine-cells* occurring singly and two and three (occasionally four) together, when geminate almost always side-by-side, spreading, usually long and rather stout, cylindrical, acuminate, blunt or acute at the apex. *Whorls* of about 9-11 *branchlets*. *Stipulodes* of both series well developed, of about equal length, cylindrical, acuminate sub-obtuse. *Branchlets* often long, almost straight or incurved, of 7-9 segments, the upper 1-3 usually ecorticate. *Bract-cells* normally 5 or 7, all usually more or less elongated, the anterior often longer, the posterior much shorter than the fruit, cylindrical,

with long acuminate often sharp points. *Bracteoles* equalling or exceeding the anterior bract-cells. *Oogonia* and *antheridia* solitary, usually produced at the four lowest nodes. *Oogonium* c. 1000–1100 μ long (excl. cor.), 650–750 μ broad; *spiral-cells* showing about 13–14 convolutions; *coronula* variable in size, c. 250–350 μ broad, c. 150–250 μ high, spreading. *Oospore* ellipsoid-obovoid, c. 700–750 μ long (excl. cage), c. 500 μ broad, showing 12–13 low ridges, prolonged downwards into a cage; *membrane* thin, flexible, translucent, light rich chestnut-brown, strongly granulated with granules of varying size and prominence. *Antheridium* c. 375–500 μ in diameter.

HABITAT.—In lakes, ponds, peat pits and ditches, widely distributed in England, Scotland and Ireland, but not seen from Wales.

DISTRIBUTION.—*England*: Cornwall, W., Somerset, N., Dorset, Wight, Hants, N. & S., Sussex, W. & E., Kent, W. & E., Surrey, Essex, N., Berks, Oxon, Bucks, Suffolk, E. & W., Norfolk, E. & W., Cambs, Beds, Hunts, Northampton, Gloucester, E., Hereford, Warwick, Salop, Lincs, N. & S., Leicester, Derby, Cheshire, Lancs, S., Yorks, N.E. & N.W., Durham, Northumberland, Westmoreland, Cumberland.

Scotland: Berwick, Haddington, Perth, E., Forfar, Aberdeen, N., Elgin, Easternness, Cantire, Ebudes, M., Sutherland, W., Caithness, Hebrides, Orkney.

Ireland: Kerry, S. & N., Cork, M. & E., Tipperary, S., Limerick, Clare, Tipperary, N., Kilkenny, Carlow, Queen's Co., Galway, S.E., W. and N.E., King's Co., Kildare, Wicklow, Dublin, Meath, Westmeath, Longford, Roscommon, Mayo, E. & W., Sligo, Cavan, Louth, Monaghan, Donegal, W., Armagh, Down, Londonderry.

First record: uncertain, some of the pre-Linnean records, no doubt, belong to this. There are two specimens in Herb. Buddle.

Outside the British Isles, *C. hispida* is recorded from Sweden, Russia, Denmark, Belgium, Holland, Germany,

Austria, Hungary, Spain, France, Switzerland, Bulgaria, Italy, Greece and Turkey, also from Asia (Siberia) and North Africa.

The largest and most robust European species, often attaining a height of 70 cm., with branchlets sometimes 8 cm. long. A very stout form (*C. equisetina*, Kütz.) has the stem nearly 3 mm. thick. The plant is nearly always much incrustated, but entirely unincrusted states occasionally occur. The spine-cells are mostly clustered, and fairly long, but are usually deciduous, so that while the upper internodes are densely covered with spines, the lower parts of the stem are often quite destitute of these appendages. The cortex sometimes out-grows the internodes, splitting and bulging out. The torsion of the cortex is very marked. The lower stem-nodes are occasionally thickened, and Giesenhagen records the occurrence of small root-bulbils.

C. hispida assumes a great variety of forms, varying from elongated to condensed, attenuate to robust, the branchlets very long to very short, and nearly straight to incurved, the spine-cells very long to very short (in the form *macracantha* they are twice as long as the diameter of the stem), and persistent to deciduous, the cortical-cells conspicuous to obscure. In young states of the plant several of the uppermost branchlet-segments are often elongated and ecorticate (f. *gymnoteles*).

A plant collected many years ago at Goldens Common near Freshwater, Isle of Wight, was referred by H. & J. G. in 'Journ. Bot.' xviii, pp. 133 (1880), to var. *horrida* (*C. horrida* Wahlst., *C. hispida* subsp. *horrida* Braun & Nordstedt), which occurs in the Baltic and some of the countries adjoining, and is characterized by having numerous clustered persistent spine-cells, by the posterior bract-cells being almost as long as the anterior, and by being usually without incrustation. The Isle of Wight plant has remarkably long posterior bract-cells, but is not otherwise so extreme as that from the Baltic, and we think it better referred to *C. hispida* proper.

C. hispida differs from *C. vulgaris* in the larger size and thicker stem, in having the spine-cells mostly clustered, the stipulodes, spine-cells and bract-cells more or less acute, by the greater development of the posterior bract-cells and by the much larger fruit and antheridia; from *C. rudis* by the generally stouter stem and branchlets, the less unequal primary and secondary cortical-cells, the production of geminate spine-cells almost

always side by side, instead of one above another, and by the rather larger fruit.

The Linnean name has by common consent been retained for this species. Dr. Nordstedt has pointed out the plant referred to in the first reference in 'Species Plantarum,' was *C. aspera*, and in consequence of this preferred the name of *C. spinosa*. Our own view, as already explained, is that the Linnean name covered all conspicuously spiny Charæ then known. *C. aspera*, *C. aculeolata* and *C. rudis* having been subsequently differentiated, the name *C. hispida* remains for the present species.

A very large imperfectly-fruited plant with long attenuate branchlets, found in Hickling Broad, E. Norfolk, appears to be a hybrid between this species and *C. contraria*. When first discovered it was referred to *C. papillosa* Kütz., see 'Journ. Bot.' XXIV, p. 1, t. 263 (1886), and p. 43.

2. *Tylacanthæ* Braun in Cohn, 'Krypt. Fl. Schles.' I, p. 404 (1876).

Primary cortical-cells larger and more prominent than the secondary, so that the spine-cells appear to be seated on ridges.

A. Diœciæ.

6. *Chara tomentosa* Linn.

(PLATE XXXII.)

Chara tomentosa LINN. Sp. Plant, p. 1156 (1753), excl. syn.

BRUZELIUS Obs. Char. pp. 13, 20 (1824).

AGARDH Syst. Alg. p. 127 (1824).

HORNEMANN in Flora Danica, t. 1941 (1829).

KÜTZING Phyc. Germ. p. 260 (1845); Syst. Alg. p. 526 (1849); Tab. Phyc. VII, t. 74, f. 1 (1867).

WALLMAN Försök syst. Charac. p. 89 (1853); Transl. p. 74 (1856).

BABINGTON in Ann. & Mag. Nat. Hist. ser. 2, V, p. 90 (1850); Man. Brit. Bot. ed. 3, p. 423 (1851).

NORDSTEDT in Bot. Notiser 1863, p. 51.

WAHLSTEDT Mon. Sver. and Norg. Charac. p. 30 (1875).

GROVES in Journ. Bot. XVIII, p. 130, t. 207, f. 5 (1880).

BOSWELL Engl. Bot. ed. 3, XII, p. 200, t. 1913 (1885).

C. latifolia WILLDENOW in Ges. Nat. Fr. Berl. III, p. 298 (1809).

HOOKEE in Lond. Journ. Bot. I, p. 43 (1842); Icones Plant. VI, t. 532 (1843).

C. ceratophylla WALLROTH Annus Bot. p. 192, t. 5 (1815).

HORNEMANN in Flora Danica, t. 1656 (1819).

BRUZELIUS Obs. Char. p. 20 (1824).

- AGARDH Syst. Alg. p. 127 (1824).
 BISCHOFF Krypt. Gew. t. i, f. 16 (1828); Handb. bot. Term. und Syst. f. 2816 (1842).
 BRAUN in Ann. sc. Nat. ser. 2, I, p. 355 (1834); in Flora, XVIII, i, p. 65 (1835); in N. Denks. Allg. Schweiz. X, p. 18 (1849); in Cohn, Krypt. Fl. Schles. I, p. 404 (1876).
 KÜTZING Phyc. Germ. p. 260 (1845); Sp. Alg. p. 526 (1849); Tab. Phyc. VII, t. 73 (1857).
 RABENHORST Deutsch. Krypt. Fl. II, p. 198 (1847).
 WALLMAN Försök syst. Charac. p. 90 (1853); Transl. p. 75 (1856).
 GANTNER Osterr. Char. p. 16, f. 10-11 (1847).
 WAHLSTEDT Bidr. Skand. Charac. p. 34 (1862).
 LEONHARDI in Verh. Naturf. ver. Brunn II, p. 197 (1864).
 MÜLLER in Bull. Soc. Bot. Genève, II, p. 60 (1881).
 BRAUN & NORDSTEDT Frag. Mon. Charac. p. 139 (1882).
 SYDOW Europ. Charac. p. 66 (1882).
 MIGULA Die Characeen, p. 386, f. 92-5 (1892); Krypt. Fl. Deutsch. II, ii, p. 292, t. 68 (1907); Syn. Charac. Europ. p. 88, f. 77-80 (1898).
 WILLE in Engl. & Prantl. Nat. Pfl. fam. I, ii, p. 175, f. 128 B (1891).
 HOLTZ in Krypt. Mark. Brandenb. IV, i, p. 93 (1903).
 PRÓSPER Carofit. Españ. p. 112, f. 20 B (1910).
 HY in Bull. Soc. Bot. France, LX, mém. 26, p. 28 (1913).
- EXSICCATA :—Areschoug 43, 127, 296; Braun, Rab. & Stiz. 8, 9, 35, 36; Fries V, 100; Groves 40, 41; Jack, Lein. & Stiz. 218, 219; Migula, Sydow & Wahlst. 37, 59, 60, 89, 133; Nielssen 19, 20 (*vide* Wahlst.); Nordstedt & Wahlst. 30, 31, 35, 36, 50, 50 b, 54, 88, 89; Rabenhorst 70, 340; Reichenbach 92; Gr. & B-W. 11, 12.

Dicecious. *Stem* stout, the internodes usually $1\frac{1}{2}$ to twice the length of the branchlets. *Cortex* irregularly diplostichous, the primary series much the larger and more prominent; *spine-cells* solitary or clustered, varying considerably in size, broadly ovoid-acuminate. *Whorls* of 6-8 branchlets. *Stipulodes* of both series developed, broadly ovoid-acuminate. *Branchlets* stout, usually somewhat incurved, when well developed of 4-6 long segments, of which the 1-3 upper are ecorticate and often much swollen, the lowest segment with a partial irregular ascending as well as a descending cortex. *Bract-cells* normally 5, broadly ovoid acuminate, the anterior longer than the fruit, the posterior usually developed and often nearly as long as the anterior. *Bracteoles* and *bractlet* variable in length, often as long as the anterior bract-cells. *Oogonia* and *antheridia* solitary or the latter occasionally geminate, produced at the 2-3 lower nodes. *Oogonium* c. 1000 μ long (excl. cor.), 800 μ broad; *spiral-cells* showing about 15 con-

volutions; *coronula* c. 200 μ high, 500 μ broad at the top, spreading. *Oospore* c. 800–875 μ long, 525–600 μ broad, showing about 14 ridges, terminating in inconspicuous claws; *outer membrane* very thin and flexible, translucent pale yellow finely granulate with granules of varying size and prominence. *Antheridium* very large, c. 1325–1425 μ in diameter.

HABITAT and DISTRIBUTION — *Ireland*: In lakes in the centre, and in some expansions of the River Shannon, all within the drainage of the latter.

Tipperary, N., and Galway, S.E., R. Shannon below Portumna and Lough Derg. Westmeath, Lough Ennel, Coosan Lough, Lough Owel, Lough Derevaragh, Lough Ree. Longford and Roscommon, Lough Ree.

First record: Hooker, 1842, from Belvedere Lake (L. Ennel) collected by D. Moore in August, 1841.

A sterile plant was found in very small quantity in 1881 by Mr. Arthur Bennett in the Hundred Stream, near Potter Heigham, East Norfolk, which resembled this species, but we believe it has not since been collected, and the material available is not sufficient to determine its identity.

Outside the British Isles *C. tomentosa* is recorded from Sweden, Denmark, Finland, Russia, Germany, Austria Hungary, Switzerland, Spain, France and Turkey, in Siberia and Persia, also in Algiers (subsp. *disjuncta*, Nordst.).

A medium to large-sized plant, sometimes attaining a height of 60 cm., the stem usually very stout and firm. It is generally thickly incrustated, this being particularly the case in some of the Irish specimens, which have a coral-like appearance, justifying perhaps more than any other species the name of "Stonewort." In its characteristic forms it can be readily distinguished by the conspicuously large gibbous bract-cells.

The young shoots have a curious salmon-pink tinge when fresh, as figured (though the colour is somewhat exaggerated) in 'Flora Danica,' t. 1941. Withering refers to the colour, but can scarcely have seen the plant from these islands.

The great prominence of the primary cortical series gives the

stem a strongly ribbed appearance, and renders the spiral torsion very conspicuous. The presence of an ascending cortex to the lowest branchlet segment is apparently peculiar to this species.

The upper segments of the branchlets, especially in the Lough Ennel plant, are often much enlarged and extremely turgid. Sometimes only the lowest segment is corticate when the plant looks curiously unlike any other European species.

C. tomentosa does not fruit freely and, although both sexes occur in Ireland, we have not found ripe oogonia, hence the description of the oospore has had to be drawn up from Continental specimens.

A slender form from a dyke off Lough Owel (Groves, 'Char. Brit. Exs.' No. 41) has small bract- and spine-cells. A very extreme form, f. *heteromalla* Braun, from Pomerania has the spine-cells much reduced, and the bract-cells narrow, the anterior only being developed. Braun states that the stipulodes are sometimes in three rows, and Dr. Migula figures a node with a triple circle. Herr Adolf Witt has written an account of the vegetative histology of this species.*

Braun, Migula and others have employed Wallroth's name, *C. ceratophylla*, published in 1815, although antedated by *C. tomentosa* Linn. (1753) and *C. latifolia* Willd. (1809). Hudson and some other early authors applied the name *C. tomentosa* to forms of *C. hispida*, misled probably by the synonyms quoted by Linnæus. As regards the identity of Linnæus's own plant, there can be no doubt. The character "*aculeis caulinis ovatis*" would hardly be applied to any other than the present species, and the identification is confirmed by the specimen in the Linnean herbarium. The two synonyms which Linnæus quotes respectively from Morison and Plukenet are ambiguous, and in neither case does the author's figure suggest the present plant. In Wallroth's otherwise admirable plate the plant is represented as monœcious.

B. Monœciæ.

7. *Chara contraria* Kützing.

(PLATE XXXIII.)

Chara fœtida var. *moniliformis* BRAUN in Ann. sc. Nat. ser. 2, I, p. 355 (1834); in Flora, XVIII, i, p. 63 (1835).

* 'Beiträge zur Kenntnis von *Chara ceratophylla* Wallr. and *C. crinita* Wallr.,' Leipzig, 1906.

- C. fastida* var. *hispidula* COSSON & GERMAIN Atl. Flor. Paris, t. 37, f. 5 (1845).
- C. contraria* KÜTZING Phyc. Germ. p. 258 (1845); Sp. Alg. p. 523 (1849); Tab. Phyc. t. 61 (1857).
 RABENHORST Deutsch. Krypt. Fl. II, ii, p. 199 (1847).
 BRAUN in N. Denks. Schweiz. Ges. Naturw. X, p. 15 (1849); in Monatsb. Akad. Wiss. Berlin for 1867, p. 905 (1868); in Cohn, Krypt. Fl. Schles. I, p. 405 (1876).
 WALLMAN Försök syst. Charac. p. 76 (1853); Transl. p. 64 (1856).
 WAHLSTEDT Bidr. Skand. Charac. p. 15 (1862); Mon. Sver. & Norg. Charac. p. 31 (1875).
 NORDSTEDT in Bot. Notiser, 1863, p. 46.
 CRÉPIN in Bull. Bot. Soc. Belg. II, p. 126 (1863).
 LEONHARDI in Verh. Naturf. Ver. Brunn, II, p. 201 (1864).
 GROVES in Journ. Bot. XIX, p. 354, t. 224, 2 (1881).
 MÜLLER in Bull. Soc. Genève II, p. 64, 1881.
 BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 141 (1882).
 SYDOW Europ. Charac. p. 57 (1882).
 MIGULA Die Characeen, p. 432, f. 99–104 (1892–3); Krypt. Fl. Deutsch. II, ii, p. 296, t. 69 B (1907); Syn. Charac. Europ. p. 96, f. 84–9 (1898).
 HOLTZ in Krypt. Mark-Brandenb. IV, i, p. 97 (1903).
 PRÓSPER Carofit. Españ. p. 116, f. 21 (1910).
 HY in Bull. Soc. Bot. France, LX, mém. 26, p. 33 (1913).
 SLUITER in Bot. Zeit. LXVIII, p. 125, t. IV, f. 1–5, text-figs. 1–9 (1910).
- C. fastida* var. *contraria* COSSON & GERMAIN Atl. Fl. Par. ed. 2, t. 41, f. 8 (1882).
 BOSWELL Engl. Bot. ed. 3, XII, p. 204, t. 1915 (1885).

EXSICCATA:—Areschoug 146, 299; Braun, Rabenh. & Stiz. 37, 38, 84, 88, 120; Erbar. Critt. Ital. 552; Fries XVI, 94; Groves 37–9; Nielssen 34, 35, 55 (*vide* Wahlst.); Nordstedt & Wahlst. 67–75; Rabenhorst, 150, 499; Gr. & B.-W. 32.

Monœcious. *Stem* of varying diameter; *internodes* usually 2–4 times the length of the branchlets. *Cortex* regularly diplostichous, the primary series more prominent than the secondary; *spine-cells* solitary, obtuse, usually short and inconspicuous, deciduous. *Whorls* of 6–8 branchlets. *Stipulodes* of both series usually developed, often of unequal size, blunt, sometimes small and almost spherical. *Branchlets* incurved or spreading, of usually 5–7 segments, 2–3 ecorticate. *Bract-cells* normally 5, acute or obtuse, varying in length, the anterior pair often equalling or exceeding the fruit, the second pair and the posterior bract-cell sometimes developed, often rudimentary; *bracteoles* exceeding the

anterior bract-cells. *Oogonia* and *antheridia* solitary, produced at the lowest 2–4 branchlet-nodes. *Oogonium*, c. 650–975 μ long (excl. cor.), c. 500–575 μ broad; *spiral-cells* showing 13–15 convolutions; *coronula* 125–190 μ high, 260–360 μ broad, spreading. *Oospore* ellipsoid to cylindrical-ellipsoid, c. 525–725 μ long, 375–425 μ broad, black, showing about 11–14 fine ridges; prolonged downwards into a cage; *outer membrane* thin, semi-rigid, translucent, yellow-brown or cold-brown, granulated, with granules varying in size and prominence. *Antheridium* c. 300–450 μ in diameter.

HABITAT.—In lakes, ponds, canals, peat-pits, etc., widely distributed, but not common except in Ireland.

DISTRIBUTION.—*England*: Devon, S. & N., Dorset, Surrey, Berks, Oxon, Suffolk, E. & W., Norfolk, E. & W., Cambs, Beds, Hunts, Northants, Warwicks, Salop, Leicestersh., Cheshire, Lancs, S. & W., Yorks, M.-W., Westmorland.

Wales: Glamorgan, Anglesea.

Scotland: Haddington, Fife, Forfar, Ebudes, S.M. & N., Caithness, Orkney, Shetland.

Ireland: Kerry, S., Tipperary, N., Carlow, Queen's Co., Galway, S.E., W. & N.E., King's Co., Kildare, Dublin, Meath, Westmeath, Longford, Roscommon, Mayo, E. & W., Sligo, Leitrim, Cavan, Monaghan, Donegal, E. & W., Armagh, Down, Londonderry.

First record: 'Journ. Bot.,' 1881.

Outside the British Isles *C. contraria* occurs in Norway, Sweden, Denmark, Belgium, Holland, Spain, France, Germany, Switzerland, Austria-Hungary, Italy, and Russia, also in Asia, N. Africa, N. & S. Africa and Australia. ⁷

Usually a rather small to medium-sized plant, and much incrusted, varying considerably in habit. In its more ordinary forms it resembles the much commoner species, *C. vulgaris*, from which it is to be distinguished by the greater relative size and prominence of the primary cortical-cells. This difference

between the primary and secondary series is usually well marked, but is occasionally inconsiderable, when it is necessary to examine the stem in transverse section. *C. contraria* is usually more slender and rigid, and there is a certain neatness in its aspect which to the practised eye serves to distinguish it in the field from the somewhat more loosely-built and rougher *C. vulgaris*. The stipulodes are less regular than in that species.

An account of the anatomy of *C. contraria* by Mdlle. Cath^a. Sluiter, with numerous illustrations, will be found in 'Bot. Zeit.' LXVIII, p. 125 (1910).

We have seen no root bulbils in this species.

The variation, though less extensive, is much on the same lines as with *C. vulgaris*, an analysis of which will be found under that species. Among the British forms, it may be roughly summarized as follows :—

The stature ranges from a small tufted form 3-4 inches high, with short internodes, to a much-drawn-out form several feet in length with very long internodes; the diameter of the stem from c. 400 μ to c. 1100 μ ; the stipulodes from minute and papilliform, to both series well developed cylindrical; the primary cortical-cells from nearly the same size as, to twice the diameter of, the secondary; the spine-cells from papilliform to cylindrical; the branchlets from short, stout and strongly-incurved to long, slender and flexuous; the branchlet-segments from almost all cörticate and diminishing gradually in length and thickness to having the three or four segments below the apex ecörticate, swollen and elongated; the anterior bract-cells from shorter than, to 2-3 times the length of, the fruit; the oospore from broadly-ellipsoid to cylindric-ellipsoid. While the more robust states resemble in facies forms of *C. vulgaris*, the most slender are almost like the extended form of *C. aspera*. A much elongated sterile form collected by G. R. B.-W. in Wicken Fen resembles *C. jubata* in having very long internodes, about 4 times the length of the much reduced branchlets. A curious little form, with short very stout and strongly-incurved branchlets, occurs in the central Irish lakes.

This species was first discriminated and named by Braun, but, as in many other cases, Kützing must be cited as the authority, having first published a description of it, though a very inadequate one.

Var. b. **hispidula**.

BRAUN in N. Denks. Schweiz. Ges. Naturw. X, p. 16 (1849).

(FIG. 9.)

EXSICCATA:—BRAUN, Rabenh. & Stiz. 89, 90; Migula, Sydow & Wahlst. 15, 61, 90; Nordstedt & Wahlst. 76, 77.

Stem and *branchlets* rather stout. *Spine-cells* well developed, once to twice as long as the diameter of the stem, spreading. *Stipulodes* and *bract-cells* long.

We have seen specimens of this variety from—

England : Berks, Cheshire, Lancs, S.

Scotland : Fife, E., Orkney.

Ireland : Queen's Co., Galway, W., Westmeath, Mayo, E., Donegal.

This variety exhibits a marked contrast to the slender neat form, at the other end of the series, with very inconspicuous spine-cells, but intermediate states occur.

8. **Chara denudata** Braun.

(PLATE XXXIV.)

Chara denudata BRAUN in N. Denks. Schweiz. Ges. Nat. X, p. 5 (1849).

GROVES in Journ. Bot. XXXIII, p. 290, t. 350 (1895).

C. dissoluta LEONHARDI in Verh. Naturf. Ver. Brunn, II, pp. 161, 182 (1864).

BRAUN in Monatsb. Berl. Akad. for 1867, p. 903 (1868).

SYDOW Europ. Charac. p. 55 (1882).

MIGULA Die Characeen, p. 378, f. 91 (1891); Syn. Charac. Europ. p. 86, f. 76 (1898).

SLUITER in Bot. Zeit. LXVIII, p. 125, t. 4 (part) -7, and text-figs. 10-14, (1910).

C. contraria subsp. *dissoluta* BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 145, t. 7, f. 224 (1882).

C. contraria var. *denudata* GROVES in BABINGTON Man. Brit. Bot. ed. 9, p. 541 (1904).

Monœcious. *Stem* rather slender, weak. *Cortex* rudimentary, consisting of single cells only, but little longer than the stipulodes, or partially developed and very imperfectly diplostichous; *spine-cells*, when present, solitary, short, spreading, or papilliform. *Whorls* of

6-8 branchlets. *Stipulodes* of both series short, ovoid. *Branchlets* spreading or somewhat incurved, of 4-6 segments, the lower 2-3 often long, the upper 2-3 usually short; *cortex* rudimentary, represented by a ring of cells at each fruiting node, one anterior cell often lengthening and projecting below the antheridium. *Bract-cells* normally 5, obtuse or subacute, the anterior pair much shorter than the fruit, the rest rudimentary or the second pair occasionally elongated; *bracteoles* about equalling the fruit. *Oogonia* and *antheridia* solitary or geminate, produced at the lowest 2-3 branchlet-nodes. *Oogonium* c. 1000-1100 μ long (excl. cor.), c. 550-600 μ broad; *spiral-cells* showing 13-15 convolutions; *coronula* c. 175-200 μ high, 350-400 μ broad, spreading. *Oospore* varying considerably in shape and size, obovoid, ellipsoid or cylindrical, c. 675-825 μ long, 400-450 μ broad, reddish-brown to nearly black, showing 12-14 fine well-marked ridges terminating in basal claws; *outer membrane* thick, semi-rigid, translucent, red-brown, very finely granulated. *Antheridium* 400-425 μ in diameter.

HABITAT and DISTRIBUTION.—*Ireland*: In Brittas Lough, a small deep lake near Mullingar, Westmeath, occurring in about 12 feet of water. Discovered by the late Mr. H. C. Levinge in 1892. Not at present known from any other locality in the British Isles, but should be looked for in other deep lakes.

First record: 'Journ. Bot.,' 1895.

Outside the British Isles *C. denudata* is recorded from Switzerland, Lac de Neuchâtel in 60 feet of water, and Italy, Lago di Mantua, as well as from Cape Colony, Strombergen, at an elevation of 5000-6000 ft. (Drège).

A medium-sized weak drawn-out straggling grey-green plant with rather slender stem and branchlets, the habit being no doubt due mainly to the conditions of growth, considerably incrustated. Evidently closely related to *C. contraria*, of which it should probably be regarded as a subspecies, or possibly only a series of degraded states. It is distinguished principally by the

rudimentary cortical system, but there is every modification of this, and *C. contraria* has forms with rudimentary cortex to the branchlets.

The descriptions and illustration here given are taken from the Irish plant, which appears to be more extreme than those from the two localities on the Continent, from which it differs in several minor points.

The Swiss plant has a cortex to the stem, but with the primary cells only developed, and has sometimes one or two corticate segments to the branchlets. The type of the species collected by Drège in Cape Colony was originally described as entirely without cortex, but was subsequently found by Braun to have a rudimentary cortical system, in consequence of which he tells us ('Charac. Afr.' p. 904) that he withdrew the earlier name *C. denudata* in favour of that of *C. dissoluta*. Although the description accompanying the publication of the former is very meagre, we prefer to retain it.

In the admirable memoir, 'Beiträge zur Kenntniss von *Chara contraria* A. Braun und *Chara dissoluta* A. Braun,' by Cath^a. P. Sluiter ('Bot. Zeit,' LXVIII, p. 125), a very careful and detailed account is given of the Swiss form of *C. denudata* with a number of excellent illustrations.

[**C. filiformis** Hertzsch (*C. jubata* Braun), very nearly allied to *C. contraria*, of which it should perhaps be regarded as a subspecies, variety, or possibly even only as a remarkable state due to unusual conditions of growth, is found in deep water in lakes in several parts of Europe. The internodes of the stem are extremely long, while the branchlets are much abbreviated and consist of only about four segments. Many species occasionally produce moniliform states, the internodes lengthened and the branchlets reduced.]

[**C. papillosa** Kütz. (*C. intermedia* Braun), a larger plant with thicker stem and with the posterior bract-cells developed, bears much the same relation in this section to *C. hispida* among the *Aulacanthæ*, which it much resembles, that *C. contraria* bears to *C. vulgaris*. It is widely distributed on the continent, and may well occur in this country, though we have not hitherto seen a specimen which could be satisfactorily referred to it.

The plant from Norfolk figured by H. & J. G. in 'Journ. Bot.' XXIV, t. 263, 1886, as *C. papillosa* was subsequently regarded as a hybrid between *C. contraria* and *C. hispida*, see Groves Exsicc. 42 and Gr. & B.-W. 33.]

8 a. **Chara muscosa** Groves & Bullock-Webster.

Journ. Bot. LXII, p. 33, t. 570 (1924). Exsicc. Gr. & B.-W. 13, 34.

(PLATE XXXV.)

Monœcious. *Stem* very short (c. 5–7 cm.), about 250–375 μ in diameter, much branched; *internodes* not much exceeding the branchlets. *Cortex* regular, the primary series very much more prominent than the secondary, extremities of secondary cells meeting squarely; *spine-cells* normally solitary spreading elongated, sometimes twice as long as the diameter of the stem, usually tapering from a somewhat broad base, obtuse to subacute. *Whorls* of 6–7 branchlets. *Stipulodes* of both series well developed unequal, sometimes as long as the lowest branchlet-node, similar in shape to the spine-cells. *Branchlets* incurved, of 4–5 short segments, the ultimate segment very short, often exceeded by the uppermost bract-cells. *Bract-cells* normally 5, usually all developed, very variable in length, the anterior shorter than the fruit, obtuse to subacute; *bracteoles* long, slender, much exceeding the bract-cells. *Oogonia* and *antheridia* solitary, produced at the first and second branchlet-nodes. *Oogonium* c. 700–800 μ long (excl. cor.), 450–500 μ broad; *spiral-cells* showing about 14–17 convolutions; *coronula* very large, c. 175–200 μ high, \rightarrow 450 μ broad, the cells spreading from their base. *Oospore* ellipsoid or ellipsoid-obovoid, c. 615–665 μ long, 340–400 μ broad, black, showing 13–16 fine low ridges, terminating in inconspicuous claws; *outer membrane* brittle, semi-opaque dark brown. *Antheridium* c. 425 μ in diameter.

HABITAT and DISTRIBUTION.—*Ireland*: Sandy soil in

about 2–3 feet of water on the eastern shore of Lough Mullaghderg, West Donegal, where it was discovered in July, 1917, by G. R. B.-W.

A low-growing tufted plant, moss-like in appearance, soft to the touch, usually unincrusted and dark green. The primary cortical-cells are often so large as almost to obscure the secondary series. In point of definite characters it comes nearest to *C. contraria* and *C. baltica*. From the former it differs in habit and colour and in the uniformly short internodes, recalling in appearance the tufted form of *C. canescens*, also in the greater development, shape and persistence of the spine-cells, the more strongly developed stipulodes, the smaller number of branchlet-segments, and the remarkably large coronula, the cells of which spread widely from their base. From *C. baltica* it differs in habit in the much weaker and more slender stem, the very large primary cortical-cells, the shape of the spine-cells, the less regular stipulodes, the weaker, more slender and less numerous branchlets with fewer segments, the more wide-spreading coronula and the smaller antheridia. The distinctive characteristics have been maintained during several years of cultivation. It is smaller than the usual forms of any other British *Chara*.

9. *Chara baltica* Bruzelius.

(PLATE XXXVI.)

C. hispida var. *baltica* HARTMAN Skand. Fl. p. 376 (1820).

WAHLENBERG Flora Suecica, II, p. 693 (1826).

N. E. BROWN in Engl. Bot. ed. 3, XII, p. 207, t. 1917 (1885).

C. baltica BRUZELIUS Obs. Char. pp. 11, 19 (1824).

AGARDH Syst. Alg. p. 127 (1824).

BRAUN in Ann. sc. Nat. ser. 2, I p. 354 (1834); Consp. Charac. Europ. p. 6 (1867).

HORNEMAN in Flora Danica, t. 2311 (1840).

KÜTZING Phyc. Germ. p. 259 (1845); Sp. Alg. p. 524 (1849); Tab. Phyc. VII, t. 63, f. 2 (1857).

WALLMAN Försök syst. Charac. p. 85 (1853); Transl. p. 71 (1856).

WAHLSTEDT Bidr. Skand. Charac. p. 16 (1862); Mon. Sver. and Norg. Charac. p. 34 (1875).

NORDSTEDT in Bot. Notiser 1863, p. 49.

BABINGTON Man. Brit. Bot. ed. VII, p. 472 (1881).

BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 156, t. 7, f. 232 (1882).

SYDOW Europ. Charac. p. 64 (1882).

MIGULA Die Characeen, p. 515, f. 114–17 (1894); Krypt.-Fl. Deutsch. II, ii, p. 310, t. 72 (1907); Syn. Charac. Europ. p. 114, f. 99–102 (1898).

- GIESENHAGEN Untersuch. ü. d. Characeen, I, f. 12-17 (bulbils) (1902).
 Hy in Bull. Soc. Bot. France, LX, mém. 126, p. 35 (1913).
C. firma AGARDH Syst. Alg. introd. p. 28 (1824).
 KÜTZING Tab. Phyc. VII, t. 64, f. 1 (1857).
C. Nolteana BRAUN in Ann. sc. Nat. ser. 2, I, p. 354 (1834); in Flora,
 XVIII, i, p. 62 (1835).
 KÜTZING Tab. Phyc. VII, t. 64, f. 2 (1857).
C. Liljebladii WALLMAN Försök syst. Charac. p. 86 (1856). Transl.
 p. 72 (1856).

EXSICCATA :—Areschoug 44, 145, 244, 400; Braun, Rabenh. & Stiz.
 44, 96, 114; Fries IX, 100; Migula, Syd. & Wahlst. 137-40; Nielssen
 37-40, 54-6 (*vide* Wahlstedt); Nordstedt & Wahlst. 35, 35 *b, c, d*, 36-40,
 103-5; Rabenhorst 260; Gr. & B.-W. 14, 15.

Monœcious. *Stem* rather stout, *internodes* usually $1\frac{1}{2}$ -twice the length of the branchlets, lower nodes often much thickened; *roots* often producing compound bulbils. *Cortex* regularly diplostichous, the primary series slightly larger than the secondary, the secondary cells usually joining squarely. *Spine-cells* normally solitary, occasionally geminate, usually shorter than the diameter of the stem, rather stout, acuminate. *Whorls* of 8-10 branchlets. *Stipulodes* of both series well developed, about equal, usually long, tapering to a rather obtuse tip. *Branchlets* usually rather stout and incurved, of 6-8 segments, of which the upper 2-3 are usually ecorticate, the ultimate cell usually long, narrow acuminate. *Bract-cells* 5-7, all developed, variable in length, none exceeding the fruit; *bracteoles* longer. *Oogonium* c. 1000 μ long (excl. cor.), 650 μ broad; *spiral-cells* showing 14-15 convolutions; *coronula* c. 200 μ high, 350-400 μ broad, usually spreading. *Oospore* c. 700 μ long, 500 μ broad, black, showing 13-14 strong ridges, prolonged downwards into a cage; *outer membrane* thick, semi-rigid, translucent, red-brown or chestnut-brown, faintly and very finely granulated. *Antheridium* c. 500-600 μ in diameter.

HABITAT.—Lakes near the sea.

DISTRIBUTION.—*England*: Dorset, Little Sea, Studland (*J. C. Mansel-Pleydell*).

Scotland: Orkney, Loch Stenness, Mainland (*F. C. Crawford*).

First record (var. *affinis*): Babington, 'Manual,' 1881.

Outside the British Isles *C. baltica* occurs in Sweden, Finland, Denmark, France and Northern Germany, also in North America (Greenland) and South America (Bolivia).

A medium-sized to rather large plant, usually of a clear dark green, owing to the absence of incrustation, fruiting rather sparsely. It occurs usually in more or less brackish water, but grows actually in sea water in the Baltic. The Orkney plant, which is variable in form, attains a height of about 1 metre. It closely resembles the Scandinavian plant. That from Little Sea is less typical, having a number of geminate spine-cells. We have not seen sufficient material from this locality to feel quite satisfied as to its identity, but do not think it can belong to any other species. A remarkably attenuated form (var. *Liljebladii* Wahlst.) with much elongated branchlets, spine-cells and bract-cells has been found in S. Norway. The large composite bulbils of *C. baltica* are distinctive in character, see Vol. I, fig. 13, p. 39. Fries is often quoted as the authority for the specific name, but his publication of it in 1823 was not a valid one.

Var. b. *affinis*.

H. & J. GROVES in Journ. Bot. XIX, p. 353, t. 244 (1881); Exsicc. No. 36.

(PLATE XXXVII, FIGS. 1—5.)

Cortex with the primary and secondary cortical-cells of nearly equal diameter. *Spine-cells* often 2 or 3 together, slender, in length exceeding the diameter of the stem, less spreading than in the type.

Cornwall, W., small pools and stream close to Kynance Cove (*J. Cunnack*, 1876).

Guernsey, Grande Mare (*E. D. Marquand*, 1889).

A weaker more flexuous plant than the type. In the Cornish specimens the spine-cells are frequently clustered, in those from Guernsey they are almost always solitary.

Var. *c. rigida*.

GROVES & BULLOCK-WEBSTER, Journ. Bot. LXII, p. 34 (1924.)
Exsicc. Nos. 16 & 35.

(PLATE XXXVII, FIGS. 6-10.)

Stem rigid, brittle, *internodes* 2-3 times the length of the branchlets; *bulbils* numerous. *Cortex* regular, the primary and secondary series often nearly equal; *spine-cells* solitary, conspicuously patent. *Branchlets* rigid, nearly straight.

Norfolk, E., Hickling Broad (*G. R. B.-W.*, 1898).

The remarkably firm, rigid habit, comparatively long internodes and patent spine-cells give a very distinctive appearance to this variety. The mature fruit is extremely rare. The multicellular bulbils resemble those of the type. It occurred in considerable abundance in the northern area of the Broad for a number of years, but was not observed when we last visited the locality.

10. *Chara aculeolata* Kützing.

(PLATE XXXVIII.)

Hippuris muscosis sub aqua repens in Hibernia PLUKENET, *Phytographia*, III, t. 193, f. 6 (1692).

Chara aculeolata KÜTZING in Reichenbach, *Fl. Germ. Excurs.* p. 843 (1832); *Phyc. Gen.* p. 320 (1843); *Phyc. Germ.* p. 258 (1845); *Sp. Alg.* p. 524 (1849); *Tab. Phyc.* VII, t. 67, f. 2 (1857).

C. pedunculata KÜTZING in *Flora* XVII, i, p. 706 (1834).

C. hispida var. *pseudo-crinita* BRAUN, *Ann. sc. Nat. ser. 2*, I, p. 355 (1834); in *Flora*, XVIII, i, p. 67 (1835).

COSSON & GERMAIN, *Atl. Fl. par.* t. 38, f. B3 (1845); ed. 2, t. 42, f. B3 (1882).

WALLMAN Försök syst. *Charac.* p. 83 (1853); *Transl.* p. 69 (1856).

BOSWELL, *Engl. Bot.* ed. 3, XII, p. 208, t. 1918 (1885).

C. spondylophylla KÜTZING *Phyc. Gen.* p. 320 (1843); *Phyc. Germ.* p. 259 (1845); *Sp. Alg.* p. 525 (1849); *Tab. Phyc.* VII, t. 68, f. 2. misprinted *spondylophora* on plate (1857).

C. hispida var. *aculeolata* RABENHORST, *Deutsch. Krypt. Fl.* p. 198 (1847).

C. hispida var. *dasyacantha* BRAUN in *N. Denks. Schweiz. Ges. Naturw.* X, p. 18 (1849).

C. polyacantha BRAUN in Braun, *Rab. & Stiz. Charac. Exsicc.* No. 48 (1859).

NORDSTEDT in Bot. Notiser 1863, p. 48.

LEONHARDI in Verh. Naturf. Ver. Brunn, II, p. 199 (1864).

LANGÉ in Flora Danica, t. 2746 (1867).

WAHLSTEDT Sver. & Norg. Charac. p. 34 (1875).

H. & J. GROVES in Journ. Bot. XVIII, p. 131, t. 208, f. 6 (1880).

MÜLLER in Bull. Soc. Bot. Genève, II, p. 63 (1881).

BRAUN & NORDSTEDT Fragm. Monog. Charac. p. 150 (1882).

SYDOW Europ. Charac. p. 61 (1882).

MIGULA Die Characeen, p. 476, f. 108-9 (1893); Krypt.-Fl. Deutsch.

II, ii, p. 303, t. 70 (1907); Syn. Charac. Europ. p. 105, f. 93, 94 (1898).

HOLTZ Charac. in Krypt. Mark.-Brandenb. IV, i, p. 101, text-fig. (1903).

HY in Bull. Soc. Bot. France, LX, mém. 26, p. 36 (1913).

C. hispida var. *polyacantha* BABINGTON Man. Brit. Bot. ed. 7, p. 461 (1874).

EXSICCATA :—Areschoug 141; Braun, Rabenh. & Stiz. 48, 72, 97, 119; Desmazières II, 335, Fries XIV, 100; Groves 10, 11; Nielssen 41, 42, 57; Nordstedt & Wahlst., 78, 79, 80 a, 80 b; Rabenhorst 48; Reichenbach 426; Migula, Sydow and Wahlst. 134-6.

Monœcious. *Stem* stout, usually with rather long internodes. *Cortex* irregularly diplostichous, the primary cells larger and more prominent than the secondary, secondary cells often much overlapping; *spine-cells* strongly developed, usually in fascicles of 3-4, spreading, long, slender, usually acuminate, persistent. *Whorls* of 8-10 branchlets. *Stipulodes* of both series well developed, long, slender, acuminate, often curved. *Branchlets* straight or incurved, usually of 5-7 corticate and 1-2 ecorticate segments. *Bract-cells* normally 5, all well developed long and slender, anterior pair longer than the fruit; *bracteoles* often double as long as the fruit, all acuminate. *Oogonia* and *antheridia* usually solitary, produced at the lowest 3-4 branchlet-nodes, occasionally long-stalked. *Oogonium* c. 850-1100 μ long (excl. cor.), 575-675 μ broad; *spiral-cells* showing 12-15 convolutions; *coronula* c. 150 μ high, 300 μ broad. *Oospore* nearly ellipsoid tapering slightly below, 650-800 μ long, 325-475 μ broad, dark brown to almost black, showing 11-14 low ridges, prolonged downwards into a cage; *outer membrane* thick, semi-rigid, translucent, dull brown, finely granulated with granules of varying prominence. *Antheridium* c. 500 μ in diameter.

HABITAT.—Lakes, pools, pits and ditches in peaty districts.

DISTRIBUTION.—*England*: Rare, occurring in a few scattered areas. Somerset, N., Suffolk, E. & W., Norfolk, E. & W., Cambs, Lincs, N., Lancs, W., Yorks, S.E. & N.E., Westmorland, Cumberland.

Wales: Anglesea.

Scotland: South and South-east, Kirkcudbright, Wigtou, Selkirk, Roxburgh, Fife.

Ireland: Widely distributed, especially in the centre. Kerry, N., Cork, E., Tipperary, S., Limerick, Tipperary, N., Kilkenny, Carlow, Queen's County, Galway, S.E., W., N.E., King's County, Kildare, Wicklow, Dublin, Meath, Westmeath, Roscommon, Mayo, E. & W., Sligo, Monaghan, Armagh, Down.

First record: Plukenet, 1692.

Outside the British Isles *C. aculeolata* occurs in Sweden, Denmark, Germany, Switzerland, Hungary, France and Italy.

A medium-sized or large plant (about 20–30 cm. in height), with stout firm stem and rather short branchlets, so that the internodes become relatively long, in the lower part of the stem sometimes as much as four times the length of the branchlets. The branchlets are usually straightish, but sometimes considerably incurved.

The spine-cells are usually more strongly developed than in most other species. Dr. A. W. Hill has shown that extra cells are produced at some of the nodes of the cortex, between the node-cell and the spine-cells (see Vol. I, p. 35, f. 10). The spine-cells are long and slender and acute, and occur usually in groups of 3–4, but in weak forms some are solitary. Occasionally adventitious bract-cells are produced below the normal ones.

C. aculeolata is usually much incrustated, when the plant has a remarkably rigid habit. Superficially it resembles some forms of *C. hispida*, but the much larger primary cortical-cells and the secondary cortical-cells joining obliquely and overlapping one another, so that the cortex is partially triplostichous, serve readily to distinguish it. It is also stricter in habit, the branchlets are shorter and it is more spinous, and the spine-cells are much less deciduous.

The foot-stalk of the antheridium is occasionally elongated, whence Kützing's name of *C. pedunculata*. In a specimen collected by G. R. B.-W., at Garboldisham, Suffolk, the foot-stalks of some of the oogonia have grown out considerably, being in some instances 2-3 times the length of the oogonia.

Very reluctantly we have replaced the well-known name of *C. polyacantha* by that of *C. aculeolata*, as the former cannot under the "Rules" be retained, three earlier names having been published. Braun referred *C. aculeolata* Kütz. to *C. intermedia* (*C. papillosa* Kütz.), and this determination has been followed by Sydow and Migula. The plant from Tennstädt in Thuringia, however, on which Kützing's species was founded, which was issued in Reichenbach's *Exsiccata* (No. 426), and which is well figured in Kützing's excellent plate in 'Tab. Phyc.' belongs, we consider, to the present species, but is a weak sterile form. The second name in priority, *C. pedunculata*, Braun was in no doubt in referring here, while the third, *C. spondylophylla*, was merely a name substituted by its author for that of *C. pedunculata*, when he found that the stalked antheridium was not the normal state.

C. aculeolata is characteristically a plant of peaty places, and, as might be expected, is much more prevalent in Ireland than in Great Britain. It was first found by Sherard in Ireland, and was described and figured by Plukenet in 1692, from his specimens. Braun says of it ('Consp. Charac. Europ.' p. 6): "amat loca salsa."

Most of the British localities are inland.

[**C. strigosa** Braun, a rather small neat plant with sub-triplostichous cortex, long slender persistent spine-cells, some solitary, some clustered, and rather smaller fruits than those of *C. aculeolata*, is recorded from Sweden, Southern Germany, Switzerland, and Austria. (Braun, Rabenh. & Stiz., *Exsicc.*, Nos. 42 and 43. Migula, 'Die Characeen,' p. 468, ff. 105-7.)]

Subsection 3. *Triplostichæ*. Rows of cortical-cells of the stem treble the number of the branchlets, two rows of secondary cells being produced to each primary row.

A. Diceciæ.

11. *Chara aspera* Willdenow.

(PLATE XXXIX.)

- C. hispida* LINN. Sp. Plant. p. 1156 (1753) *pro parte*.
 WAHLENBERG Fl. Suecica, II, p. 692 (1826), excl. vars.
 HORNEMANN in Fl. Dan. t. 1940 (1829).
 RUPRECHT Symb. Hist. Pl. Ross, p. 85 (1845).
 NORDSTEDT in Bot. Notiser p. 44 (1863).
- C. aspera* WILLDENOW in Mag. naturf. Freunde Berl. III, p. 298 (1809).
 WALLROTH Annus Botanicus, p. 185, t. VI, f. 3 (1815).
 BRUZEL Obs. Charac. p. 12, 22 (1824).
 AGARDH Syst. Alg. p. 130 (1824).
 GREVILLE Scott. Crypt. Flor. VI, No. 339 (1828).
 REICHENBACH Fl. Germ. Exc. p. 149 (1830).
 WILSON Engl. Bot. Suppl. 2738 (1834).
 BRAUN in Ann. sc. Nat. ser. 2, I, p. 356, *pro parte* (1834); in Flora, XVIII, i, p. 71, excl. var. (1835); Schweiz. Charac. p. 20 (1849), Consp. Charac. Eur. p. 6 (1867); in Monatsb. Akad. Berl. for 1867, p. 923 (1868); in Cohn, Krypt. Schles. p. 408 (1876).
 KÜTZING (*pro parte*) Phyc. Germ. p. 257 (1845); Sp. Alg. p. 521 (1849); Tab. Phyc. VII, t. 51, f. ii, t. 52, f. i, ii (1857).
 COSS. & GERM. Atl. Flor. Par. t. 38, f. D (1845); ed. 2, t. 42, f. D (1882).
 RABENHORST Deutsch. Krypt. Fl. II, ii, p. 199 (1847); Krypt. Fl. Sachs. I, p. 289 (1863).
 GANTERER Österr. Char. p. 15 (1847).
 BABBINGTON in Ann. Nat. Hist. ser. 2, V, p. 90 (1850); Man. Brit. Bot. ed. 3, p. 423 (1851).
 WALLMAN Försök. syst. Charac. p. 94 (1853); Transl. p. 78 (1856).
 LEONHARDI in Verh. naturf. Ver. Brünn II, p. 204 (1864).
 WAHLSTEDT Mon. Sver. & Norg. Charac. p. 35 (1875).
 GROVES in Journ. Bot. XVIII, p. 129, t. 207, f. 4 (1880).
 MULLER in Bull. Soc. Bot. Genève II, p. 87 (1881).
 SYDOW Europ. Charac. p. 85 (1882).
 BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 174 (1882).
 BOSWELL Engl. Bot. ed. 3, XII, p. 210, t. 1919 (1885).
 MIGULA Die Characeen, p. 653, f. 134-5 (1896); Krypt. Fl. Deutsch. II, ii, p. 339, t. 76 (1907); Syn. Charac. Europ. p. 140, f. 119-20 (1898).
 GIESENHAGEN Untersuch. Charac. I, p. 4, f. 1-10 (1902).
 PRÓSPER Carofit. de Españ. p. 149, f. 25 A (1910).
 HY in Bull. Soc. Bot. France, LX, Mém. 26, p. 38 (1913).
- C. delicatula* and *C. intertexta* DESV. in LOISEL. Notice aj. Fl. France, p. 137, 138 (1810), *vide* Braun.
- C. fallax* AGARDH Syst. Alg. pp. xxviii (1824), *vide* Braun.
- C. equisetifolia* KÜTZ in Flora, XVII, i, pp. 705-6 (1834).
- C. curta*, KÜTZ Tab. Phyc. VII, t. 53, f. 1 (1857).

EXSICCATA :—Areschoug 41, 297-8; Billot 1984; Braun, Rabenh. & Stiz. 11, 12, 50, 98-9; Desmazières II, 327-9; Fries III, 110; Groves

9, 33; Jack, Lein. & Stiz. 206; Krypt. Exsicc. 1350; Lloyd, 418-19; Migula 127-8; Migula, Syd. & Wahlst. 36, 56-8, 80-6, 145-7; Nordstedt & Wahlst. 106-7, 108a, b, c, 109 a, b, 110-11, 112a, b, 113-14; Gr. & B.-W. 17, 18.

Dioecious. *Stem* slender, with rather long *internodes*; *root-nodes* often producing solitary or clustered whitish spherical bulbils. *Cortex* usually fairly regularly triplostichous, the cells of the secondary series usually joining obliquely, the primary series larger than the secondary. *Spine-cells* normally, solitary, but occasionally geminate or even three together, spreading, long, slender, acute, often bulbous-based. *Whorls* of about 8 or 9 branchlets. *Stipulodes* of both series well developed, usually long, slender and tapering, often bulbous-based, the upper series sometimes equalling the lowest branchlet-segments the lower rather shorter. *Branchlets* usually slender and rather weak, sometimes stouter and firmer, straight or somewhat incurved, of 6-8 segments, the ultimate ecorticate and very acute. *Bract-cells* normally 5, all well developed, very variable in length, usually falling short of, but sometimes exceeding, the fruit, *bracteoles* and *bractlet* usually longer than the bract-cells. *Oogonia* and *antheridia* solitary, produced at the lowest 2-3 nodes. *Oogonium* 650-700 μ long (excl. cor.), 450-525 μ broad; *spiral-cells* showing 13-15 convolutions; *coronula* short, 75-100 μ high, c. 200 μ broad, spreading. *Oospore* 400-600 μ long, 250-375 μ broad, black, showing 12-14 ridges terminating in basal claws; *outer membrane* thick laminated, brittle, opaque, dull brown, delicately granulated. *Antheridium* 500-600 μ in diameter.

HABITAT.—Characteristically a plant of lakes and large ponds, but sometimes found in pools, canals and rivers.

DISTRIBUTION.—*England*: Cornwall, W., Devon, S., Dorset, Wight, Hants, N., Surrey, Suffolk, E., Norfolk, E. & W., Cambs, Hunts, Lincs, S. & N., Notts, Cheshire, Lancs, S. & W., Yorks, S.E., S.W., & N.W., Northumberland, Isle of Man.

Wales: Glamorgan, Cardigan, Carnarvon, Anglesea.

Scotland : Kirkcudbright, Selkirk, Roxburgh, Haddington, Fife and Kinross, Perth, W., M., & E., Forfar, Aberdeen, N., Easternness (Nairn), Argyll, Ebudes, M., Caithness, Sutherland, W., Hebrides, Orkney, Shetland.

Ireland : Kerry, S. & N., Cork, W., M. & E., Clare, Kilkenny, Wexford, Queen's Co., Galway, S.E., W. & N.E., King's Co., Kildare, Wicklow, Dublin, Meath, Westmeath, Longford, Mayo, E. & W., Sligo, Leitrim, Cavan, Fermanagh, Donegal, W., Tyrone, Armagh, Down, Antrim, Londonderry.

Channel Isles : Guernsey.

First record : Greville, 1828.

Outside the British Isles *C. aspera* occurs over most of Europe, having been found in Norway, Sweden, Finland, Russia, Denmark, Germany, Austria, Switzerland, Portugal, Spain, France, Italy and Greece ; in Central Asia (Turkestan) ; in North-West Africa (Algiers), and in North America (Newfoundland, N. United States and the Mexican Boundary). It is not known from the Southern Hemisphere.

Of small stature, not usually more than 30 cm. in height, usually slender, often much incrustated and extremely brittle. The incrustation in the more spiny forms gives the stems the appearance of being stout. In well-grown typical forms the slender habit and long tapering spine-cells give it a distinctive appearance, and when not incrustated it is an extremely beautiful plant. The spine-cells are, however, sometimes inconspicuous, when it may bear a superficial resemblance to *C. fragilis* and *C. delicatula*, and extreme forms in which the spine-cells, stipulodes and bract-cells are stout and bluntish are in the sterile state not always easy to distinguish from *C. delicatula*. Speaking generally, *C. aspera* is a more slender and weaker plant than either of the two species mentioned, the branchlets are less strongly incurved below and are often spreading at the tips. It is of a less intense green and lacks the firm hard look of those species. A form with unusually long spine-cells, stipulodes and bract-cells, var. *capillata* Braun, was collected by W. Wilson at Holyhead. We have not seen another plant quite so extreme, but very long-spined forms are not infrequent.

A marked peculiarity of *C. aspera* is the production from the lower nodes of the numerous nearly spherical whitish bulbils, which are very conspicuous when the plant is pulled up. These are usually in clusters of 2 to 6, though sometimes solitary, and attain a diameter of about 1·5 mm. The only other British species known to produce similar bulbils are the allied *C. desmantha* and *Lamprothamnium papulosum*. *C. aspera* does not fruit very freely, and no doubt relies partly on this very efficient method of reproduction. Dr. Giesenhagen (*l. c.*) has published the results of a careful investigation of its root-bulbils and proembryonic growth, with illustrations, two of which are reproduced in our Vol. I, p. 38.

Var. b. **subinermis**.

KÜTZING Sp. Alg. p. 521 (1849); GROVES, Exsicc. 32.

(PLATE XXXIX, FIG. 8.)

Spine-cells, *stipulodes* and *bract-cells* for the most part very short and obtuse. *Spine-cells* often reduced to minute papillæ.

In many of the counties enumerated for the type, especially in Scotland and Ireland.

Usually more slender and of weaker habit than the type, often having elongated spine-cells on some of the internodes. In its extreme form a distinct-looking variety, but connected by intermediates with the type.

Var. c. **lacustris**.

H. & J. GROVES in Journ. Bot. XVIII, p. 129, t. 207, f. 4A (1880).
Exsicc. Gr. & B.-W. 36.

(PLATE XXXIX, FIGS. 9–11.)

Stem very short, stout, *internodes* short, *branchlets* short, stout, strongly incurved. *Spine-cells* short, thick, obtuse.

Abundant in Lough Neagh, from whence it was originally described, and in Lough Beg. Somewhat similar forms, not so extreme, have been found in several other Irish lakes.

Growing in dense tufts, much resembling the var. *annulata* of *C. delicatula*.

12. *Chara desmacantha* Groves & Bullock-Webster.

(PLATE XL.)

Chara aspera subsp. *desmacantha* H. & J. GROVES in Journ. Bot. XXXVI, p. 410, t. 391 (1898).

C. desmacantha GROVES & BULLOCK-WEBSTER, see Vol. I, p. 94.

EXSICCATA:—Braun, Rabenh. & Stiz. 116; Groves 8, 34, 35; Migula, Sydow & Wahlst. 148; Mougeot & Nestl. 1196; Gr. & B.-W. 37, 38.

Dioecious. *Stem* moderately stout; *internodes* usually twice to three times the length of the branchlets. *Root-nodes* sometimes producing solitary or clustered whitish spherical bulbils. *Cortex* usually regularly triplostichous, the primary cortical-cells broader than the secondary, the secondary usually meeting squarely, but sometimes obliquely. *Spine-cells* well developed in groups of 2–6 (most commonly 3–4), rarely a few solitary, often of very irregular size, mostly long, slender, acuminate, bulbous-based, but in the larger clusters often with 1–2 papilliform. *Whorls* usually of 8–11 branchlets. *Stipulodes* usually long, tapering, acuminate, bulbous-based. *Branchlets* moderately stout, straightish or incurved, of usually 7–8 segments, of which the upper 1–2 are ecorticate. *Bract-cells* 5–7, usually all long and slender, *bracteoles* equalling or exceeding the bract-cells, *bractlet* usually shorter. *Oogonia* and *antheridia* solitary produced at lowest 1–3 branchlet-nodes. *Oogonium* c. 625–750 μ long (excl. cor.), c. 375–450 μ broad; *spiral-cells* showing 14–17 convolutions; *coronula* c. 125 μ high, 250 μ broad, spreading. *Oospore* c. 525 μ long, 275–325 μ broad, showing 13–16 ridges, terminating in basal claws; *outer membrane* thick-laminated, semi-rigid, semi-opaque, light brown, granulated with granules of varying prominence. *Antheridium* \rightarrow 650 μ in diameter.

HABITAT.—Lakes and large ponds.

DISTRIBUTION.—*England*: Cornw., W., Norf., E. & W., Cambs, Hunts, Lancs, S., Yorks, S.E., Westmorland.

Wales: Anglesea, Pembroke.

Scotland: Argyll, Orkney.

Ireland: Tipperary, S., Limerick, Tipperary, N., Kilkenny, Queen's Co., Galway, S.E., W. & N.E., King's Co., Kildare, Dublin, Meath, Westmeath, Longford, Roscommon, Mayo, E. & W., Sligo, Leitrim, Cavan, Monaghan, Fermanagh, Donegal, W., Down.

First record: Groves, 'Journ. Bot.,' 1898.

Outside the British Isles we have seen specimens of *C. desmacantha* from Sweden and Bavaria.

A small to medium-sized plant, not usually exceeding a foot in height, with rather stout rigid stem and branchlets. The spine-cells, stipulodes and bract-cells are usually very well developed, and the spine-cells being persistent and often in large clusters, the plant is conspicuously spiny in appearance. The spine-cells are often very long, sometimes as much as four times as long as the diameter of the stem. The bractlet is as long or almost as long as the bracteoles.

The bulbils resemble those of *Lamprothamnium papulosum* and *C. aspera*, but we have not found them as frequently produced as in these species.

C. desmacantha does not fruit freely and ripe oospores are rarely found. This is perhaps hardly to be wondered at, considering its remarkably exuberant vegetative growth. We have observed extra cells between the node-cells of the cortex and the spine-cells, similar to those in *C. aculeolata*.

It has a close superficial resemblance to *C. canescens*, for which species it has been frequently mistaken even by the most experienced collectors. An examination of the cortex will at once disclose the sectional distinction between the two. It is not so likely to be confused with the other very spiny species, *C. aculeolata*, which besides being monœcious is, except in its weakest states, larger and more robust, and has usually characteristically upward-directed branchlets. The present species is most nearly related to *C. aspera*, of which it has been regarded as a subspecies or variety, but differs in the stouter and more rigid stem and branchlets, and in the clustered persistent spine-cells. The nodes of the cortex are more numerous than is usual in *C. aspera*, there being 14-18 to an internode of the stem, counting the opposite ascending and descending rows.

The most typical forms are found in Ireland, where the plant appears to have its headquarters. These have a stout rigid stem, with moderately long straightish branchlets, often slightly

recurved at the top. Moniliform states, with elongated internodes and short incurved branchlets with rather fewer segments, have been found in several localities, the most extreme form being that from Cunswick Tarn, collected by Mr. C. H. Waddell, the branchlets of which have about five segments. A small condensed form, approaching in appearance *C. aspera* var. *lacustris*. was found by Mr. Lloyd Praeger in L. Melvin, Co. Leitrim, A form was collected by Mr. R. A. Phillips at Dromineer, Co. Tipperary, in which the secondary cortical series is only partially developed. In weak forms solitary spine-cells are more numerous.

[*C. galioides* D.C., a triplostichous (isostichous) monœcious species with a firmer and stouter stem than *C. aspera*, stouter usually strongly incurved branchlets, well-developed stout patent spine-cells and very large antheridia ($\rightarrow 1100 \mu$ diam.), is typically a plant of S. Europe and N. Africa, but is also reported from Schleswig-Holstein.]

13. *Chara connivens* Braun.

(PLATE XLI.)

- Chara connivens* BRAUN in Flora, XVIII, i, p. 73 (1835); in Monatsb. Akad. Berl. for 1867, p. 927 (1868).
 WALLMAN Försök syst. Charac. p. 99 (1853); Transl. p. 82 (1856).
 KÜTZING Sp. Alg. p. 521 (1849); Tab. Phyc. VII, t. 63, f. 1 (1857).
 BRÉBISSEAU Fl. Normand. ed. 3, p. 381 (1859).
 CHABOISSEAU in Bull. Soc. Bot. France, XVIII, p. 149, t. 1 (1871).
 GROVES in Journ. Bot. XVI, p. 120 (1878); XVIII, p. 103, t. 207, f. 3 (1880).
 LLOYD & FOUCAUD Fl. de l'Ouest Fr. Ed. 4, p. 438 (1886).
 BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 180 (1882).
 SYDOW Europ. Charac. p. 89 (1882).
 COSSON & GERMAIN Atl. Fl. Par. ed. 2, t. 43 (1882).
 MIGULA Die Characeen, p. 703, f. 142-3 (1897); Krypt. Fl. Deutsch. II, ii, p. 353, t. 77, f. 3 (1907); Syn. Charac. Europ. p. 152, f. 127-8 (1898).
 PRÓSPER Carofit. de Españ. p. 158, f. 26B (1910).
 HY in Bull. Soc. Bot. France, LX, Mém. 26, p. 41 (1913).
C. fragilis var. ? *connivens* BOSWELL Engl. Bot. ed. 3, p. 215, t. 1921 (1885).

EXSICCATA:—Groves 7; Kralik (Pl. Tunetanæ) 344 and 344 bis; Migula, Syd. & Wahlst. 23; Gr. & B.-W. 19.

Dicœcious. *Stem* slender, rather rigid. Not known to produce bulbils. *Cortex* evenly triplostichous, the

primary and secondary cortical-cells of equal diameter. *Spine-cells* quite rudimentary. *Whorls* of 6–9 branchlets. *Stipulodes* rudimentary. *Branchlets* rather rigid, strongly incurved, especially in the male plant, usually of 8–9 segments, the upper 1–2 ecorticate. *Bract-cells* normally 7, one pair only developed, short, *bracteoles* and *bractlet* elongated, but shorter than the fruit. *Oogonia* and *antheridia* solitary, usually produced at the lowest 2–3 nodes. *Oogonium* narrowly ellipsoid, c. 750 μ long (excl. cor.), 400 μ broad; *spiral-cells* showing 13–14 convolutions; *coronula* c. 200 μ long, 185 μ broad, the cells strongly connivent and tapering to the apex. *Oospore* nearly cylindrical, very truncate below, c. 500–600 μ long, 250–300 μ broad, very dark brown to black, showing 12–13 faint ridges, terminating in inconspicuous basal claws; *outer membrane* thick laminated, semi-rigid, opaque, dark red-brown, granulated, with clearly-defined, very numerous but non-contiguous granules. *Antheridium* large, c. 600–700 μ in diameter.

HABITAT.—In pools, lagoons, etc., near the sea, in a few scattered localities, and by no means plentiful.

DISTRIBUTION.—*England*: Devon, S., Slapton Ley, W. Curnow and W. B. Waterfall, 1878. Still there in 1916.

Hants, S. In fresh-water ditches at Stokes Bay, Gosport, W. S. Bayton, 1828, Herb. Borrer.

Suffolk, E., Benacre Broad, G. R. B.-W., 1897.

Norfolk, E., Heigham Sound, J. E. Bidgood, 1889; Hickling Broad, G. R. B.-W., 1901, Martham Broad, C. E. Salmon and J. W. White, 1915.

Ireland: Wexford, lagoon, north of Wexford Harbour, E. S. Marshall, 1896.

Galway, W. and Mayo, E., between L. Mask and L. Corrib, C. Bailey, 1885.

First record: 'Journ. Bot.' 1878.

Outside the British Isles *C. connivens* is recorded from Spain (Central), France, N.W., Central & S., Germany, N.E., Italy and Austria, in North Africa (Morocco to Egypt), and in Palestine.

A slender, graceful plant, of medium size, sometimes attaining a height of about two feet, but usually much shorter, a lightish green and, though not much incrustated, generally very brittle. Its principal distinctive characteristics are the markedly connivent branchlets, especially those of the male plant, in which the tips of opposite branchlets often cross one another, the long remarkably conical coronula, the cells of which taper to a point, the long cylindrical oospore, the short bract-cells and the rudimentary stipulodes and spine-cells. The branchlet-segments are often tumid.

In this country it has only been found quite near the sea, but in France and Spain it occasionally reaches inland.

In southern countries, where the plant is more luxuriant, the antheridia are much larger and the number of segments of the branchlets more numerous.

A hybrid with *C. fragilis* (*C. connivento-fragilis* Hy) has been described from a locality in Maine-et-Loire. This plant, which closely resembles *C. connivens*, has the upper whorls bearing antheridia only, with some fruits with antheridia on the lower ones.

14. *Chara fragifera* Durieu.

(PLATE XLII.)

Chara fragifera DURIEU DE MAISON NEUVE in Bull. Soc. Bot. France, VI, p. 185 (1859); VII, p. 627 (1860).

CLAVAUD in Bull. Soc. Bot. France, X, p. 140, tab. 3, f. 19, 20 (bulbils) (1863).

BRAUN in Monatsb. Akad. Berl. for 1867, p. 935 (1868).

TRIMEN in Journ. Bot. XV, p. 353, tab. 192 (1877).

H. & J. GROVES in Journ. Bot. XVIII, p. 102, tab. 207, f. 2 (1880).

BRAUN & NORDSTEDT Fragm. Mon. Charac. (1882), p. 180.

SYDOW Europ. Charac. (1882), p. 91.

BOSWELL English Botany, ed. 3, XII, p. 217, tab. 1922 (1884-5).

LLOYD & FOUCAUD Fl. de l'Ouest de la France, ed. 4, p. 439 (1886).

NORDSTEDT in Lund's Univ. Årsskr. XXV, p. 37 (1889).

MIGULA Die Characeen, p. 695, f. 139-41 (1897); Syn. Charac. Europ., p. 149, f. 14, 124-6 (1898).

GIESENHAGEN Untersuch. ü. d. Characeen, I, pp. 35-6, f. 18-20 (bulbils) (1902).

PRÓSPER Carófit. de Españ. (1910), p. 159, f. 26A, p. 162.

Hy in Bull. Soc. Bot. France, LX, Mém. 26, p. 40 (1913).

C. trichophylla KÜTZ in HENRIQUES, Contrib. Flor. Crypt. Lusit. (1881), p. 21 (*vide* Nordstedt).

EXSICCATA:—Billot 3273; Braun, Rabenh. & Stiz. 73a, b; Groves 4-6; Lloyd 416-7; Migula 129; Gr. & B.-W. 20, 21.

Dioecious. *Stem* slender, flexuous, producing laterally at some of the lower nodes, as well as at the root-nodes,

large irregular compound whitish bulbils; *internodes* often scarcely exceeding the branchlets. *Cortex* usually evenly triplostichous, the primary series rather larger than the secondary; *spine-cells* quite rudimentary. *Whorls* of 6–9 branchlets. *Stipulodes* rudimentary. *Branchlets* slender, flexuous, those of the male plant usually shorter and more connivent, of 9–13 segments, the upper 1–3 ecorticate. *Bract-cells* normally 5, the anterior pair only developed, very short, much less than half the length of the fruit (in the ♂ still shorter); *bracteoles* and *bractlet* rather longer than the anterior bract-cells, rather acuminate. *Oogonia* and *antheridia* solitary or rarely geminate, produced at the lowest 3–5 branchlet-nodes. *Oogonium* c. 875–1000 μ long (excl. cor.), 550–675 μ broad; *spiral-cells* often reddish orange, showing 12–14 convolutions; *coronula* c. 125–175 μ high, 175–200 μ broad, connivent straight or sometimes spreading. *Oospore* oblong-ellipsoid, 550–700 μ long, 375–450 μ broad, chestnut-brown to nearly black, showing 9–12 ridges, prolonged downwards into a cage; *outer membrane* thick-laminated, semi-rigid, semi-opaque, dark red-brown, finely and evenly granulated. *Antheridium* c. 500–575 μ in diameter.

HABITAT and DISTRIBUTION.—In pools and ponds, Cornwall, West. Apparently confined to the Scilly Isles, and the Land's End and Lizard districts. Tresco, Scilly Isles; near Sennen, Chyanhal Moor, near Penzance; Marazion Marsh, near Helston, and in many pools and ponds on the downs, north of Lizard Town, and in valleys running down westward to the sea; Mabe Reservoir. First described as British from specimens collected by the eminent algologist, John Ralfs, at Chyanhal Moor, collected earlier by Mr. Townsend at Tresco, and by Messrs. Beeby and Tellam near Lizard, but referred to *C. fragilis*.

First record: 'Journ. Bot.' 1877.

Outside the British Isles *C. fragifera* is recorded from France (North, West and Central), Spain (North),

Portugal, Algiers, Tunis, and from one locality in Cape Colony.

Normally an extremely slender flexuous plant of medium stature, moderately branched, and without incrustation. A small form with shorter and stouter branchlets was collected by J. Cunnack near Helston, and a dwarf much-branched and tufted form occurred in the large shallow ponds on the Lizard plateau known as Hayle Kimbro and Ruan Pool. The fertile branchlet-nodes on this species are unusually numerous. On a French specimen we have counted as many as seven antheridia on one branchlet. Nordstedt (*l. c.*) described a variety *oligospira* from Algiers, showing only 8 ridges on the oospore. The French plant has sometimes much larger antheridia than ours.

On a whorl of one of the Helston specimens of the female plant, a few antheridia were found on the same branchlets as fruits, but at different nodes.

C. fragifera is distinguished from the other dioecious unarmed species of the Section, *C. connivens*, by its more slender stem, more slender and flexuous and less connivent branchlets, greater number of branchlet-segments, shorter and broader coronula and less cylindrical fruit; from *C. fragilis* and *C. delicatula* in being dioecious, in the greater number of branchlet-joints and the shorter bract-cells; from *C. delicatula* also in both series of stipulodes being rudimentary; from *C. aspera*, *C. desmacantha*, and *C. galioides*, apart from the rudimentary spine-cells, by the rudimentary stipulodes, more numerous branchlet-joints and much shorter bract-cells. The most distinctive character, however, consists in the remarkable composite bulbils, sometimes attaining a diameter of 7 mm., which, from their fancied resemblance to strawberries, gave rise to the specific name. Durieu reported the occasional presence of unicellular bulbils in this species, but Braun, who carefully investigated the matter, has shown ('*Monatsb. Akad. Berl.*' for 1867 p. 936) that these belonged to a form of *C. aspera* growing intermixed with it

B. Monœciæ.

15. *Chara fragilis* Desvaux.

[PLATE XLIII, (var. *Hedwigii*).]

C. vulgaris LINN. Sp. Plant. p. 1156 (1753), *pro parte*.

C. capillacea THUILLIER, Flor. env. Par. p. 474 (1799), *fide* Braun.
KÜTZING Tab. Phyc. VII, t. 55, f. 2 (1857).

- C. fragilis* DESVAUX in LOISELEUR Notice aj. F. France, p. 137 (1810).
 REICHENBACH Fl. Germ. Excurs. I, p. 149 (1830).
 BRAUN in Ann. sc. Nat. ser. 2, 1, p. 356 (1834); in Flora, XVIII, i, p. 68 (1835); in N. Denks. Schweiz. Ges. Naturw. X, p. 21 (1849);
 Consp. Char. Eur. p. 7 (1867); in Monatsb. Akad. Wiss. Berlin for 1867, p. 938 *omn. pro parte*; in Cohn, Krypt. Fl. Schles. I, p. 410 (1876).
 COSSON & GERMAIN Atl. Fl. Par. t. 38, f. c (1845); ed. 2, t. 42, f. c (1882).
 KÜTZING Phyc. Germ. p. 257 (1845) *pro parte*; Sp. Alg. p. 521 (1849) *pro parte*; Tab. Phyc. VII, t. 54 (1857).
 GANTERER Oesterr. Char. p. 20 (1847) *pro parte*.
 RABENHORST Deutsch. Krypt. Fl. II, p. 199 (1847) *pro parte*.
 BABBINGTON in Ann. and Mag. Nat. Hist. ser. 2, V, p. 91 (1850) *pro parte*.
 WALLMAN Försök. syst. Charac. p. 101 (1853); Transl. p. 84 (1856).
 WAHLSTEDT Bidr. Skand. Charac. p. 38 (1862) *pro parte*; Mon. Sver. and Norg. Charac. p. 36 (1875) *pro parte*.
 NORDSTEDT in Bot. Notiser 1863, p. 43 *pro parte*.
 CRÉPIN in Bull. Soc. Bot. Belg. II, p. 126 (1863).
 LEONHARDI in Verh. naturf. Ver. Brünn, II, p. 207 (1864) *pro parte*.
 LANGE in Flora Danica 2797, f. 1-2 (1869).
 GROVES in Journ. Bot. XVIII, p. 101, t. 207, f. 1 (1880) *pro parte*.
 J. MÜLLER in Bull. Soc. Bot. Genève, II, p. 89 (1881), *pro parte*.
 BRAUN & NORDSTEDT Fragm. Mon. Charac. p. 181 (1882).
 SYDOW Europ. Charac. p. 94 (1882).
 MIGULA Characeen, p. 722, f. 146-7 (1897); Krypt. Fl. Deutsch. II, ii, p. 353, t. 78, f. 1-3 (1907); Syn. Charac. Europ. p. 158, f. 131-2 (1898).
 HOLTZ Charac. in Krypt. Mark Brandenb. IV, i, pp. 113, 115 (1903).
 PRÓSPER Carofit. de Españ. p. 164, f. 27 (1910) *pro parte*.
 HY in Bull. Soc. Bot. France, LX, Mém. 26, p. 42 (1913) *pro parte*.
- C. pulchella* WALLROTH Annus Botanicus, p. 184, t. 2 (1815).
 ÅGARH Syst. Alg. p. 129 (1824).
 BERKELEY in Engl. Bot. Suppl. III, No. 2824 (1843).
 BERTOLONI Fl. Ital. X, p. 15 (1854).
- C. hirta* MEYEN in Linnæa, II, p. 78 (1827).
C. fulcrata GANTERER Oesterr. Char. p. 20, t. 2, f. 16 (1847).
- EXSICCATA:—Braun, Rabenh. & Stiz. 13, 15; Desmazières II, 331; Erbar. Critt. Ital. II, 253; Groves 31; Jack, Lein. & Stiz. 207a, b; Migula, Syd. & Wahlst. 45, 47-8, 71-3, 95-8, 100-2; Nordst. & Wahlst. 116-18; Rabenhorst 140, 280; Reichenbach 94; Westendorp & Wall. 899; Gr. & B.-W. 32.

Monœcious. *Stem* rather slender (diam. c. 750 μ), the internodes as long as or exceeding the branchlets; occasionally producing irregular multicellular bulbils. *Cortex* regular, the cells of the secondary nearly or quite as broad as those of the primary series; *spine-cells* extremely small, hardly visible except on very young internodes. *Whorls* of 7-8 branchlets. *Stipulodes* nor-

mally quite rudimentary, but occasionally one or more elongated. *Branchlets* usually c. $375\ \mu$ in diam., straightish or somewhat incurved, of 8–10 segments, the upper 1–3 ecorticate. *Bract-cells* normally 7, the anterior pair, and occasionally also a second, developed, acuminate-mucronate, usually much shorter than the fruit; *bracteoles* usually from $\frac{2}{3}$ to about as long as the fruit. *Oogonia* and *antheridia* solitary produced at the three, rarely more, lowest branchlet-nodes. *Oogonium* c. $800\text{--}950\ \mu$ long (excl. cor.), $500\text{--}675\ \mu$ broad; *spiral-cells* showing 14–17 convolutions; *coronula* c. $175\text{--}250\ \mu$ high, $200\text{--}375\ \mu$ broad, connivent straight or slightly spreading. *Oospore* ellipsoid tapering slightly below, c. $550\text{--}700\ \mu$ long, $350\text{--}450\ \mu$ broad, nearly black, showing 12–15 well-defined ridges prolonged downwards into a cage; *outer membrane* thick, laminated, semi-rigid, semi-opaque, very dark brown, very finely granulated. *Antheridium* \rightarrow c. $500\ \mu$ in diameter.

HABITAT.—In ponds, clay-pits and canals, but not apparently in running water.

DISTRIBUTION.—Fairly common in the south and Midlands, scarcer northwards, and rare in Wales, Scotland, and Ireland. We have seen specimens recently from the following counties, and it probably occurs in many others.

England: Cornwall, E., Devon, S., Somerset, S., Wilts, S., Wight, Hants, S., Sussex, E. & W., Kent, E. & W., Surrey, Essex, N., Middlesex, Berks, Suffolk, W., Cambs, Beds, Hunts, Gloster, W., Worcester, Warwick, Staffs, Salop, Derby, Yorks, N.W.

Wales: Glamorgan, Carnarvon.

Scotland: Edinburgh, Perth, E., Forfar.

Ireland: Cork, W., Limerick.

First record: Hooker, 'British Flora,' 1833 (var. *Hedwigi*).

C. fragilis is world-wide in its distribution, occurring over most of Europe and in all the other continents. Some of the Australasian forms show an approach to the next species in having the spine-cells partially developed.

The form regarded as the type is a medium-sized rather neat-looking plant, the internodes of the upper part of the stem usually not much exceeding the branchlets. The stem very brittle, the branchlets usually nearly straight. The plant is often incrustated but rarely to the extent of the diplostichous species. It does not apparently form tufts like *C. delicatula*, and bulbils do not seem to be often produced, but unfortunately many of the herbarium specimens are lacking in the rooting parts. Though both circles of stipulodes are normally quite rudimentary, it occasionally happens that one, or two, belonging to the upper circle is elongated.

The varietal name *capillacea* has been applied to very slender forms of both this species and *C. delicatula*.

Owing to the fact that this and the following species have hitherto been generally combined under the name of *C. fragilis* in this country, we have not been able to apportion all the older records, so that the particulars of their respective distribution and synonymy are incomplete.

Desvaux's name for the species is so generally adopted that we hesitate to supersede it by either of the earlier ones given by Thuillier, and in consequence have treated the smaller, less extended forms as representing the type, rather than the var. *Hedwigii*. The latter is, however, the more vigorous and highly developed form, and if Thuillier's name of *C. globularis* is adopted, will stand as the type. For this reason we have chosen it for the illustration of the species.

A curious almost entirely sterile plant with subtriplostichous stem-cortex and ecorticate branchlets collected by Abram Sturrock in Monk Myre, a small loch in East Perth, was described by H. & J. Groves ('Journ. Bot.' XXII, p. 2, 1884) as var. *Sturrockii* of *C. fragilis*. We think this may probably be a hybrid with one of the Diplostichæ, the stipulodes resembling those of some species of that section.

Var. b. *Hedwigii*.

(PLATE XLIII.)

- C. globularis* THUILLIER Fl. Env. Par. ed. 2, p. 472 (1799).
C. Hedwigii BRUZELIUS Obs. Char. pp. 7, 21 (1824).
 HOOKER Brit. Fl. II, p. 245 (1833).
 BERKELEY in Engl. Bot. Suppl. 2762 (1834).
 KÜTZING Tab. Phyc. VII, t. 55, f. 1 (1857).
C. fragilis var. *Hedwigii* KÜTZING Phyc. Gen. p. 319 (1843).
 LANGE in Flora Danica, 2797, f. 2 (1869).

C. fragilis var. *elongata* COSSON & GERMAIN Fl. Env. Par. p. 680 (1845).

EXSICCATA :—Braun, Rabenh. & Stiz. 14, 112, 121; Erbar. Critt. Ital. 551, 101 (1101); Jack, Lein. & Stiz. 208; Migula, Syd. & Wahlst. 44, 99, 150; Nordstedt & Wahlst 115a, b; Rabenhorst 240.

Larger and more robust than the type. *Stem* stouter; *internodes* much exceeding the branchlets; *branchlets* long, usually stout, often with 4 fertile nodes.

We have seen specimens referable to this variety from Somerset, S., Sussex, E. & W., Surrey, Essex, N., Middlesex, Berks, Norfolk, E., Cambs, Beds, Hunts, Northants, Worcester, Warwicks, Lincoln, S., Derby, Anglesea, Stirling, Aberdeen, N., Galway, W., and Mayo, E. It is probably to be found in many other counties.

A large, rather rough-looking and often straggling plant, sometimes attaining to a height of several feet, in its extreme forms remarkably different in appearance from the type, the whorls often 5 cm. or more across, the branchlets occasionally even lengthening to as much as 10 cm. A form with extremely slender stem and branchlets was collected by Dr. Kidston in Airthrey Loch, Stirling.

16. *Chara delicatula* Agardh.

(PLATE XLIV.)

Chara fragilis Auct. plur. *pro parte*.

C. viridis HARTMAN Hdb. Skand. Fl. p. 378 (1820)?

C. delicatula AGARDH Syst. Alg., p. 130 (1824) *non* Desv.

BRAUN in Cohn, Krypt. Fl. Schles. I, p. 411 (1876).

SYDOW Europ. Charac. p. 97 (1882).

MIGULA Die Characeen, p. 752, f. 148 (1897); Krypt.-Fl. Deutsch. II, ii, p. 362, t. 78, f. 4 (1907); Syn. Charac. Europ. p. 164, f. 133 (1898).

HOLTZ Charac. in Krypt. Mark-Brandenb. IV, i, pp. 119 and 113, f. 2 (1903).

KUCZEWSKI Morph. u. biol. Unters. an *C. delicatula* (1906).

C. pilifera AGARDH Syst. Alg. Introd. p. xxviii (1824).

C. virgata KÜTZING in Flora, XVII i, p. 705 (1834); Tab. Phyc. VII, t. 56, f. 2 (1857).

C. foliolata HARTMAN Hdb. Skand. Fl. ed. 3, p. 259 (1838).

C. fragilis var. *longibracteata* RABENHORST Deutsch. Krypt. Fl. II, ii, p. 200 (1847).

BRAUN in N. Denks. Schweiz. Ges. Nat. X, p. 21 (1849).

LEONHARDI in Verh. Naturf. Ver. Brünn II, p. 208 (1864).

C. verrucosa ITZIGSOHN in Bot. Zeit. 1850, p. 338.

- C. capillacea* WALLMAN Försök syst. Charac. p. 102 (1853); Transl. p. 85 (1856), non Thuillier, *vide* Braun.
C. fragilis var. *delicatula* LEONHARDI in Verh. Naturf. ver. Brünn, II, p. 209 (1864).
 BRAUN Consp. Char. Europ. p. 7 (1867).
C. fragilis vars. *pulchella* and *bulbilifera* LANGE in Fl. Dan. 2796, 1, and 2798, 1 (1869).
C. fragilis subsp. *delicatula* BRAUN & NORDSTEDT Fragmente, p. 184, t. 7, f. 269-270 (1882).
C. fragilis ser. *Macroptila* PRÓSPER, Carofit. de Españ. p. 169 (1910).
C. fragilis var. *capillacea* HY in Bull. Soc. Bot. France, LX, Mém. 26, p. 43 (1913).

EXSICCATA:—Areschoug 140; Braun, Rabenh. & Stiz. 75, 100, 115; Desmazières II, 330; Groves 2; Hansen 1298; Krypt. Exsicc. 738, 739; Migula, Syd. & Wahlst. 24; Nordstedt & Wahlst. 119, 120; Gr. & B.-W. 41.

Monœcious. *Stem* slender (diam. c. 375-500 μ); *internodes* usually but little longer than the branchlets, but occasionally even more than twice as long. *Cortex* regular, the cells of the secondary little more than half the diameter of those of the primary series; *spine-cells* papilliform or rarely elongated. *Whorls* of usually 7 branchlets. *Stipulodes* of the upper series \pm developed but often very short, of the lower usually rudimentary. *Branchlets* about 225-325 μ in diameter, usually curved, of 9-11 segments, the upper 1-3 ecorticate. *Bract-cells* normally 7, occasionally 5, the anterior pair only developed, usually acuminate, from one-half the length of, to equalling that of, the fruit; *bracteoles* almost always exceeding the fruit. *Oogonia* and *antheridia* solitary, produced usually at the 3 lowest branchlet-nodes. *Oogonium* c. 750-1000 μ long (excl. cor.), 500-675 μ broad; *spiral-cells* showing 14-15 convolutions; *coronula* very variable in height, c. 250 μ broad at the base, usually connivent, occasionally straight. *Oospore* ellipsoid, c. 625-700 μ long, 350-475 μ broad, black, showing 12-14 thin ridges, terminating in basal claws; *outer membrane* thick, laminated, semi-rigid, semi-opaque, nearly black, granulated with well-defined granules of varying sizes. *Antheridium* \rightarrow c. 450 μ in diameter.

HABITAT.—In ponds, pools, lakes and streams, common especially in moorland districts.

DISTRIBUTION.—Distributed almost throughout the British Isles. We have seen specimens from more than half the English and Welsh counties, from Cornwall and the I. of Wight northwards, from the Channel I., from more than three-quarters of the Scottish, and two-thirds of the Irish, counties, and it occurs probably in most of the others.

We have not as yet been able to work out the separate distribution of *C. delicatula*, outside the British Isles. It is apparently much less generally distributed than *C. fragilis*, but we have seen specimens from many parts of Europe, from Asia Minor and Japan, S. Africa, and North America.

Closely allied to *C. fragilis*, of which it has been regarded as a variety or subspecies. It is usually a smaller, firmer and neater plant than the ordinary forms, and never attains to the size of the larger forms of that species. It can usually be readily distinguished by the appreciably larger and more prominent primary cortical-cells, sometimes giving the stem a distinctly ribbed appearance, by the spine-cells being apparent, though often quite small, and by one series at least of the stipulodes being elongated; the bract-cells and bracteoles also are longer. The coronula, which is usually connivent, varies considerably in height. The cells are usually long; on a plant from Biddulph, Staffs (Coll. R. F. & F. P. Thompson), some of them measure as much as 300 μ . Occasionally they are quite short; on a plant from Cringla Field, Orkney (Coll. H. H. Johnston), they are less than 100 μ long, while in one from Clonbrock, Galway (Coll. R. Ll. Praeger), they are still shorter. The branchlets are usually rather short and firm, but, in extreme states, they are elongated and almost as slender and flexuous as those of *C. fragifera*. Kuczewski (*l. c.*) has made a histological study of *C. delicatula*, especially of the bulbiferous form. We have followed Braun as regards the name and authority for this species, but the position is an ambiguous one. The name *C. delicatula* was first given by Desvaux ('Journ. Bot.' p. 137, 1810) to a plant which, according to Braun, was *C. aspera*. Agardh quotes Desvaux as the authority and would appear to be merely following Bruzelius, but presumably Braun had seen the plants described by both authors. Neither Desvaux's, Bruzelius's nor Agardh's description is alone sufficient for identification.

Var. b. **barbata**.

(PLATE XLIV, FIG. 9.)

C. fragilis var. *barbata* GANTERER Oesterr. Char. p. 20, t. 2, f. 15 (1847).

C. trichodes KÜTZING in Flora, XVII i, p. 705 (1834); Tab. Phyc. VII, t. 56, f. 1 (1857).

Stipulodes of both series well developed, the lower often almost as long as the upper. *Bract-cells* and *bracteoles* very long.

This may be regarded as an exuberant form of the species. In a specimen collected by Dr. G. C. Druce at Weston-in-Gordano, Somerset, there are instances of two antheridia being developed at the same node, one above and one below the oogonium, and the spine-cells are unusually long, sometimes exceeding the diameter of the stem.

We have seen specimens referable to this variety from Cornwall, W., Somerset, N., Kent, W., Salop, Radnor, Pembroke, Merioneth, Anglesey, Lincs, S., Cheshire, and Westmorland; from many Scottish counties from Kirkcudbright to Orkney; from many Irish counties from Waterford and Kerry, N., to Antrim and Mayo, E.

Var. c. **annulata**.

(PLATE XLIV, FIGS. 10–11.)

C. annulata WALLMAN Försök Syst. Charac. p. 100 (1853); Transl. p. 82 (1856).

C. fragilis var. *annulata* LANGE in Flora Danica, 2798, fig. 2 (1869).

C. fragilis var. *delicatula* GROVES in Journ. Bot. XVIII, p. 102, t. 207, f. 1 a (1880).

EXSICCATA:—Groves 3; Groves and Bullock-Webster 42.

Plant dwarf, densely tufted; often producing root-bulbils. *Stem* with very short internodes, often not as long as the branchlets; *branchlets* very short and much incurved, the segments very short and with the cortical-cells inclined to be tumid.

A small plant forming small bushy detached tufts, growing on the clay or stony margins of lakes.

Specimens have been collected from Sutherland, W. (L. Maol-a-Choire and Lochan Hacoin, Tongue); Orkney (L. of Harray); Shetland (Tingwall L.); Meath (Oldcastle); Roscommon (L. Ree); Mayo, W. (Clare I.); Leitrim (Glenade L.); Donegal (Tullyconnel L., Kindrum L.); Antrim and Down (L. Neagh).

[**C. tenuispina** BRAUN, a rather small monœcious triplostichous species with strongly developed stipulodes, spine-cells and bract-cells, has been found in Schleswig-Holstein, several parts of Germany and in Switzerland.]

LIST OF DISTINCTIVE APPELLATIONS FOR
CHAROPHYTA PUBLISHED ANTERIOR TO
THE GENERAL ADOPTION OF
BI-NOMINAL NOMENCLATURE.

- Equisetum est & quintum genus, minimum, aquis cœnosis innatans*, &c. (see Vol. I, p. 14) DALECHAMPS 'Hist. Gen. Plant.' p. 1070, 1587.
- Hippuris lacustris quædam foliis mansu arenosis*, GESNER 'De Stirpium collectione tabulæ, &c.' (ed. C. W.) [p. 81*b], 1587.
- Eq. olidum* C. BAUHIN 'Phytopinax,' p. 33, 1596 (*C. vulgaris*, L.).
- Eq. fœtidum sub aqua repens* C. BAUHIN 'Prodr. Theat. Bot.' p. 25, 1620 (*C. vulgaris* L.).
- H. coralloides* GERARD 'Herball,' ed. T. Johnson, p. 1115, 1633.
- Eq. palustre ramosum aquis immersum* RAY 'Cat. Cant.' p. 49, 1660.
- Eq. s. H. lacustris foliis mansu arenosis* PLUKENET 'Phytographia,' I, t. 29 f. 4, 1691 (*C. vulgaris*).
- H. mucosus sub aqua repens in Hibernia* PLUKENET 'Phytographia,' III, t. 193, fig. 6 (1692) (*C. aculeolata*, Kütz.).
- Eq. s. H. mucosus sub aqua repens* PLUKENET 'Alm. bot.' p. 135, t. 193, fig. 6, 1696 (see Phytographia above).
- Eq. fragile majus subcinereum aquis immersum* MORISON 'Pl. Hist. Univ. Oxon.' III, p. 621, sect. 15, t. 4, fig. 9, 1699 (probably *C. vulgaris*, L.).
- Eq. s. H. mucosus cauliculis spinulis crebrius exasperatus sub aquis repens.* MORISON *l. c.* III p. 621, 1699 (*C. hispida*, L.).
- Eq. Indicum mansu arenoso simile*, PLUKENET 'Alm. bot. Mantissa,' p. 68, 1700 (*C. brachypus*?).
- Eq. mucosum sub aqua repens semine Lithospermi* RAY 'Hist. Plant,' III, p. 104, 1704.
- Eq. non fœtens, sub aquis repens* RAY *l. c.* p. 104, 1704.
- Eq. sub aqua repens ad genicula polyspermon* RAY *l. c.* p. 104, 1704.
- H. mucosa setis per extremis stellatis* DILLENIUS 'Ephem. Acad. Leop. Carol.' V and VI, Appendix, t. 13, fig. 1, 1717.
- H. setis bifurcis* DILLENIUS *ibid.* t. 13, f. 2, 1717 (*N. flexilis* or *N. opaca*).
- H. fœtidus* DILLENIUS 'Cat. pl. circa Gissam nasc.,' p. 105, 1719.

- Chara aspera fragilis segmentis foliorum per intervalla confertis*
 VAILLANT in 'Mem. Acad. R. d. Sc.' 1719, p. 18.
- C. foliis senis inferioribus integris* VAILLANT l. c. p. 18, t. 3, f. 5,
 1719 (*C. fragilis*?).
- C. minor caulibus et foliis tenuissimis* VAILLANT l. c. p. 18, 1719.
- C. major caulibus spinosis* VAILLANT l. c. p. 18, t. 3, f. 3, 1719
 (*C. hispida*?).
- C. major subcinerea fragilis* VAILLANT l. c. p. 18, 1719.
- C. vulgaris foetida* VAILLANT l. c. p. 17, t. 3, f. 1, 1719 (*C. vulgaris*
 and *C. fragilis*?).
- C. Florentina, pullo viridis* VAILLANT l. c. p. 18, 1719.
- C. translucens major flexilis* VAILLANT, l. c. p. 18, t. 3, f. 8, 1719
 (*N. translucens*).
- C. translucens minor flexilis* VAILLANT l. c. p. 18, t. 3, f. 9, 1719
 (*N. opaca*?).
- Hippuris aquatica foetida polysperma* PONTEDEIRA, 'Anthologia
 sive de floribus natura,' III, vi, 1720.
- C. caulibus aculeatis* LINNÆUS 'Hortus Cliffortianus,' p. 477,
 1737.
- C. vulgaris* LINNÆUS, 'Flora Lapponica,' p. 351, 1737.
- C. caulibus lævibus* VAN ROYEN 'Floræ Leydensis Prodromus,'
 p. 533, 1740.
- C. caulium articulis inermibus diaphanis superne latioribus*
 LINNÆUS 'Öländska och Gothländska Resa,' 1745.
- C. aculeis caulinis ovatis* LINNÆUS 'Fl. Suecica,' p. 362, 1745.
- C. aculeis caulinis capillaribus* LINNÆUS l. c. p. 363, 1745.
- H. subcinerea fragilis* SEGUIER 'Plantæ Veronenses,' I, p. 101,
 1745.
- C. caule levi, fragili* HALLER 'Hist. Stirp. Helv.' No. 1681, 1768.
- C. caule fragili spinoso* HALLER l. c. No. 1682, 1768.
- C. caule tomentoso fragili* Haller l. c. No. 1683, 1768.
- C. caule levi pellucido flexili* HALLER l. c. No. 1684, 1768.

A SKETCH OF THE GEOLOGICAL HISTORY OF THE CHAROPHYTA.

FOR considerably more than a century the fossil fruits of Charophytes have been known to geologists, though it was some time before their real nature was recognized. Their occurrence was apparently first brought to notice in 1785 in a paper read before the Académie des Sciences in Paris, by Dufourny de Villiers, who styled them "tourbillons ou vortex," and regarded them as Echinoderms. This paper does not appear to have been published. Lamarck (9)* subsequently named them *Gyrogonites* and considered them Mollusca. Leman (10), in 1812, was, I believe, the first to identify them with the *Charophyta*. The earlier discoveries of the fruits were made in some of the fresh- and brackish-water beds of the Eocene and Oligocene series, in which they occur in the greatest profusion. They have subsequently been traced downwards to several of the formations of the Mesozoic era, but, up to quite recently, the earliest remains which could with certainty be referred to the *Charophyta* had been obtained from the Oolites. It is true that in 1867 Moore (13) published the name *Chara liassica*, without figure or description, in respect to a single "seed-vessel . . . associated with the Liassic remains from the Charterhouse Mine." In the absence of the specimen, which we understand cannot be traced, and with such meagre information, the occurrence of these plants in the Lias is open to grave doubt.

Owing, apparently, to some error, Charophyte-remains are reported in some of the text-books, as well as by Schimper (20), as having been found in the Muschelkalk (Triassic) in the environs of Moscow. I have not been able to trace the source of this report, and, accord-

* The numbers after the names of authors cited refer to the list of books and papers on pp. 89-90.

ing to Karpinsky (5), p. 127, Muschelkalk is not found in the district named.

Far down in the rocks of the PALÆOZOIC era organisms occur which have been ascribed to the *Charophyta*.

SILURIAN.—From a deposit of the Silurian period on the Kellerwald, remains closely resembling the vegetative parts of a *Nitella* are figured by Potonié (15) (see Fig. 26), but in the absence of fruit it is not possible to determine their nature.

DEVONIAN.—In the Corniferous Limestone of Ohio, Meek, in 1873 (12), recorded the presence, in company with marine Mollusca, of small globose bodies, “about

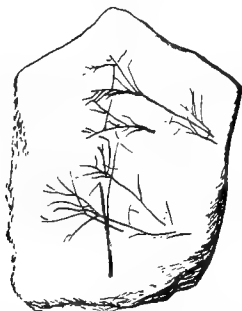


FIG. 26.—Problematic *Nitella*-like organism from the Silurian (after Potonié).

0.05 of an inch in diameter, and each ornamented by 9 strongly defined and very regularly disposed spiral ridges which start on one side around a minute pit with perfect regularity. . . .” These, the author “can scarcely doubt,” are the fruits of *Chara*. Williamson in 1880 (30) and Dawson in 1883 (2), in describing similar organisms from a different locality in Ohio, considered them *Foraminifera*, the former referring them to his genus *Calcisphæra*, the latter to *Saccamina*. Ulrich, in 1886 (26), again described these organisms, with excellent figures, under the name of *Moellerina* (see Fig. 27 *a, b*), also regarding them as *Foraminifera*. In 1889 they were again described and figured by

Knowlton (8) (see Fig. 27 *c, d*) under the name of *Calcisphæra Lemoni*. In all the living, and, with the exception of those from the Carboniferous, in all the fossil Charophyte-fruits the number of the spiral-cells is five, and they are invariably coiled sinistrally. In these Devonian organisms the spiral lines are nine or ten in number, and evidently normally they have a dextral twist, though in

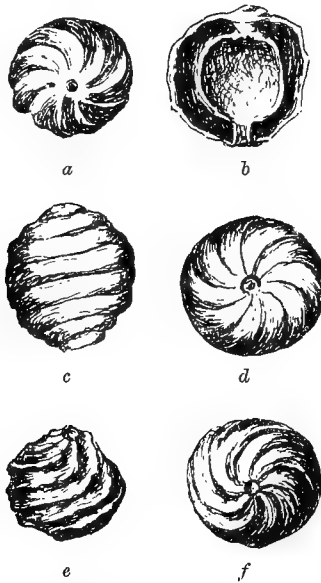


FIG. 27.—Problematic organisms from the Devonian of N. America. *a, b*, *Moellerina Greenei*, Ulrich (after Ulrich); *c, d*, *Calcisphæra Lemoni*, Knowl. (after Knowlton); *e, f*, *Trochiliscus bulbiformis*, Karp. (after Karpinsky).

one of Ulrich's figures the reverse is shown (see Fig. 27 *a*). In Knowlton's paper the question as to whether or not they are Charophytes is discussed at length, and the opinions of a number of authorities on the point are cited. Of these Prof. Nordstedt, whose views on any question relating to *Charophyta* must carry great weight, and Dr. Allen, who had long worked at these plants, were both of opinion that they did *not* belong to the

group. Dr. Wieland in 1914 (29) recorded the discovery of similar bodies in the Hamilton Shales of Missouri (a higher horizon), and regarded them as undoubted Charophytes, giving them the name *Chara devonica*. Prof. Seward (22), pp. 225-6, says of them: "Without going into the arguments for or against placing these fossils in the *Chareæ*, they may at least be mentioned as possible, but not certain Palæozoic forms of *Chara*, or an allied genus." Quite recently Dr. Bell (1) has published the results of a careful investigation of the matter, in which he points out that the internal structure of these bodies, as well figured by Ulrich (26) (see Fig. 27 *a, b*), does not correspond with that of a Charophyte, and adds, "The spiral ridges are restricted to the outer wall and are a part or ornamentation of the wall itself, so that they afford no evidence of a *Chara* construction in support of the superficial appearance."

From the evidence adduced by Dr. Bell and the examination of specimens with which he has kindly furnished me I think that their affinity with the *Charophyta* is extremely doubtful.

Karpinsky, in a well-elaborated and excellently illustrated memoir (5), has described and figured a number of fossil organisms of the Devonian period, from Germany, Russia, and North America, which he classes under a general heading *Trochilisken*, and which he considers to be related to the *Charophyta*. He divides his *Trochilisken* into two genera, *Sycidium*, G. Sandb., and *Trochiliscus*, Panz. The organisms included in the former cannot, I think, belong to the *Charophyta*, and I understand are usually referred to the calcareous *Siphonææ*. The author would appear to have been misled by some of Dr. Stache's illustrations of tuberculate-fruited fossil *Charas* (which he reproduces), and in which the tubercles on adjacent spiral-cells happen to coincide in position, and so give an appearance of imperfect interrupted longitudinal ridges to the fruit. In the second genus, *Trochiliscus*, Karpinsky includes the Devonian organisms from Ohio, already referred to, and three others from

Russia. The one of the latter most resembling a *Chara*-fruit is shown in Fig. 27 *e, f*.

In Part V of their fine memoir on the Rhynie Chert

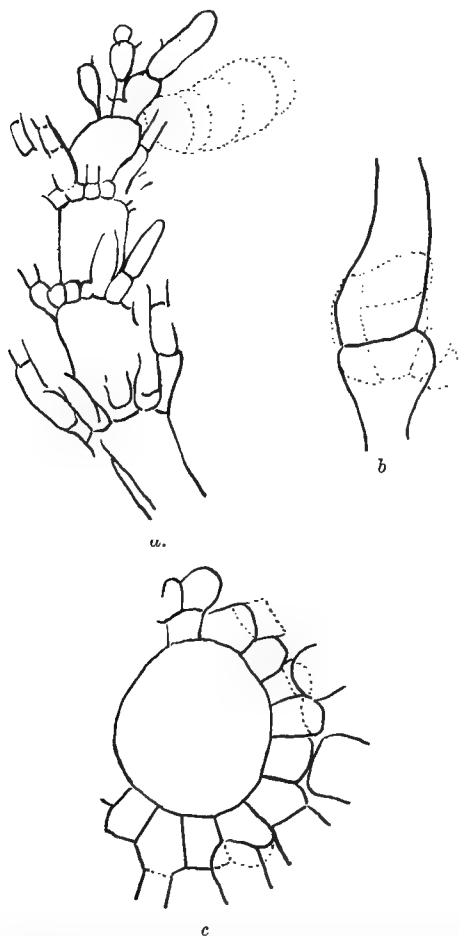


FIG. 28.—*Algites (Palæonitella) Cranii*, Kidst. & Lang., outline drawings (after Kidst. & Lang.), from Old Red Sandstone (Rhynie Chert Bed). *a*, verticillately branched axis; *b*, rhizoid node; *c*, transverse section of stem-node.

Bed of the Old Red Sandstone (6), p. 877, tt. 8-9, fig. 91-108, Dr. Kidston and Prof. Lang describe and figure, under the name of *Algites (Palæonitella) Cranii*,

certain vegetative remains (see Fig. 28) exhibiting points of resemblance to the *Charophyta*, and which may well belong to that group. It is much to be hoped that further search may bring to light specimens with gametangia. The wonderful state of preservation of fossils in this bed renders their minute cellular structure clearly visible, and should the plant in question prove to be a Charophyte, it may throw a very important light on the early history and affinities of the group. The double-foot processes on the rhizoids of the fossil (see Fig. 28*b*) are very like those of living Charophytes.

The plant described by Stur (25) as a new genus, *Barrandeina*, from beds now regarded as Middle Devonian, in Bohemia, and placed by him under "*Ordo Characeæ præcursores*," does not, as far as one can



FIG. 29.—*Palæochara acadica*, Bell (after Bell), from the Coal Measures of Nova Scotia. *a*, side view; *b*, view of basal end; *c*, longitudinal section, all $\times 26$.

judge from the author's rather obscure illustrations, show any clear affinity to the group.

CARBONIFEROUS.—In 1922 Dr. W. A. Bell (1) published an account of the very important discovery, in the Lower Coal Measures of Nova Scotia, of what appear to be undoubtedly the oogonia of a Charophyte, to which he has given the name *Palæochara acadica* (see Fig. 29). These represent the earliest remains which can with any degree of confidence be at present assigned to the group. The structure of the fruits is similar to that of existing types, except that the number of spiral-cells is six instead of five. I am greatly indebted to Dr. Bell for specimens of these fruits.

Some spherical organisms with faint spiral markings have been found in the Calciferous Sandstone of Fife

and Edinburgh, in association with remains of *Entomotraca*. These may possibly be the fruits of a Charophyte, but their structure is too imperfectly preserved to admit of a conclusion being reached. I am indebted to Dr. Kidston for the opportunity of examining them.

As regards the MESOZOIC era, the reputed discoveries of Charophyte remains in the Trias and Lias have already been referred to (p. 72).

JURASSIC.—In the Bajocian stage of the Oolites detached Charophyte-fruits have been found in the Chipping Norton Limestone, in three of the Neaeran Beds (associated with marine organisms), and in the Paludina Bed, above, at Sharp's Hill (Oxon.); in the Bathonian stage, in the Forest Marble near Tarlton (Glos.), they have also been found, again in association with marine organisms. Both the Bajocian and Bathonian fruits belong to several types, but these have not yet been worked out, with the exception of one from the Forest Marble described and figured by Mr. Upton as *Chara lævigata* (27). I am indebted to Messrs. Upton & Walford and to the late Mr. Windoes for the opportunity of examining the various gatherings. No doubt the association of the fruits with marine organisms is due to their having been washed out to sea. If they had belonged to plants inhabiting the sea, there would almost certainly be many remains of them in the numerous marine formations of that period. From the Oxfordian stage in the Dépt. Lot, Saporta (18) described and figured under the name of *C. Bleicheri* a small Charophyte-fruit with tubercles on the spiral-cells. The nature of these tubercles, which occur frequently on Tertiary fossil fruits, is not at present understood. In some cases they may be due to external incrustation, but in others, such as those shown in Fig. 30, they seem much too regular and symmetrical in outline to be attributable to this cause.

The MIDDLE PURBECK Beds of Dorset abound in Charophyte remains, and, both in point of diversity in

types and condition of preservation, represent by far the most productive field for the study of the fossil forms of this group which has yet been discovered. The remains occur in limestone and chert and comprise both vegetative parts and fruits, the latter being in a few cases attached to the branchlets. The prevalent type, described and figured by Clement Reid and myself under the name of *Clavator* (16), is the only one which has yet been worked out. Some sections of the stem were described and figured by Mr. E. B. Wethered in 1889 (28). Whether or not it was the *Chara Purbeckensis*, of Forbes MS., there is no evidence to show. *Clavator* presents some very remarkable points of difference from any other Charophyte, recent or fossil. Its outstanding features are :

1. The oogonium being enclosed in an outer utricle, or nut (see Plate XLV, Fig. 8). These utricles have longitudinal ribs with somewhat rounded hollows between, and our conclusion was that the ridges represent part of the side walls of more or less cylindrical cells adnate to one another, and of which the outer portions of the walls had not been preserved. In a living South African species of *Chara* the bracteoles and bract-cells which partially surround the fruit are swollen in the middle and taper at each end, the tips tending to converge. Were these to become more numerous, and adnate to one another, a structure would be produced very similar to the utricle of the Purbeck plant as we interpreted it.

2. The remarkable development of the cortex of the stem. The stem-cortex consists invariably of twelve rows of cells. On the portions of the stem remote from the nodes the twelve rows are of about equal diameter (see Fig. 2); as they approach a stem-node six of them rapidly increase in diameter (see Figs. 3-4), so that at the node they form a spindle-shaped thickening, in most cases tapering about equally upwards and downwards (see Fig. 1). The alternating six rows do not increase in size, but are forced outwards by the larger ones, and lie in valleys between them (see transverse section,

Fig. 5). From the thickest part of the node six spreading branchlets are produced (see Fig. 1). Some of the thickened nodes, which we thought were probably the terminal ones, are truncated above, and in these cases the branchlets take a more upward direction (see Fig. 7).

3. The production on the stem-cortex and on the branchlets, which are ecorticate, of small more or less symmetrically clustered club-shaped processes (see Fig. 6). These are quite unlike the spine-cells of *Chara* in that they are not separate cells, but protuberances from the cortical-cells and branchlet-segments, with which they communicate at their base. They are therefore similar to the club-shaped protuberances on the fronds of some species of *Caulerpa*. In many of the fossil specimens the lower parts only of these protuberances are preserved. Among the other types present in the Dorsetshire material is one with a corticate stem, but in other respects somewhat *Nitella*-like in its growth. This type was found well-preserved in a single block of chert. Among the remains there are many detached fruits widely different in form and size, one of them extremely minute—the smallest *Charophyte*-fruit, I believe, which has yet been discovered.

In 1891 Saporta (19) described and figured, under the name of *C. Maillardi*, from the Purbeck Beds of Jura, some curious pyriform organisms, with numerous longitudinal ridges, which appear, from the figures, to bear some resemblance to the utricles of *Clavator*. In 1865 Heer (4) described and figured under the name of *C. Jaccardi* a small ellipsoid fruit also from the Purbeck Beds of Jura. In Purbeck marl, obtained near Haddenham (Bucks), Dr. Morley Davies found some specimens of a very small ellipsoid-biconical fruit.

WEALDEN.—In this series Charophyte remains are not common. As exemplified by specimens in the British Museum from Ecclesbourne near Hastings, for the first time we here meet with the large spherical fruits of the type of *C. medicaginula*, Brongn.—a type which with little modification occurs in many of the

fresh- and brackish-water formations up to and including the Oligocene series, when it apparently became extinct. No doubt the modified forms in different beds represent several different species, and a number of specific names have been bestowed upon them. They have thick spiral-cells and the convolutions are therefore relatively few. In many specimens the tips of the spiral-cells are considerably swollen, which, from the analogy of living species, points to their having deciduous coronulæ, and to belonging to the division *Nitellæ*. Though in size and outline they somewhat resemble the fruits of *Nitellopsis* their structure is different. In *Nitellopsis* the oospore belongs to the elongated type characteristic of the *Chareæ*, while in the *medicaginula* type the oospore itself is spherical. The nearest approach to the fossil fruit among living species is to be found in *Tolypella nidifica*, Leonh. The curious organism from the Wealden beds near Hastings, described and figured by Prof. Seward (21) as *Chara Knowltoni*, did not seem to Clement Reid or myself to belong to the Charophyta.

CAINOZOIC or TERTIARY era.

EOCENE.—In some very restricted beds belonging to the lowest Tertiary formation which are exposed in the neighbourhood of Triest and in a narrow area running some distance southwards, Dr. Stache discovered a large number of Charophyte-remains. These he described with excellent figures in his splendid memoir, 'Die Liburnische Stufe' (24), the name given to the formation in question. In this work, and in a short paper with the same title which preceded it (23), two important new genera and many species were described and figured. Most of the fruits figured belong to the spherical type already referred to. Some of them have the curious tubercular processes on the spiral-cells mentioned on p. 78. Fruits having these processes were described by Lyell (11) from the Oligocene beds of the Isle of Wight, and were named by him *Chara tuberculata*.

Dr. Stache constituted a separate genus, *Kosmogyra*, for the plants with fruits so ornamented. The tubercles on the fruits of one of his species, *K. superba* (see Fig. 30), are remarkably regular in arrangement and evenly rounded in outline. The other new genus, *Lagynophora*, is based on a number of vegetative parts as well as fruit remains, and represents an extremely interesting and distinct type (see Fig. 31). The fruits, as the name implies, are flask-shaped, the spiral-cells being prolonged upwards and forming a cylindrical projection at the apex. The fruits occur in great numbers attached to the branchlets—a very unusual state of things with fossil Charophytes. The plant was extremely small,

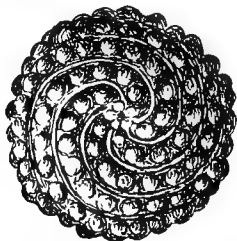


FIG. 30.—*Kosmogyra superba*, Stache (after Stache), from Lower Eocene, Liburnische Stufe, end view.

the fruiting whorls apparently not much exceeding 3 mm. across. The stem was corticate, the whorls consisted of 6–9 branchlets formed in some species of one, in some of more than one segment, but with only a single fruiting node. At the node (or nodes) a whorl of lateral rays arise, which, at the fruiting nodes, surround the fruit. Five species were described. Thanks to the kindness of Dr. Drejer I have had the opportunity of examining some of Dr. Stache's type-specimens of *Charophyta* preserved in the Vienna Museum.

In some Eocene beds of North America, the age of which in relation to the European beds it is difficult to fix, Dr. Knowlton (7) found several types of Charophyte-fruits, one of which, *C. compressa*, Knowlt., is appreciably broader than long.

In several of the Middle and Upper Eocene beds in this country Charophyte-fruits have been found rather sparingly, but of these none is of a sufficiently distinct type to call for notice.

In the Headon beds, variously regarded by geologists as Eocene and Oligocene, the remains are particularly abundant, and a number of types of fruit are represented. In the Lower Headon beds of Hordle Cliffs (Hants), alone, as many as 16 more or less distinct forms were described and figured by Clement Reid and myself (17); a few of these are shown on Plate XLV, Figs. 11–18. One of the large spherical type, *C. Wrightii*, Salter, occurs in

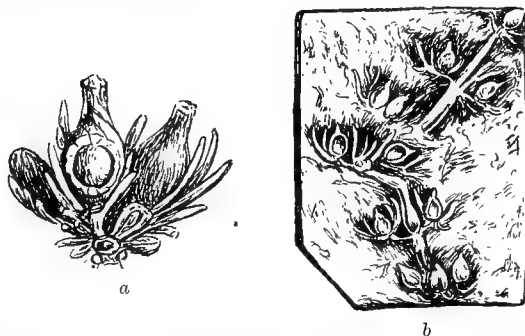


FIG. 31.—*Lagynophora*, Stache (after Stache), from Lower Eocene.
a, *L. liburnica*, St.; b, *L. symmetrica*, St.

immense quantity, two types of tuberculate fruit, a large ellipsoid fruit which we referred to *C. helicteres*, Brongn., and two very minute forms belonging almost certainly to the genus *Tolypella* were present. Portions of stems and branchlets were found in one of these beds in fair quantity, also a few stem-nodes with the bases of branchlets. The cortex of some of the stems is of the single-ranked type (*Haplostichæ*), a type rare at the present time, others of the common two-ranked type (*Diplostichæ*). I have not so far met with any of the three-ranked type (almost equally common in living species) among Eocene or Oligocene remains.

The Eocene and Oligocene of the Paris Basin are

particularly rich in Charophyte-remains and many specific names have been given to them. We are indebted to Messrs. Dollfus & Fritel (3) for a recent conspectus of the various types recognized. The Oligocene series of the Isle of Wight (Osborne, Bembridge and Hamstead beds) abound in remains of these plants, but these have not yet been fully worked out. In the Bembridge beds one of the large *medicaginula* type of fruits and *C. tuberculata* are the most prevalent. In the "White Band" of the Hamstead beds *C. tuberculata* and *C. helicteres* occur in great numbers, in small "pockets."

MIOCENE.—Charophyte remains, both fruits and vegetative parts, are plentiful in the Miocene beds, which are not represented in this country. A number of specific names have been given to them. Of the types of fruit the most remarkable is a very large obovoid one, *C. Meriani*, Braun.

PLIOCENE and PLEISTOCENE.—In some of the Pliocene and Pleistocene beds *Chara*-fruits are abundant, but, as might be expected, these resemble for the most part those of species common and widely distributed at the present day. In the Cromer Forest Bed, Reid found a large type of fruit which I have little hesitation in referring to *Nitellopsis obtusa*, and a small rather cylindrical type resembling that of *C. connivens*. Both of these are comparatively rare species but both still grow in Norfolk. The vegetative parts of *Charas* are also present in some of the beds, occasionally forming great masses of so-called "shell-marl," and in all probability many deposits of lime which now show no trace of organic structure originated in the same manner (see Vol. I, p. 11).

Among the fossil remains of Charophytes no trace of antheridia has up to the present, I believe, been found. This is, no doubt, due to the very delicate thin-walled cells of which this organ is formed. In many of the clay and limestone deposits detached fruits only are found, and, when accompanied by vegetative remains, the latter are in such small fragments that it is not possible to reconstruct the plant. Occasionally only are

nodes of the stem preserved. The solitary instance in which I have been able to make out stipulodes clearly was in some chalcedonized rock of uncertain age from Matabeleland, described by Mr. R. Bullen Newton (14). Of the fruits it is often the outer part consisting of the spiral-cells only which is preserved, but sometimes the oospore is also present. The coronula is apparently never preserved, no doubt because its cells do not secrete lime. In one instance only have fruits been found of the longitudinally flattened form characteristic of the genus *Nitella*.* In the Tertiary marls and limestones this is to be accounted for by the fact that the fruits of *Nitella* do not develop a lime-shell, but in the cherts of earlier formations in which thin-walled cells are perfectly preserved, if plants with the flattened type of fruit existed one would expect to find some trace of them.

In most productive deposits more than one distinct type of fruit, and often several, are present, so that it is rarely possible to identify fruits and vegetative parts as belonging to the same species.

Very much still remains to be done in connexion with the fossil remains of the *Charophyta*, and it is from the siliceous rocks of Mesozoic and Palæozoic eras that the most important results are to be looked for. From the remains of the *Charophyta* which have as yet been found, there is no reason to suppose that they were ever larger plants than at the present time. There are no signs of an exuberant development like that exhibited by the Palæozoic Pteridophytes. Charophyte-remains are not often found in company with those of other water-plants, from which it may be inferred that they usually monopolized the pieces of water in which they occurred, much as they do at the present time.

The fact that the very specialized form of "fruit" has remained practically unchanged, from Carboniferous times to the present day, would seem to point to the *Charophyta* representing an extremely ancient and

* From a deposit near Moscow regarded as Interglacial.

distinct type of vegetation, and not, as some authors suppose, merely a subordinate group of *Algæ*.

Had not the untimely death of my valued friend Clement Reid interrupted our joint work in this field, it would have been possible to give a more complete account of the fossil remains in the British deposits. I am very much indebted to Mr. W. N. Edwards, of the British Museum, for the great assistance he has rendered me in connexion with this chapter, and at all times with fossil *Chara* work. My grateful thanks are due to Dr. Kidston and Prof. Lang for permission to reproduce some of the illustrations in their memoir on the Rhynie Chert, to Dr. Bell for a like permission in respect to his figures of *Palæochara*, to Miss M. E. J. Chandler, Mr. G. W. Colenutt, Dr. Morley Davies, MM. Dollfus and Fritel, Dr. Kitchin, Dr. Kidston, Prof. Lang, Mr. R. B. Newton, Dr. J. Pia, Mrs. E. M. Reid, Dr. Scott, Prof. Seward, Mr. C. D. Sherborn, Dr. Marie Stopes, Mr. Hamshaw Thomas, Dr. G. R. Wieland, and other friends and correspondents who have kindly helped me from time to time with specimens and information. I have to thank Miss Maud Neal for kindly copying the text-figures.

TABLE SHOWING RANGE IN TIME OF THE CHAROPHYTA.

PALÆOZOIC.

CARBONIFEROUS.

Coal Measures :

Palæochara acadica, Bell.

MESOZOIC.

JURASSIC.

OOLITIC.

Lower Oolites—Bajocian :

Charæ (sens. latiss.) spp. (indet.).

Lower Oolites—Bathonian (Forest Marble) :

Chara lævigata, Upton, and *C.* spp. (indet.).

Middle Oolites—Oxfordian :

C. Bleicheri, Sap.

Upper Oolites—Purbeckian :

C. Jaccardi, Heer, *C. Maillardi*, Sap., *C.* spp. (plur. indet.),
Clavator Reidii, J. Groves.

MESOZOIC—continued.**CRETACEOUS.**

Wealden :

Charæ spp. (indet.).

Upper Cretaceous :

C. polonica, Ung., *C. Stantonii*, Knowlt., *C. Malcolmsonii*, Sowerby.**CAINOZOIC.****EOCENE.**

Eocene of America (age uncertain) :

C. compressa, Knowlt.

Liburnian :

C. Stacheana, Ung.; *C. cosinensis*, *C. devastita*, *C. globulus*, *C. doliolum*, *C. robusta* and *C. subimpressa*, all of Stache; *Kosmogyræ acanthica*, *K. guttifera*, *K. ornata*, *K. perarmata*, *K. cingulata* and *K. superba*, all of Stache; *Kosmogyrælla carinata*, Stache; *Lagynophora articulata*, *L. foliosa*, *L. liburnica*, *L. nodulifera* and *L. symmetrica*, all of Stache.

Thanetian :

C. minima, Sap., *C. helicteres*, Brongn.

Sparnacian :

C. helicteres, Brongn., *C. torulosa*, Dollf. & Fritel, *C. squarrosa*, D. & F., *C. Nielfalensis*, D. & F., *C. Dutemplei*, Watel., *C. onerata*, Watel., *C. sparnacensis*, Watel.

Ypresian (London Clay) :

C. sp. (indet.).

Lutetian :

C. Archiaci, Watel., *C. Lemanii*, Brongn.

Auversian :

C. Archiaci, Watel., *C. Lemanii*, Brongn., *C. fyeensis*, Crie.

Marinesian (or Bartonian) :

C. Archiaci, Watel., *C. Lemanii*, Brongn., *C. crassa*, D. & F., *C. elegans*, D. & F.

Ludian (Headon Beds) :

C. anaplotheriorum, Sap., *C. aragonensis*, Braun, *C. destructa*, Sap., *C. Grepini*, Heer, *C. siderolitica*, Grepin, *C. Voltzii*, Braun, *C. helicteres*, Brongn., *C. Wrightii*, Salter (? = *C. medicaginula*, Brongn.), *C. calata*, *C. vasiformis*, *C. distorta*, *C. tornata*, *C. subcylindrica*, *C. polita*, *C. strobilocarpa*, *C. turbinata*, *Tolypella headonensis* and *T. parvula*, all of Reid & Groves.

Ludian (Osborne Beds) :

C. Lyellii (? = *C. medicaginula*).

Eocene of Hungary :

Characeites verrucosa, *C. globosa* and *C. acuminata*, all of Tuzson.**OLIGOCENE.**

Sannoisian (Paris Basin) :

Chara elegans, D. & F., *C. Tournoueri*, Dollf.

Sannoisian (Bembridge Beds) :

C. medicaginula, Brongn., *C. tuberculata*, Lyell, *C. spp.* (indet.).

CAINOZOIC—*continued.***OLIGOCENE**—*continued.*

Sannoisian (Hamstead Beds):

C. helicteres, Brongn., *C. tuberculata*, Lyell, *C. Escheri*, Braun (*vide* Heer), *Tolypellæ*, spp. (indet.).

Sannoisian (?):

C. petrolei and *C. variabilis*, Andræ.

Firmitian (or Stampian):

C. Brongniarti, Braun, *C. medicaginula*, Brongn., *C. depressa*, Wat.**OLIGOCENE or MIOCENE.**

Aquitanian:

C. Boulleti, Unger, *C. Brongniarti*, Braun, *C. Escheri*, Braun, *C. granulifera*, Heer, *C. helicteres*, Brongn., *C. inconspicua*, Braun, *C. medicaginula*, Brongn., *C. Meriani*, Braun, *C. prisca*, Ung., *C. Rochettiana*, Heer, *C. Rollei*, Ung., *C. Sadleri*, Ung., ? *C. stiriaca*, Ung., ? *C. Schübleri*, Ung.**MIOCENE.**

Burdigalian and Helvetian:

? *C. Bernouillii*, Braun, ? *C. Reussiana*, Ettingsh.

Tortonian (Eningen Beds):

C. Blassiana, Heer, *C. dubia*, Braun, *C. Zolleriana*, Heer.

Miocene of Hayti:

C. Woodringi, Berry.

Florissant Beds:

C. peritula, Cockerell.**PLIOCENE.**

Plaisancian:

? *C. Zoberbieri*, Fritsch.

Cromerian:

? *Nitellopsis obtusa*, J. Groves, ? *C. connivens*, Braun, *Charæ*, spp. (indet.).**PLEISTOCENE.**

Many Charophyte remains referable with little doubt to living species.

The foregoing is to a great extent based on a MS. table drawn up by the late Clement Reid. The paper by MM. Dollfus & Fritel (3) has been followed as regards the range of species in the Paris Basin.

The generic name *Chara* has been used in its original and broadest sense, the parts of the plants on which the parent genus has been divided, the coronula and antheridium, not being preserved in the fossils.

It is not claimed that the table is in any way complete—it has not been practicable to verify all the real or

supposed Charophyte-remains on record—but it is hoped that the table may be of some use as a rough outline for further work.

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- (6) **Kidston, R., & W. H. Lang**, "On Old Red Sandstone Plants . . . from the Rhynie Chert Bed, Aberdeenshire, V," 'Trans. Roy. Soc. Edinb.' LII, iv, pp. 876-81, tt. 8-9 (1921).
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COLLECTING AND PRESERVING
CHAROPHYTA.

FOR field work the collector will do well to provide himself with a substantial vasculum, a drag, and, if possible, a hoe. The ordinary tin vasculum when used for collecting water plants quickly becomes rusty and defective unless protected by an inside coating of paint. A vasculum made of zinc obviates this disadvantage. A drag is a necessity where the water to be explored is deep. At the same time it should be emphasized that nothing can take the place of the hand where the plants are within arm's reach. The hand can carefully feel for, detach, and hold the roots, and these are usually the toughest part of the whole plant. A specimen thus held and lifted can usually be brought to the surface not only undamaged, but retaining its characteristic form of growth. Moreover the root forms an important feature of the plant, since, in many species, the root bears the curious starch bulbils which differ in shape and form according to the particular species.

When a plant is growing beyond arm's length, a small garden hoe will prove a very useful assistant. If the handle is made in two sections with a screw adjustment, it becomes easily portable, and also provides a longer reach. The blade of the hoe can get down to the roots and the whole plant can be brought to the surface resting on the flat of the blade.

Where neither hand nor hoe can operate a drag is necessary. This should consist of a bulb of lead about from $\frac{1}{2}$ to 1 lb. in weight, with three or more hooks of strong galvanized iron wire. Wire rather than iron has the very substantial advantage that it will straighten out when it may have chanced to get caught in some obstacle, and can thus free itself. The line should be

of stout water-cord about $\frac{1}{8}$ inch thick, and twenty yards will generally be found sufficient. The drag can be thrown from the shore, or, better still, where the water is deep, be used from a boat.

Thus equipped the collector will find himself within reach of most water beds that he may desire to explore.

The Charophytes with their delicate structure can seldom hold their own with stronger vegetation. Old ditches and pools therefore which show any large growth of other water-plants seldom yield Charophytes. Their favourite habitat is a newly-dug or newly-cleaned ditch, or a clay pit where stronger vegetation has not yet established itself. They are frequently found in abundance in lakes and rivers, but usually in massed growth for support and protection.

It has to be borne in mind that many Charophytes are both local and fugitive. A species may be found in lake or other piece of water in some one quite restricted area, while the rest of the water shows no sign of the plant. Again, a species which grows in abundance one year may be wholly absent from the same spot another year. Thus the collector needs to search a water area in all its reaches and for several years before he can be satisfied as to the various species which that area yields.

Plants should, if possible, be collected at the various stages of their development, but it is specially important to secure specimens in their full fruiting state. This is particularly important in the case of the Nitelleæ. *N. flexilis* cannot be distinguished with certainty from *N. opaca* when the fruit is absent, and in the case of dioecious species the sexes can only be distinguished by their gametangia. Except when quite out of season fruiting specimens can generally be found with a little searching.

When a specimen has been brought to the surface it will usually require a considerable amount of washing to free it from the mud and from other matter collected in its branchlets. This can best be done by holding

the plant by its roots (when the root has been secured) and drawing it from right to left and left to right through the water for a few moments. Then hold it up till as much water as possible has run off.

It should be laid straight out on a piece of paper or calico of suitable size, wrapped up, and placed at once in the vasculum to avoid exposure to the air. The water which collects gradually in the vasculum must from time to time be drained off, otherwise the plants will become sodden and injured.

The preparation of specimens for the herbarium is not quite easy, but few plants better repay a little care and pains in pressing and drying.

Charas can sometimes be pressed without floating out, though few specimens can be gathered in such condition that they will not require some amount of washing at home. The Nitelleæ should always be floated out in the same way as Algæ—that is, a sheet of paper placed in a pan of water, and the plant (after having been washed) placed on it, and arranged as naturally as possible with the fingers or a brush. The shallow “baths” used by photographers are excellent for the purpose, but an oblong, white enamelled-iron or zinc tray about 2 inches deep is equally serviceable and more portable. Failing either of these, a large dish or basin may be used. A sheet of perforated zinc laid under the paper will be found of great assistance in removing the specimens from the water. Good, firm white printing paper should be used for floating the specimens upon. In the case of dioecious species the sexes should, if possible, be kept apart and either placed on separate sheets of paper, or perhaps preferably a specimen of each placed side by side on the same sheet.

When the specimen has been removed from the water it should be drained, and a piece of thin calico or linen (previously washed free from dressing) should be placed over it to prevent its adherence to the drying-paper. The calico should be removed when the drying-paper

is first changed. With very gelatinous species waxed paper should be substituted for calico.

If the plant has submitted to a successful floating out in the first instance, no further handling will be necessary, but where any specimen is refractory it will be found convenient to arrange and adjust it after it has undergone pressure for a couple of hours or so between two or three sheets of drying-paper. In this damp and pliant condition the plant lends itself to easy manipulation, and overlooked extraneous weeds or other matter can be detected and removed. After the first change of drying paper the plants should be subject to very considerable pressure—preferably by a heavy weight resting on the top rather than in a press, where the pressure is liable to be unevenly distributed and does not follow the shrinkage of the specimens in the process of drying.

The Charophytes naturally yield up their moisture very rapidly, frequent changes of drying-paper are therefore desirable. With three or four such changes the plants are dry in a week or so, and are ready for the herbarium.

It has been a common practice in preparing herbarium specimens to arrange them in tufts, and there is much in favour of this plan as giving a more correct idea of the plants as they grow, but if adopted, care must be taken that the selected plant is not too thick. On the other hand, if the stems are arranged separately, the comparative length of the internodes, the extent of the branching, etc., are more clearly seen. In any case it is advisable for some selected specimens to be arranged separately. A few good fruiting whorls, and in the case of Charas, portions of stem, may advantageously be dried separately, to be placed in pockets for attachment to the herbarium sheets, and thus avoid the necessity of mutilating the specimens for purposes of examination.

It is also well to select a few good fruiting whorls from each species collected and preserve them in a test-tube of formalin solution (about 2 per cent.) for microscopic exa-

mination, since no reliable determination can be arrived at without the aid of a microscope. For examination of dried specimens reagents will often be found useful. The *Charas* usually secrete a large amount of lime, which has to be removed before the plant can be examined. This is successfully ensured by placing the piece to be examined in a weak solution of sulphuric, nitric, or hydrochloric acid. The acid, moreover, has the effect in many instances of reviving the tissues. For the *Nitelleæ*, which do not secrete lime in the same way, strong ammonia sometimes serves as an effective reagent. The piece to be examined may be placed on a slide, a little ammonia dropped on it, and then boiled over a spirit-lamp. The specimen should be well washed before mounting. Iodine is often found useful in preparing specimens for examination.

For histological study it will be found convenient to keep growing plants. If not exposed to too much light most of the Charophytes will grow well in tanks, bell-glasses, or even comparatively small jars, with a small amount of earth at the bottom. It is best to keep each species in a separate receptacle, to use rain-water to avoid incrustation, and to have a few of the common fresh-water mollusca in each receptacle to prevent the plants being choked and the glass discoloured by minute Algæ.

G. R. B.-W.

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ADDITIONS AND CORRECTIONS TO VOL. I.

p. 96, line 24. After "genus" add *Tolypella nidifica* and a few *Charæ*.

p. 102. Add [*Nitella opaca*]:—

Var. c. **brachyclema**.

GR. & B.-W. Journ. Bot. LXII, p. 33 (1924); Exsicc. No. 22 (1924).

Stem very stout (diameter \rightarrow 800 μ), *internodes* much elongated, *branchlets* short stout incurved, *dactyls* often longer than the primary rays.

In fairly deep water in lakes.

We have seen specimens from the following localities, and it is probably to be found in similar habitats elsewhere.

England: Westmoreland, Grasmere (*T. A. Cotton*, comm. *A. Bennett*).

Scotland: Caithness, Yarehouse Loch, near Wick (*J. Grant*, comm. *W. H. Beeby*); Shetland, Asta Loch (*G. C. Druce*).

Ireland: Donegal, W., Kindrum Lough; Lough Naglea (*G. R. B.-W.*).

A very large distinct-looking plant resembling *N. translucens*, attaining to a metre in height, the internodes often as much as 12 cm. long and the branchlets usually quite short, the upper often very thick and tumid, not much longer than the diameter of the stem, strongly incurved, and giving the appearance of small knots along the branches. It fruits rather sparingly. This variety presents a marked contrast to the ordinary forms of *N. opaca*, which is characteristically rather a small compact-growing plant.

p. 109. *Nitella spanioclema*, add to Distribution:—

Scotland: Perth, W., Loch Lubnaig (*N. Annandale* & *N. G. J. Smith*, 1921).

p. 118. Last line should read [oogonia] "c. 425 μ long."

p. 140. *Tolypella nidifica*, add to Distribution:—

Scotland: Orkney, Loch of Stenness, Mainland, in brackish water (*G. C. Druce* & *H. H. Johnston*, 1920).

To the Exsiccata quoted under the various species add "British and Irish Charophytes," Gr. & B.-W. (1924), with the following reference numbers:—

p. 97. *Nitella capillaris*, No. 1.

p. 107. *N. flexilis* v. *Fryeri*, 2.

p. 108. *N. spanioclema*, 3.

p. 114. *N. mucronata*, 23, 24.

p. 121. *N. tenuissima*, 4, 25.

p. 127. *N. hyalina*, 5.

p. 138. *Tolypella glomerata* v. *erythrocarpa*, 6.

p. 139. *T. nidifica*, 26.

ADDITION TO VOL. II.

p. 86. The name of Mr. E. T. Newton to be added to the list of those to whom thanks are due for specimens and information.

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EXPLANATION OF THE PLATES.

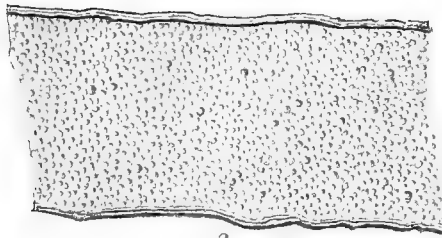
Plate 22

PLATE XXII.

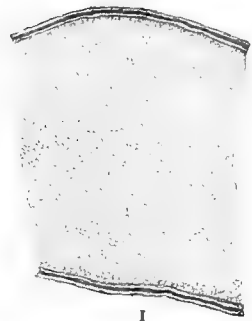
DECORATION OF MEMBRANES.

FIG.

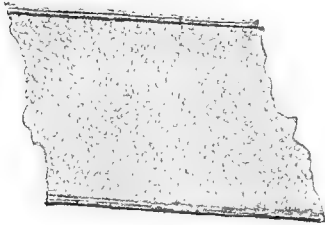
1. *Nitellopsis obtusa*. × c. 400.
2. *Lamprothamnium papulosum*. × c. 500.
3. *Chara Braunii*. × c. 600.
4. *C. canescens*. × c. 450.
5. *C. vulgaris*. × c. 600.
6. *C. rudis*. × c. 330.
7. *C. rudis*, showing the base of an oospore with the strongly-developed granules. × c. 240.
8. *C. hispida*. × c. 450.
9. *C. tomentosa*. × c. 400.
10. *C. tomentosa*, showing part of the base of the oospore with the more developed granules. × c. 400.



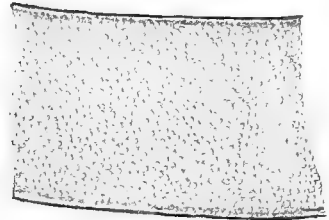
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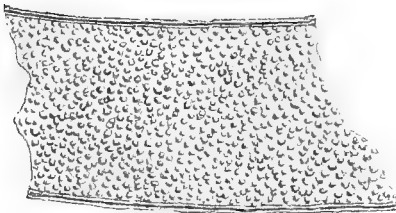
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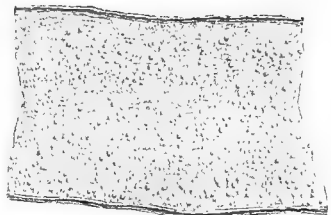
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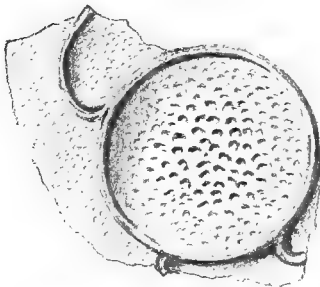
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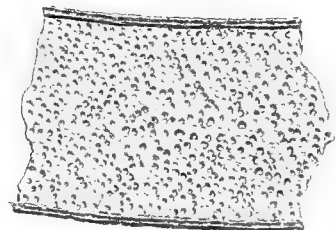
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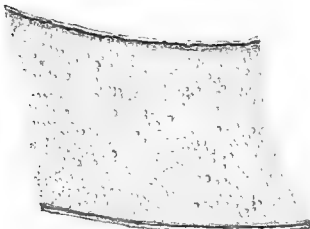
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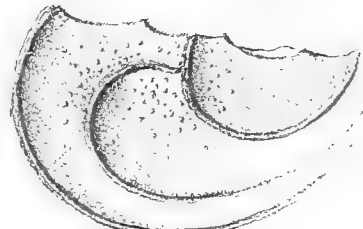
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10

DECORATION OF MEMBRANES

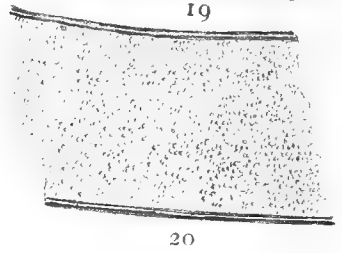
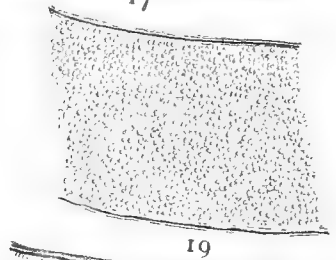
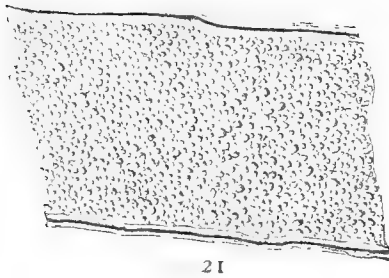
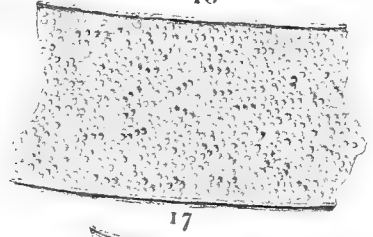
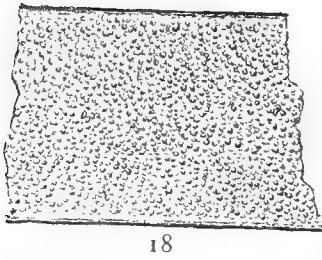
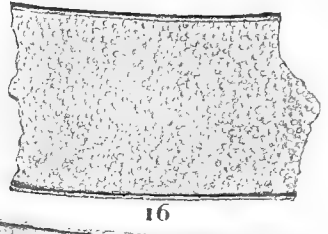
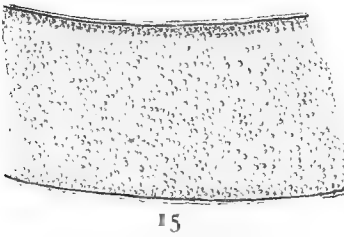
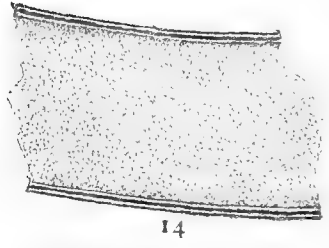
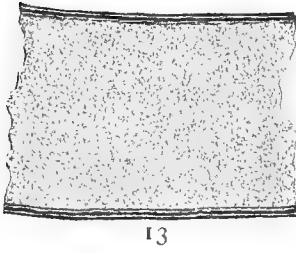
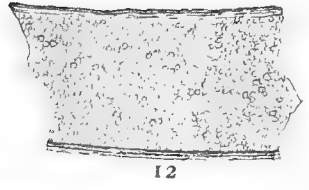
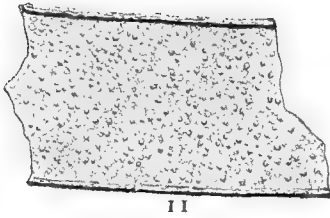
Plate 23

PLATE XXIII.

DECORATION OF MEMBRANES.

FIG.

11. *Chara contraria.* × c. 450.
12. *C. muscosa.* × c. 450.
13. *C. denudata.* × c. 360.
14. *C. baltica.* × c. 480.
15. *C. aculeolata.* × c. 400.
16. *C. aspera.* × c. 600.
17. *C. desmacantha.* × c. 600.
18. *C. connivens.* × c. 360.
19. *C. fragifera.* × c. 430.
20. *C. fragilis.* × c. 500.
21. *C. delicatula.* × c. 520.



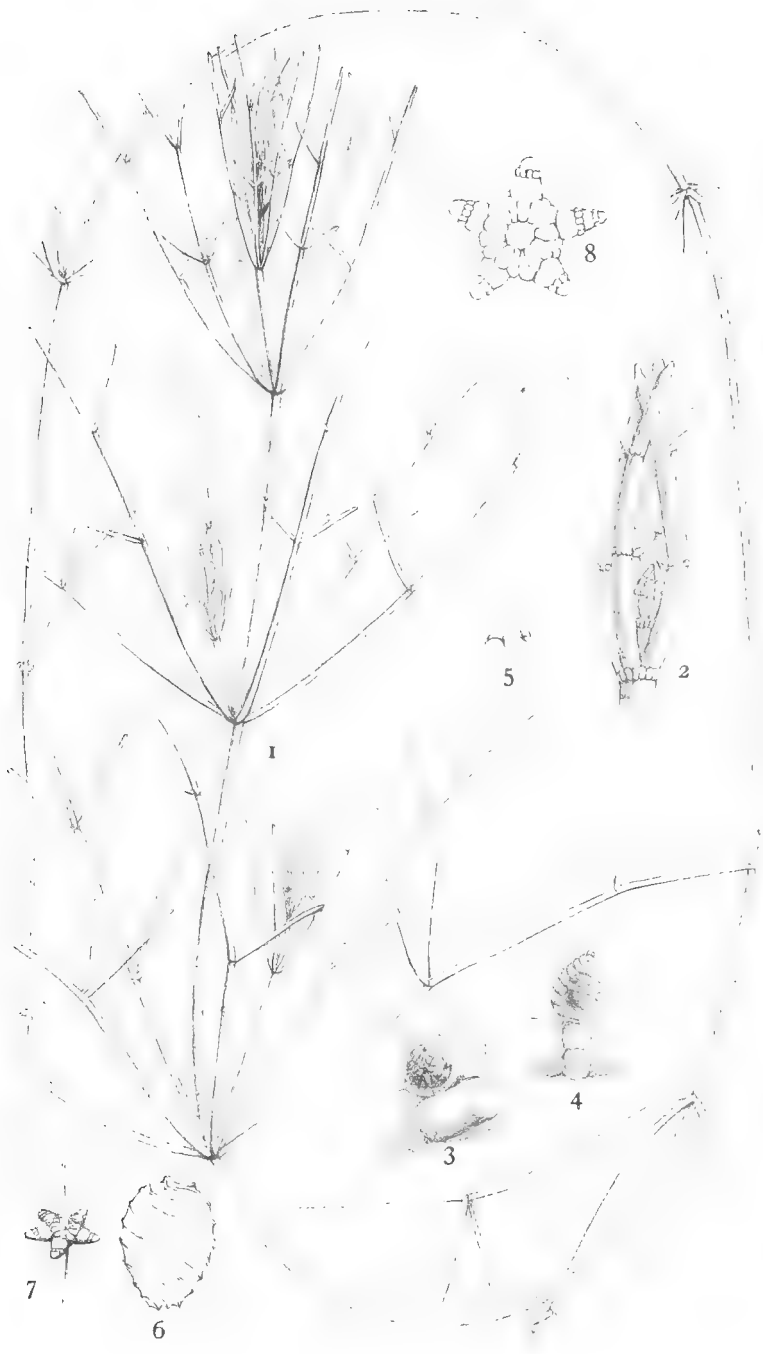
DECORATION OF MEMBRANES

PLATE XXIV.

Nitellopsis obtusa J. Groves.

FIG.

1. Plant, natural size, from Norfolk Broads.
2. Young whorl. \times c. 8.
3. Branchlet-node with antheridium. \times c. 10.
4. Branchlet-node with oogonium. \times c. 10.
5. Apex of oogonium with coronula. \times c. 30.
6. Oospore. \times c. 20.
7. Stelliform bulbil. \times c. 4.
8. Do., further enlarged. \times c. 8.



NITELLOPSIS OBTUSA

Plate 25

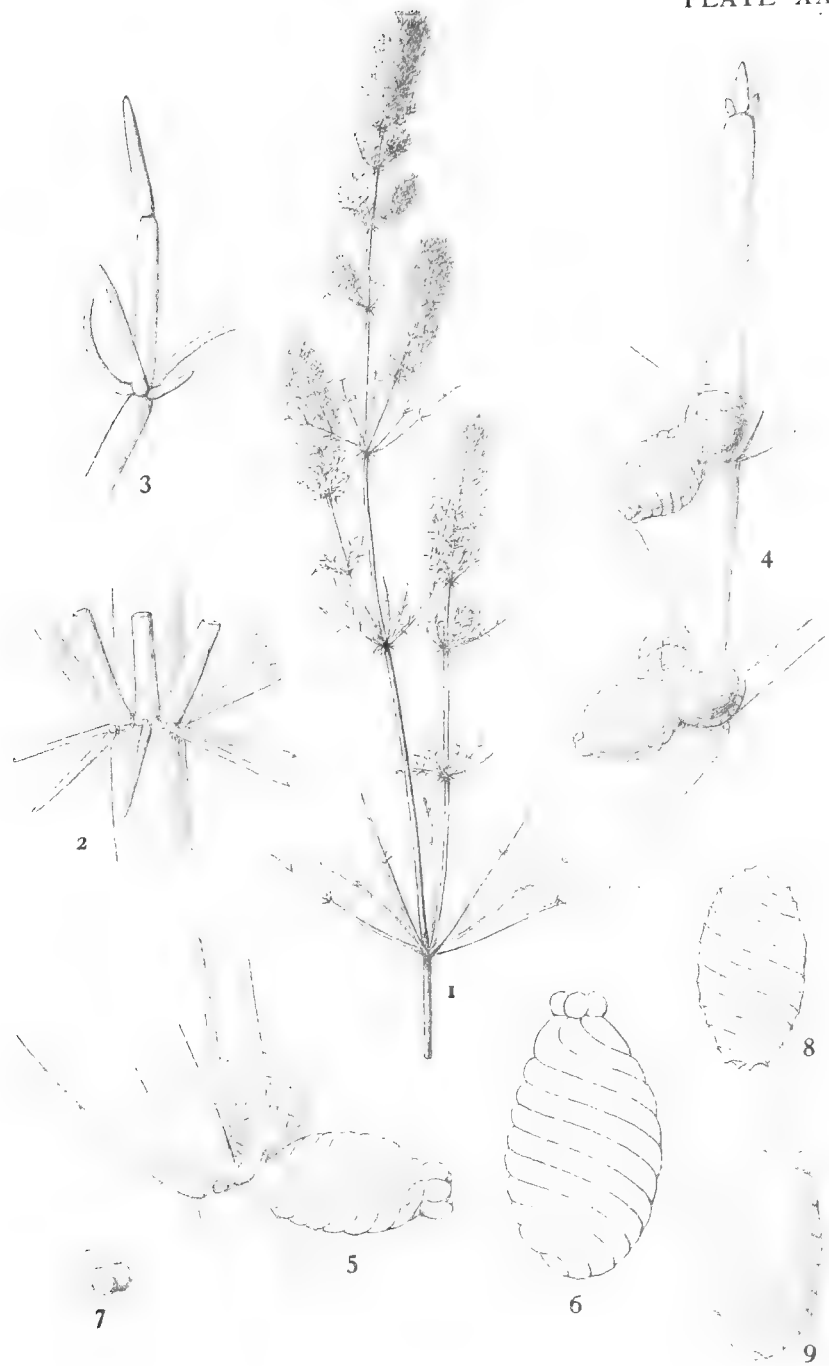
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PLATE XXV.

Lamprothamnium papulosum J. Groves.

FIG.

1. Plant, natural size, from Newtown, I. of Wight.
2. Base of whorl showing stipulodes. \times c. 20.
3. Apex of branchlet. \times c. 20.
4. Upper part of branchlet with two fertile nodes. \times c. 20.
5. Branchlet-node. \times c. 25.
6. Oogonium. \times c. 40.
7. Coronula. \times c. 40.
8. Oospore. \times c. 40.
9. Oogonium which has secreted lime-shell. \times c. 40.



LAMPROTHAMNIUM PAPULOSUM

Plate 26

PLATE XXVI.

Chara Braunii Gmelin.

FIG.

1. Plant, natural size, from Reddish, Lancs.
2. Base of whorl with one entire branchlet. \times c. 20.
3. Apex of branchlet. \times c. 60.
4. Branchlet-node with oogonium. \times c. 25.
5. Oospore. \times c. 50 (G. R. B.-W.).



CHARA BRAUNII

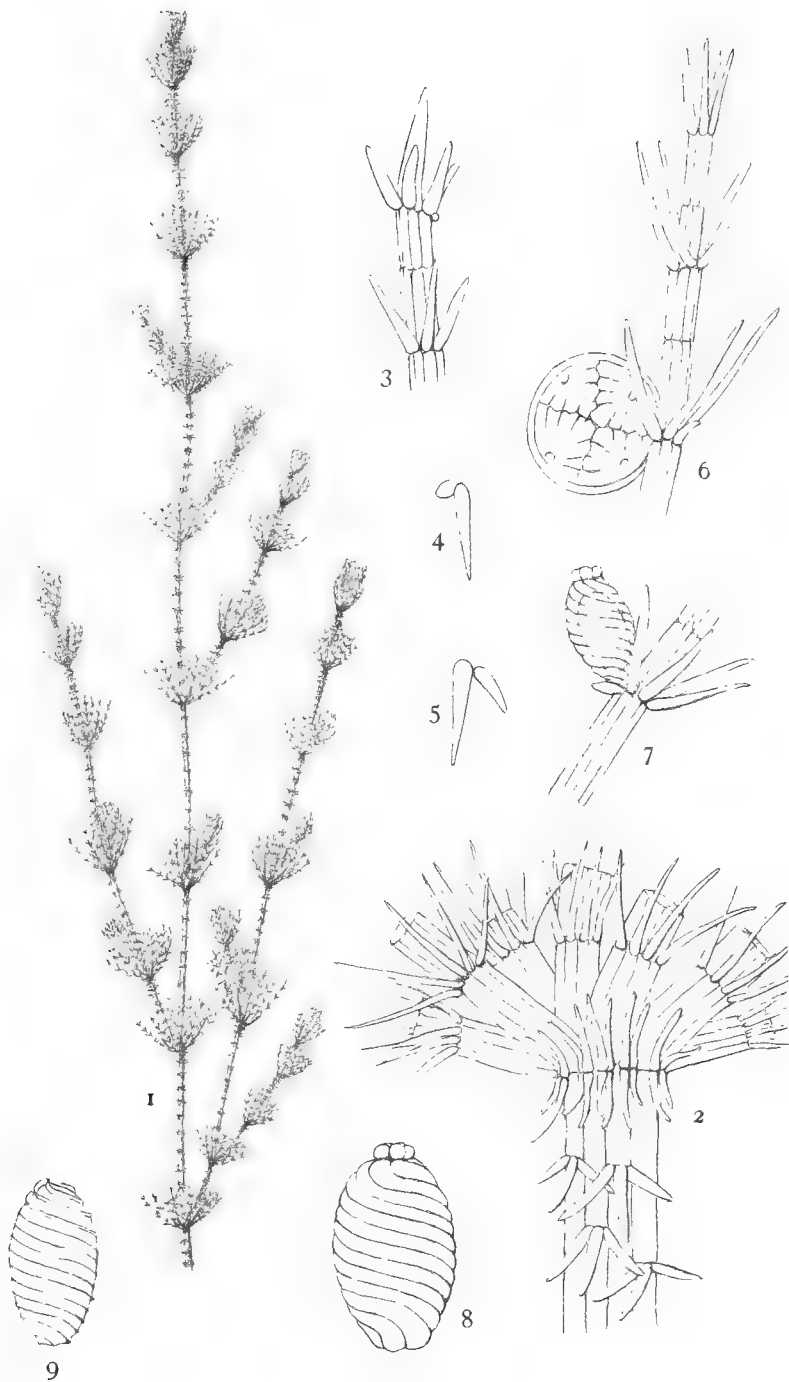
Plate 27

PLATE XXVII.

Chara canescens Loiseleur.

FIG.

1. Plant, natural size, from Studland, Dorset.
2. Portion of stem showing cortex, clustered spine-cells, stipulodes and bases of branchlets. \times c. 30.
3. Apex of branchlet. \times c. 25.
- 4, 5. Spine-cells. \times c. 25.
6. Upper portion of branchlet with fertile node, ♂ (from Hungarian specimen). \times c. 25.
7. Branchlet-node, ♀. \times c. 25.
8. Oogonium. \times c. 45.
9. Oospore. \times c. 45.



CHARA CANESCENS

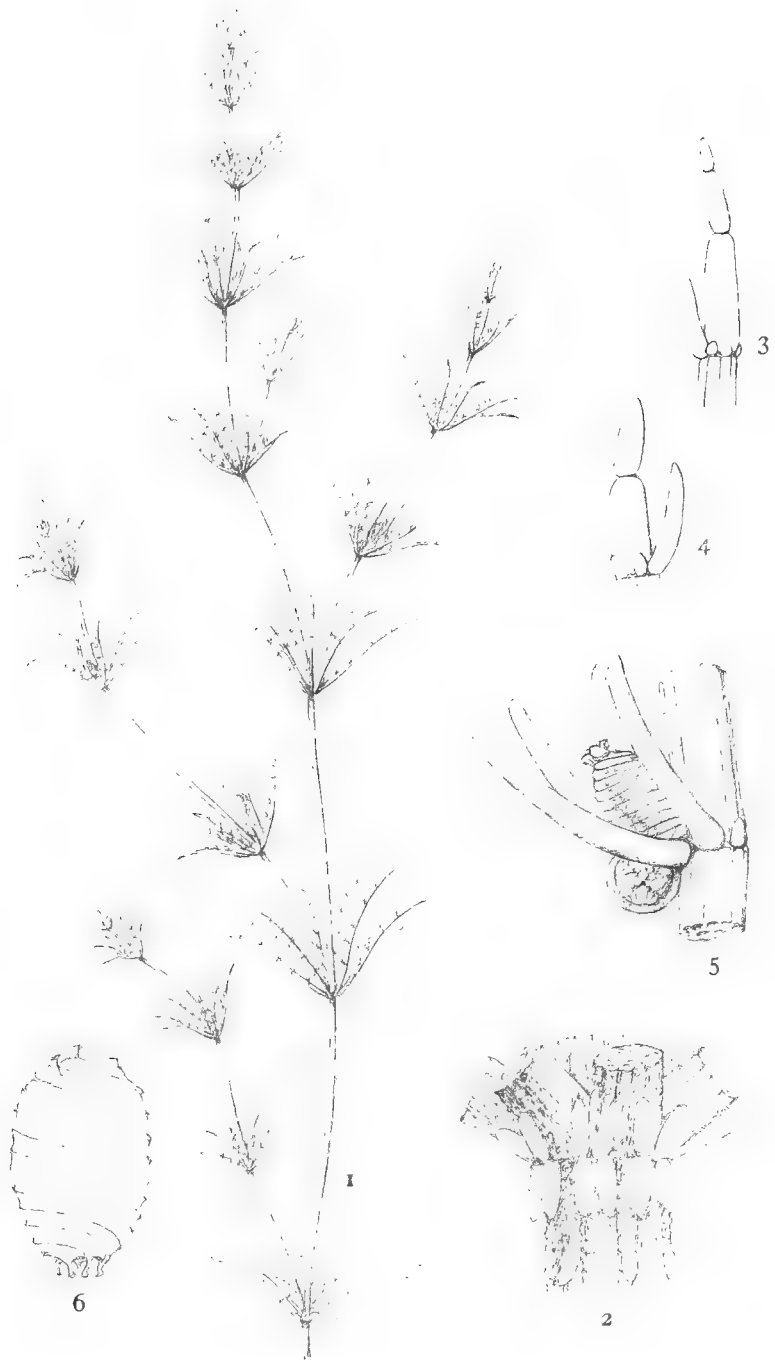
Plate 28

PLATE XXVIII.

Chara vulgaris Linnæus.

FIG.

1. Plant, natural size.
2. Base of whorl showing stipulodes. \times c. 25.
- 3, 4. Apices of branchlets. \times c. 25.
5. Fertile branchlet-nodes. \times c. 25.
6. Oospore. \times c. 50 (G. R. B.-W.).



CHARA VULGARIS

Plate 29

PLATE XXIX.

Chara vulgaris Linnæus, varieties.

FIG.

1. Var. *refracta* (*C. refracta* Kütz.), from Plumstead, W. Kent.
2. Var. *papillata* Wallroth, from Folkestone, E. Kent.
3. Var. *longibracteata* Kützing, from Freshwater, I. of Wight.
4. Var. *crassicaulis* Kützing, from Burwell, Cambs.



CHARA VULGARIS, VARIETIES

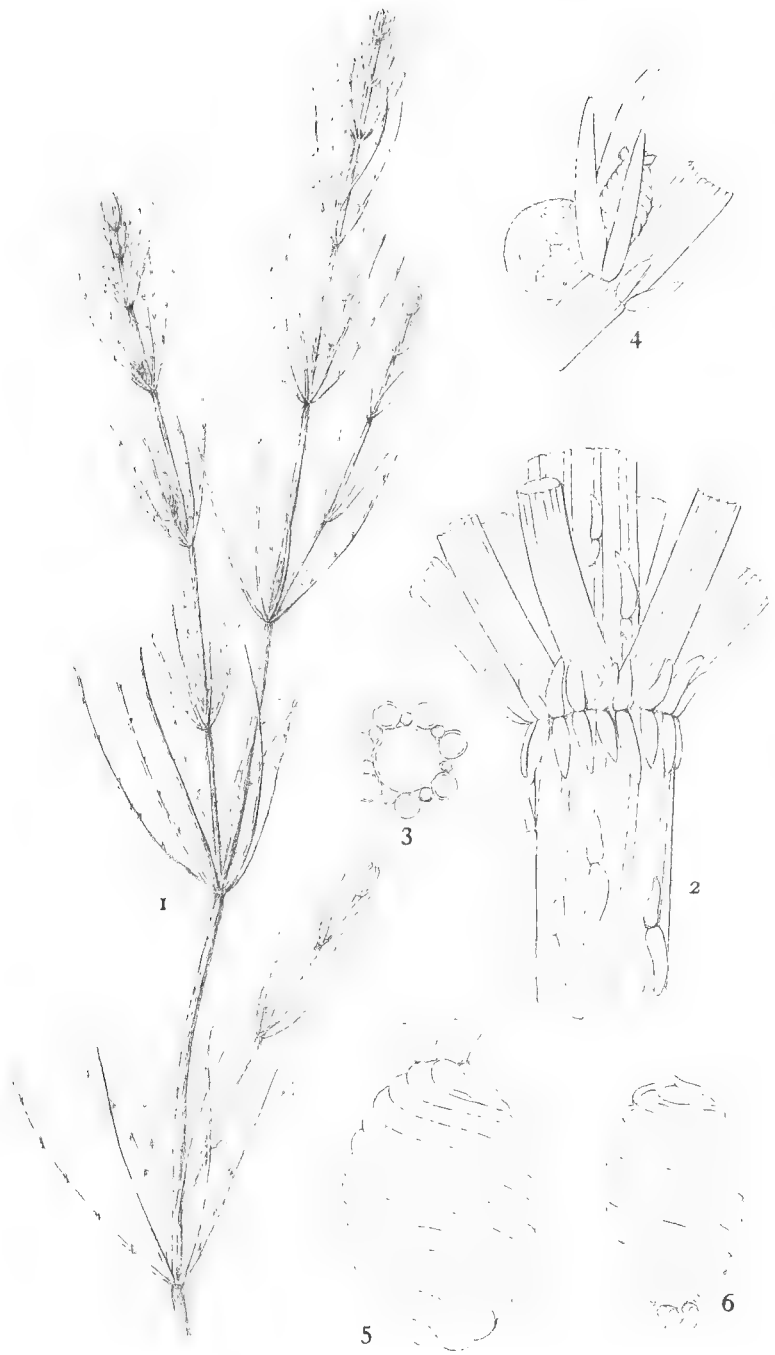
Plate 30

PLATE XXX.

Chara rudis Leonhardi.

FIG.

1. Plant, two-thirds natural size, from Nairn.
2. Portion of stem showing spine-cells, stipulodes and base of whorl. \times c. 20.
3. Transverse section of stem. \times c. 20.
4. Fertile branchlet-node. \times c. 20.
5. Oogonium. \times c. 40.
6. Oospore. \times c. 40.



CHARA RUDIS

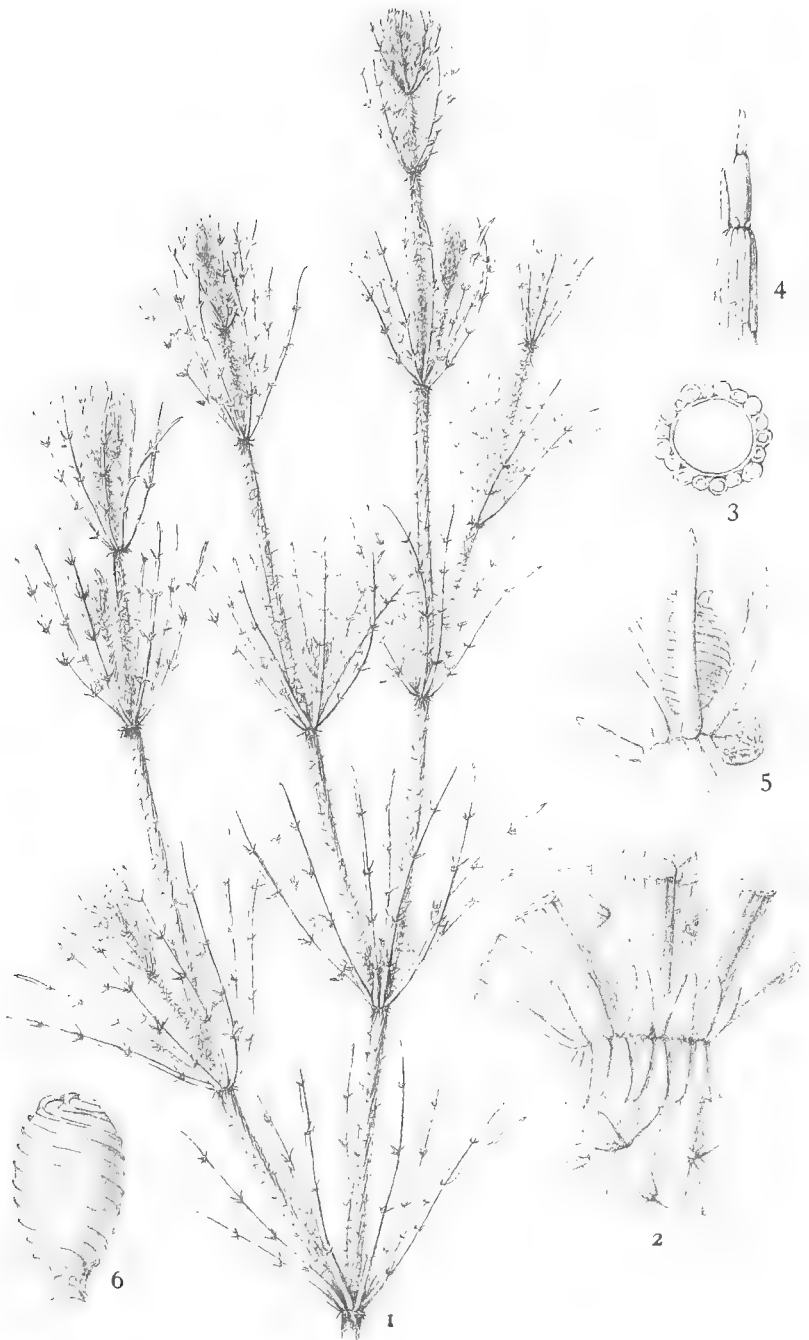
Plate 31

PLATE XXXI.

Chara hispida Linnæus.

FIG.

1. Plant, natural size, from Whittington, Salop.
2. Portion of stem showing spine-cells, stipulodes and base of whorl. \times c. 10.
3. Transverse section of stem. \times c. 10.
4. Apex of branchlet. \times c. 15.
5. Fertile branchlet-node. \times c. 20.
6. Oospore. \times c. 35.



CHARA HISPIDA

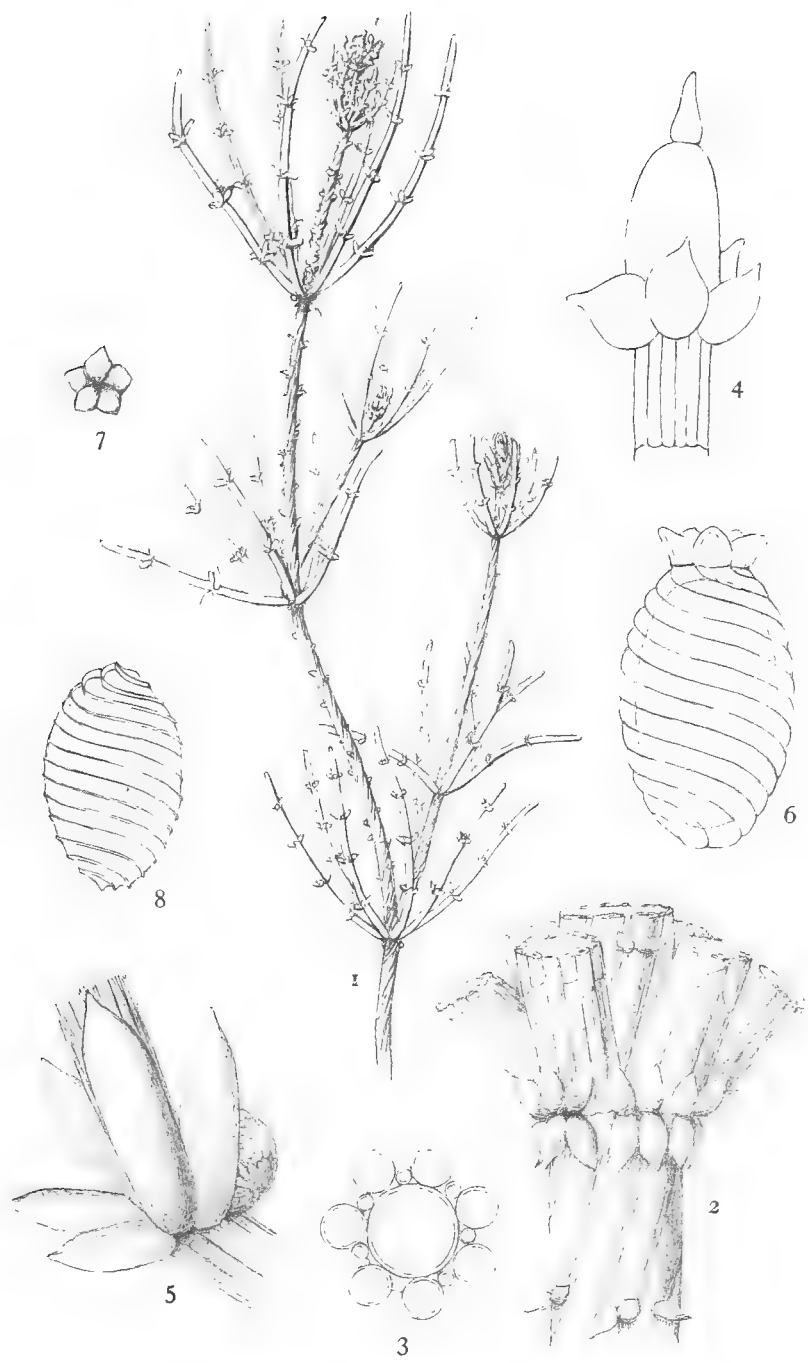
Plate 32

PLATE XXXII.

Chara tomentosa Linnæus.

FIG.

1. Plant, three-quarters natural size, from Lough Owel, Westmeath.
2. Portion of stem showing cortex, spine-cells, stipulodes and bases of branchlets with ascending cortex. \times c. 12.
3. Transverse section of stem. \times c. 15.
4. Apex of branchlet. \times c. 12.
5. Branchlet-node with antheridium. \times c. 12.
6. Oogonium. \times c. 35.
7. Coronula. \times c. 15.
8. Oospore. \times c. 35.



CHARA TOMENTOSA

M. G. & G. R. B.-W. del.

Plate 33

PLATE XXXIII.

Chara contraria Kützing.

FIG.

1. Plant, natural size, from Hickling Broad, E. Norfolk.
2. Portion of stem, showing cortex, spine-cells, stipulodes and base of whorl. \times c. 30.
3. Transverse section of stem. \times c. 30.
4. Apex of branchlet with several ecorticate segments. \times c. 25.
5. Apex of branchlet with ultimate node and two ecorticate segments. \times c. 25.
6. Fertile branchlet-node. \times c. 30.
7. Oogonium. \times c. 40.
8. Oospore. \times c. 40.
9. Var. *hispidula* Braun. Portion of stem showing cortex, elongated spine-cells, stipulodes and base of whorl. \times c. 25.



CHARA CONTRARIA

Plate 34

PLATE XXXIV.

Chara denudata Braun.

FIG.

1. Plant, natural size, from Brittas Lough, Westmeath.
2. Base of whorl, with one entire branchlet. $\times 15$.
- 3, 4. Portions of stem, showing nodes, bases of branchlets and rudimentary cortex. $\times 32$.
5. Upper (sterile) branchlet-node showing rudimentary cortex. $\times 32$.
6. Fertile branchlet-node showing antheridium and young oogonium. $\times 32$.
7. Fertile branchlet-node with mature oogonium. $\times 19$.
8. Oospore. $\times 32$.



H. Graces del.

CHARA DENUDATA

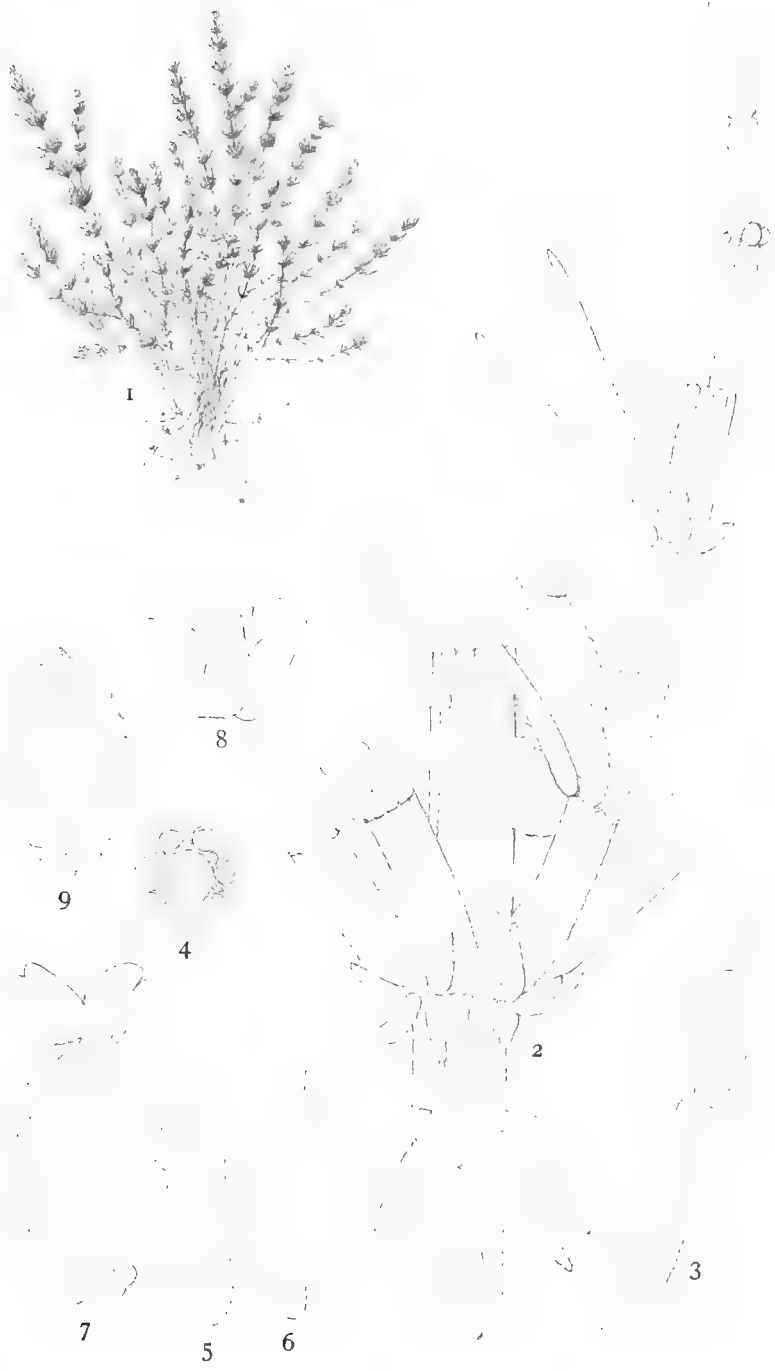
Plate 35

PLATE XXXV.

Chara muscosa Gr. & B.-W.

FIG.

1. Plant, natural size, from Lough Mullaghderg, W. Donegal.
2. Portion of stem with base of whorl and one entire branchlet.
× c. 40.
3. Apex of branchlet. × c. 40.
4. Transverse section of stem. × c. 40.
- 5, 6. Spine-cells. × c. 40.
7. Oogonium. × c. 50.
8. Coronula. × c. 70.
9. Oospore. × c. 50.



CHARA MUSCOSA

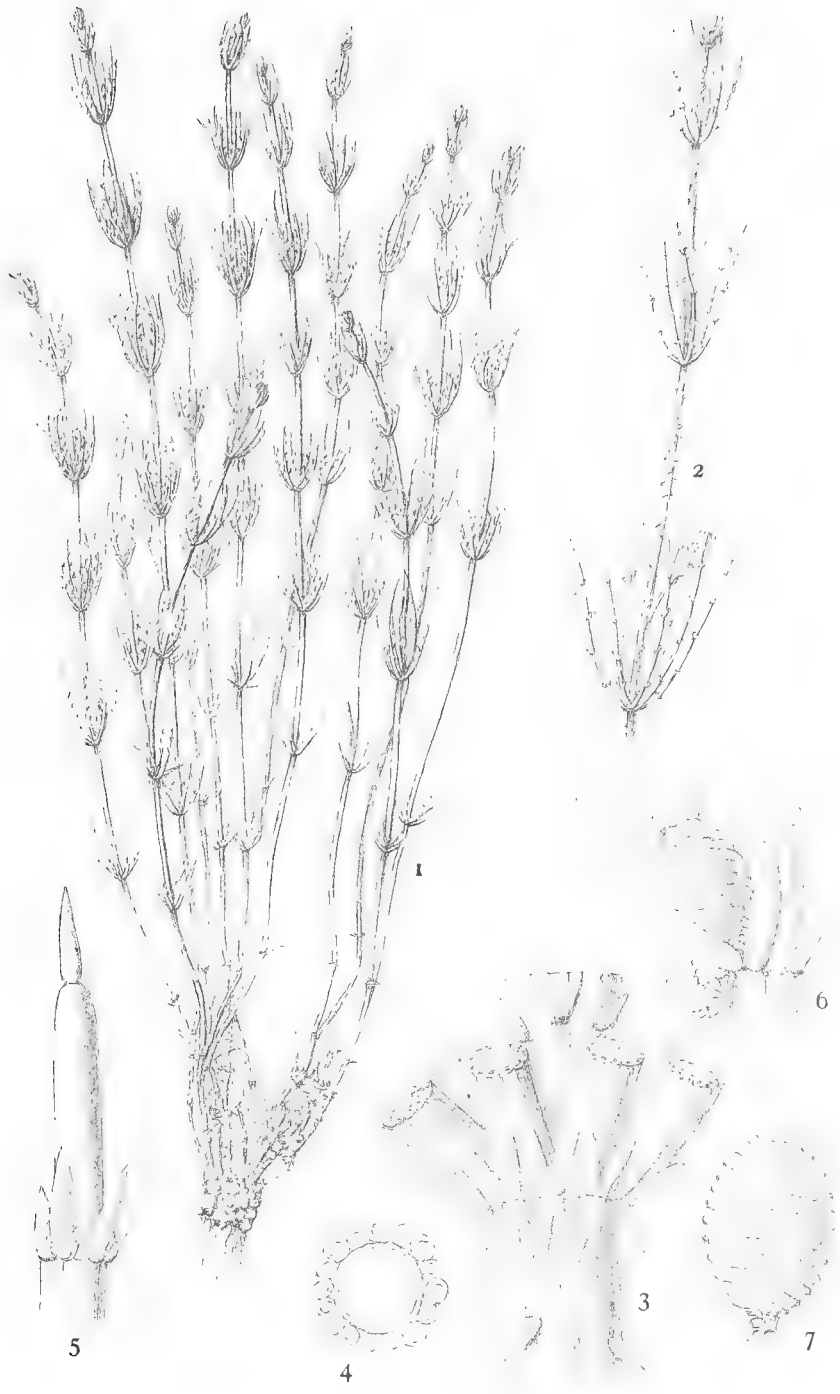
Plate 36

PLATE XXXVI.

Chara baltica Bruzelius.

FIG.

1. Plant, natural size, from Loch Stenness, Orkney Islands.
2. Portion of larger form, natural size, from Loch Stenness.
3. Portion of stem, showing cortex, spine-cells, stipulodes and base of whorl. \times c. 20.
4. Transverse section of stem. \times c. 20.
5. Apex of branchlet. \times c. 18.
6. Fertile branchlet-node. \times c. 18.
7. Oospore. \times c. 35.



CHARA BALTICA

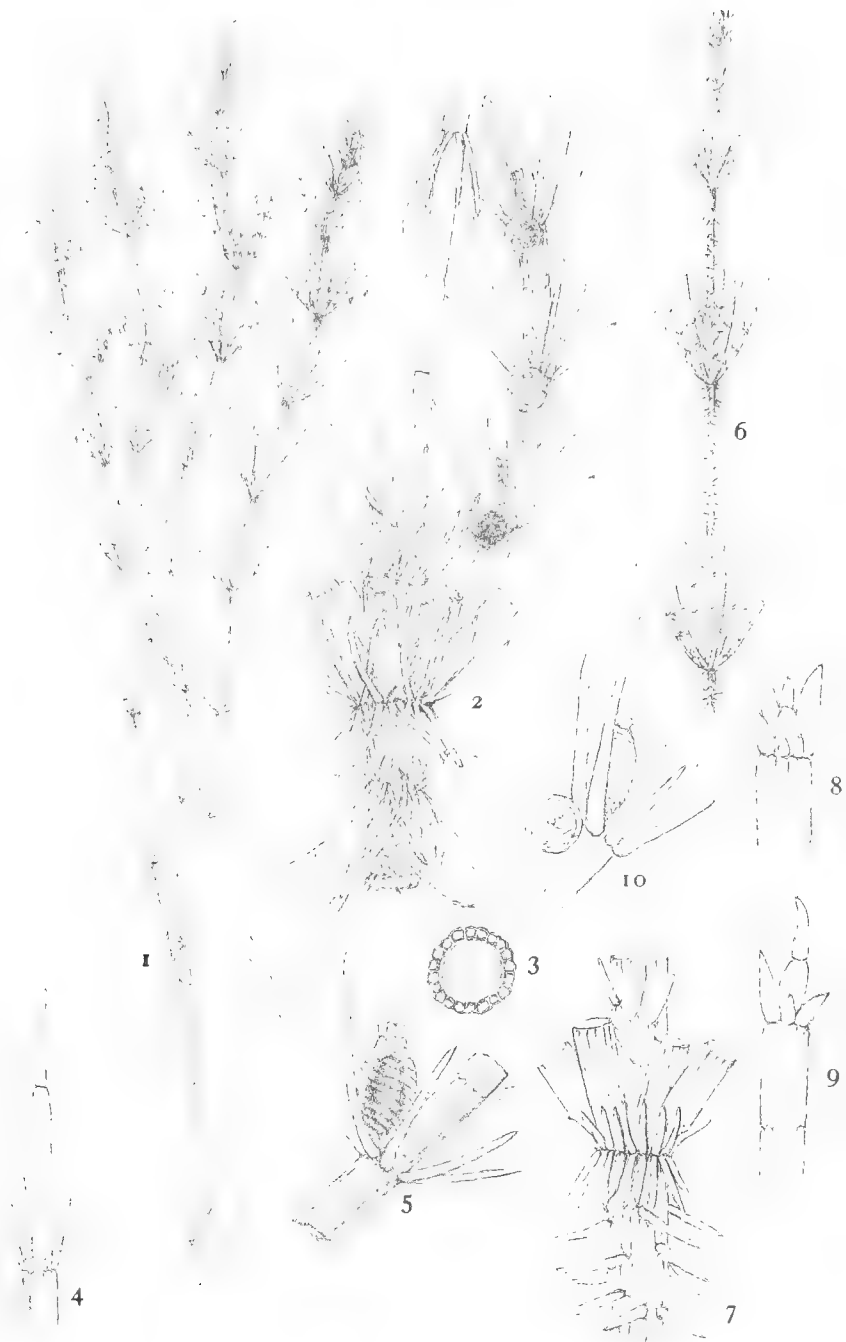
Plate 37

PLATE XXXVII.

Chara baltica Bruzelius, varieties.

FIG.

1. Var. *affinis* H. & J. Groves, plant, natural size, from Kynance Cove, W. Cornwall.
2. Portion of stem, showing spine-cells, stipulodes and base of whorl, with one entire branchlet. \times c. 12.
3. Transverse section of stem. \times c. 20.
4. Apex of branchlet. \times c. 12.
5. Fertile branchlet-node. \times c. 15.
6. Var. *rigida* Gr. & B.-W., portion of plant, natural size, from Hickling Broad, E. Norfolk.
7. Portion of stem showing cortex, spine-cells, stipulodes and base of whorl. \times 12.
- 8, 9. Apices of branchlets. \times 20.
10. Fertile branchlet-node. \times c. 15



CHARA BALTICA, VARIETIES

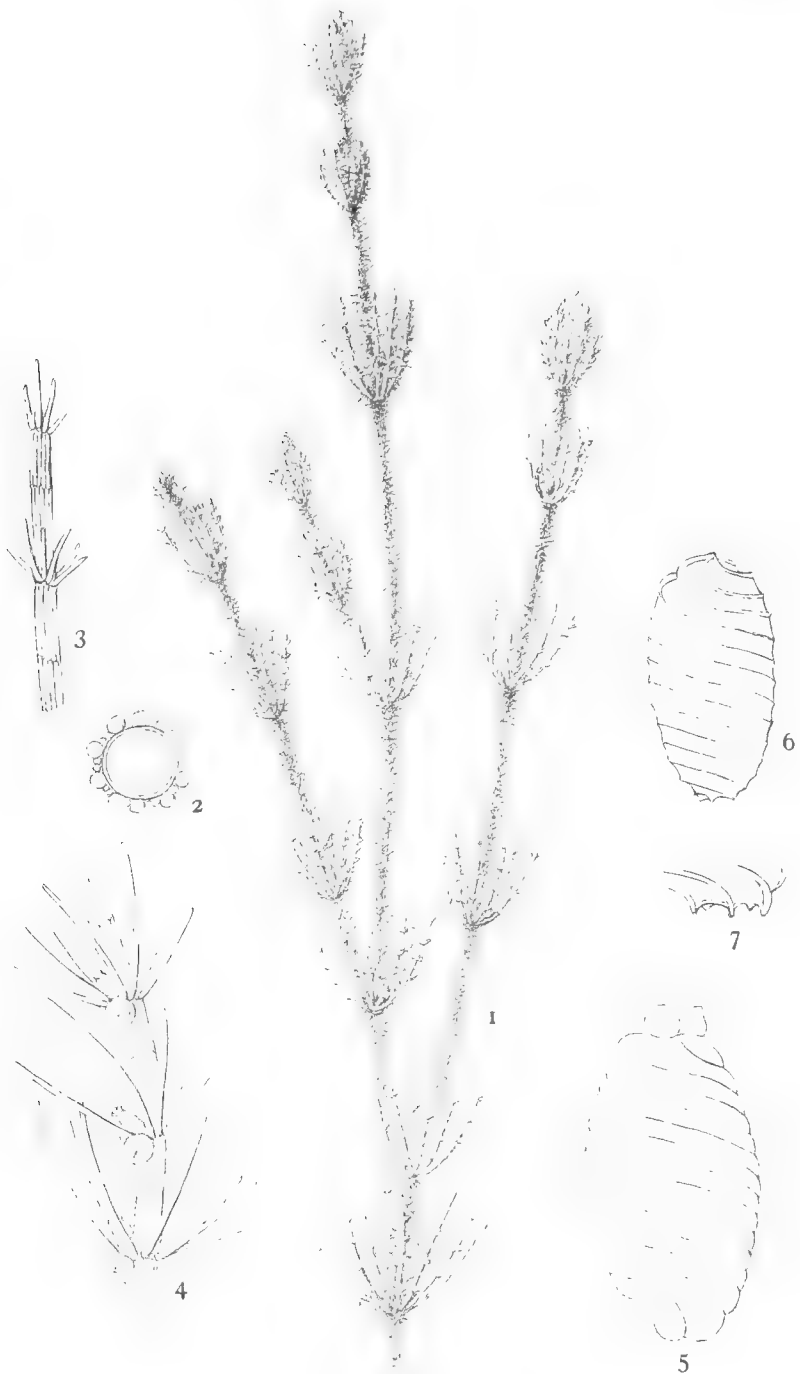
Plate 38

PLATE XXXVIII.

Chara aculeolata Kützing.

FIG.

1. Plant, natural size, from Bottisham Fen, Cambs.
2. Transverse section of stem. \times c. 15.
3. Apex of branchlet. \times c. 18.
4. Portion of branchlet with fertile nodes. \times c. 18.
5. Oogonium. \times c. 40.
6. Oospore. \times c. 40.
7. Base of oospore, with short claws. \times c. 80.



CHARA ACULEOLATA



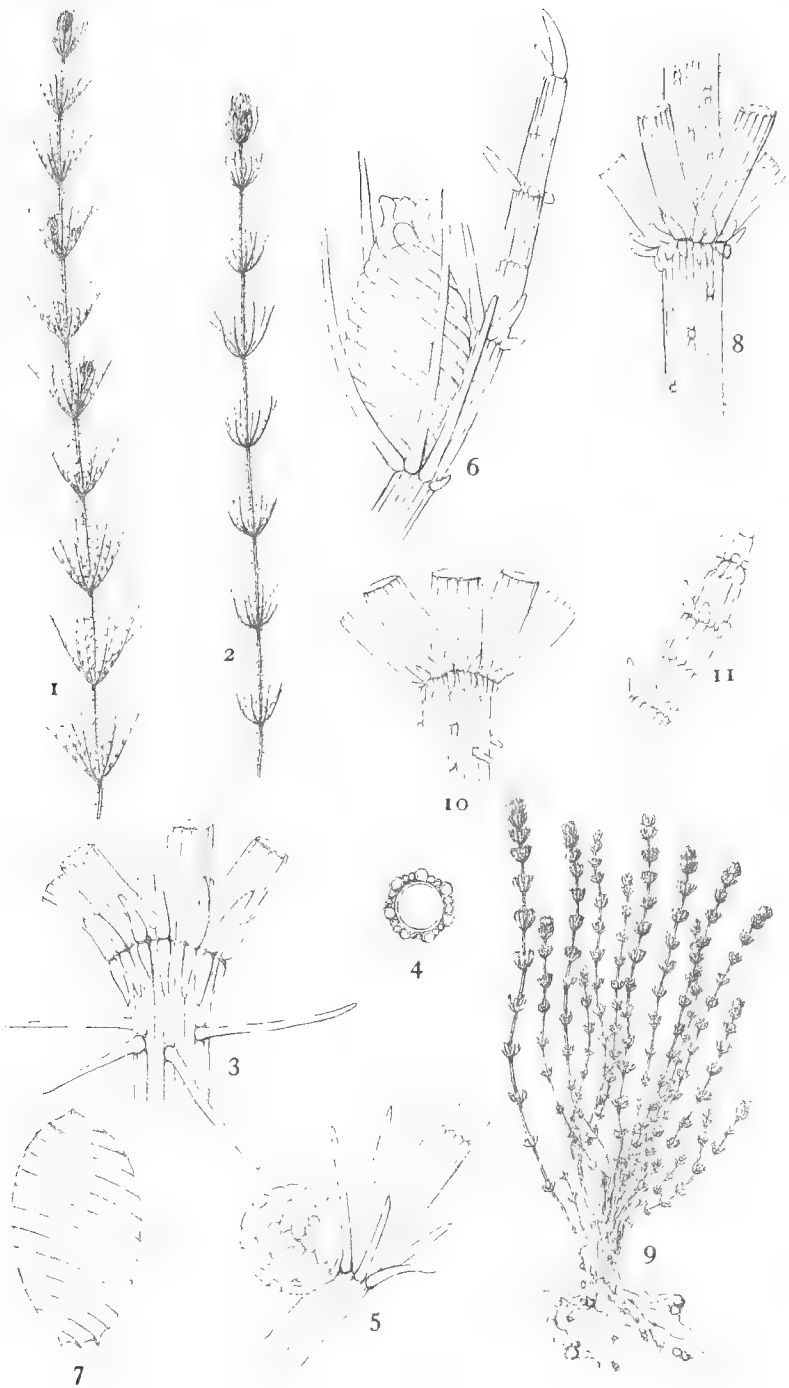
Plate 39

PLATE XXXIX.

Chara aspera Willdenow.

FIG.

1. ♀ plant, natural size, from Frensham, Surrey.
2. ♂ plant, natural size, from the same locality.
3. Portion of stem, showing cortex, spine-cells, stipulodes, and base of whorl. \times c. 35.
4. Transverse section of stem. \times c. 25.
5. Fertile branchlet-node. ♂ \times c. 30.
6. Fertile branchlet-node ♀. \times 45.
7. Oospore. \times c. 50.
8. Var. *subinermis* Kützing, portion of stem and base of whorl, with much reduced spine-cells. \times c. 25.
9. Var. *lacustris* H. & J. Groves, plant, natural size, from Lough Neagh.
10. Portion of stem and base of whorl. \times 25.
11. Upper part of branchlet. \times c. 25.



CHARA ASPERA

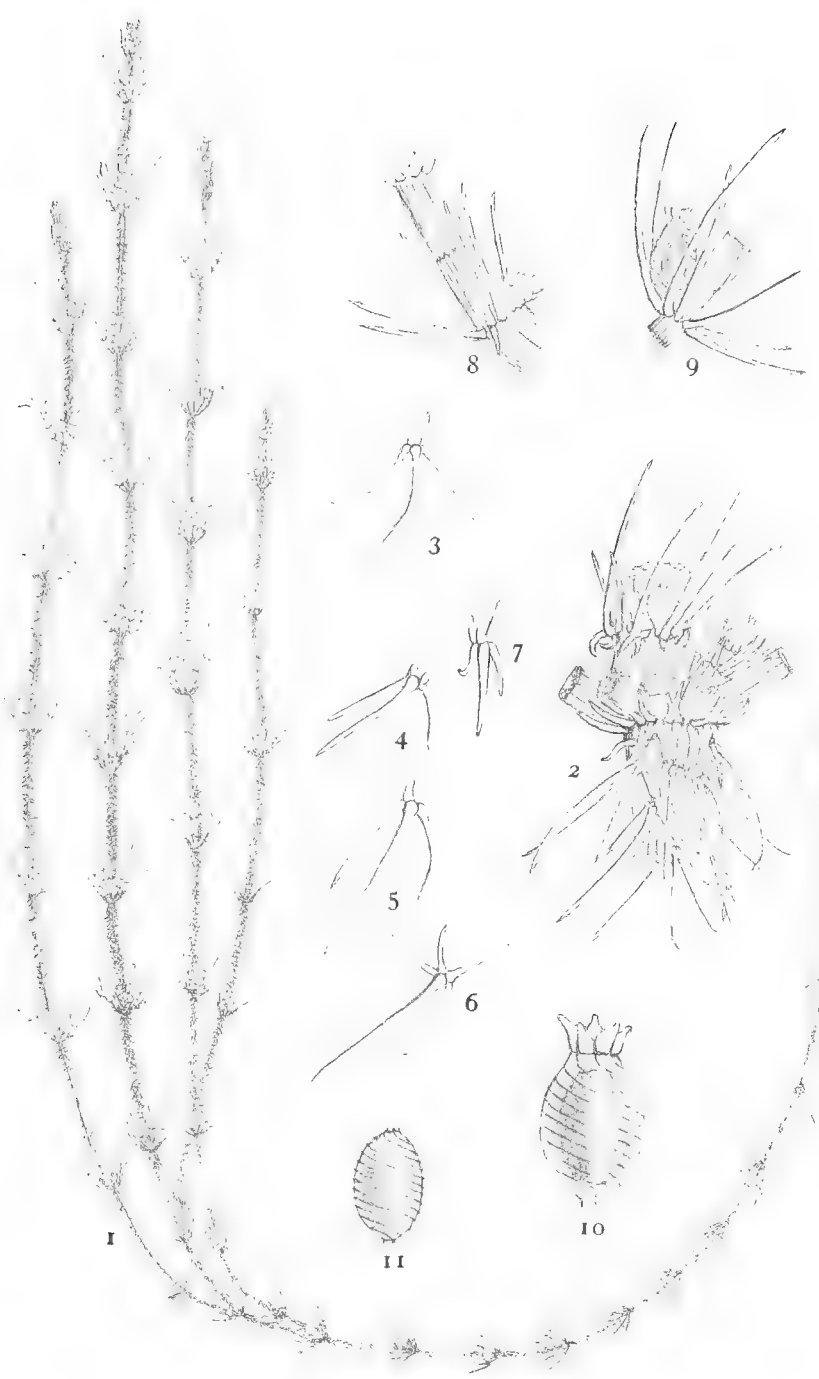
Plate 40

PLATE XL.

Chara desmacantha Gr. & B.-W.

FIG.

1. Plant, natural size, from Brittas Lough, Westmeath.
2. Portion of stem showing cortex, clustered spine-cells, stipules and base of whorl. \times c. 15.
- 3-7. Clusters of spine-cells. \times c. 15.
8. Branchlet-node, ♂. \times c. 15.
9. Branchlet-node, ♀. \times c. 15.
10. Oogonium. \times c. 30.
11. Oospore. \times c. 30.



CHARA DESMACANTHA

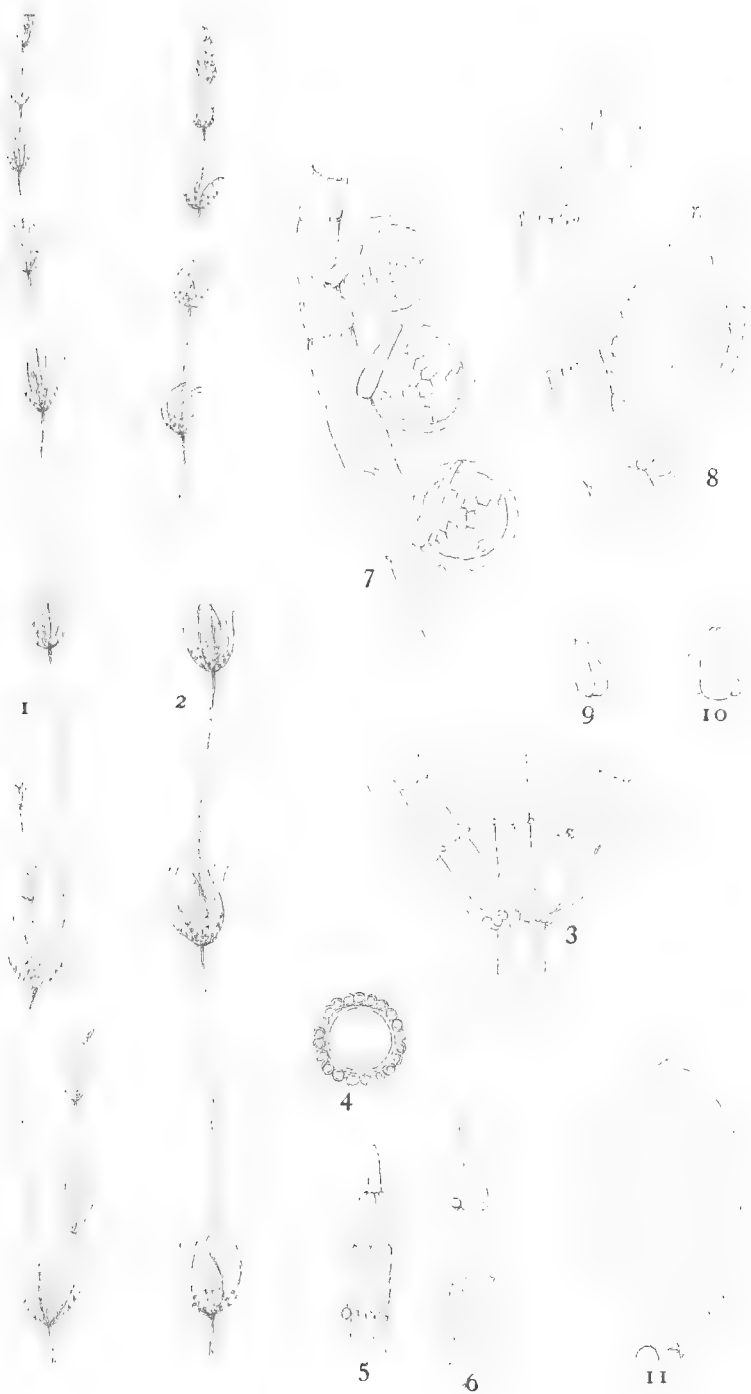
Plate 41

PLATE XLI.

Chara connivens Braun.

FIG.

1. ♀ plant, natural size, from Slapton Ley, S. Devon.
2. ♂ plant, natural size, from the same locality.
3. Portion of stem showing rudimentary stipulodes and lower parts of branchlets. × c. 20.
4. Transverse section of stem. × c. 35.
- 5, 6. Apices of branchlets. × c. 25.
7. Portion of branchlet of ♂ plant with fertile nodes. × c. 40.
8. Portion of branchlet of ♀ plant with fertile and sterile nodes. × c. 40.
- 9, 10. Coronulæ. × c. 40.
11. Oospore. × c. 60.



CHARA CONNIVENS

Plate 42

PLATE XLII.

Chara fragifera Durieu.

FIG.

1. ♀ plant, natural size, from Kynance Valley, W. Cornwall.
(An unusually large form.)
2. ♂ plant, natural size, from near Penzance, W. Cornwall.
3. Stem-node, showing rudimentary stipulodes and base of whorl. × c. 30.
- 4, 5. Apices of branchlets. × c. 30.
6. Portion of branchlet, ♂, with fertile nodes. × c. 30.
7. Portion of branchlet, ♀, with fertile node. × c. 25.
- 8, 9. Coronulæ. × c. 30.
10. Oospore. × c. 35.
11. Composite strawberry-like root bulbils. × 2.



CHARA FRAGIFERA

Plate 43

PLATE XLIII.

Chara fragilis Desvaux, var. *Hedwigii* Kützing.

FIG.

1. Plant, natural size, from Kingston, Surrey.
2. Stem-node showing stipulodes and base of whorl. \times c. 14.
3. Transverse section of stem. \times c. 14.
- 4, 5. Apices of branchlets. \times c. 14.
6. Fertile branchlet-node. \times c. 14.
7. Oospore. \times c. 35.



CHARA FRAGILIS
VAR. HEDWIGII

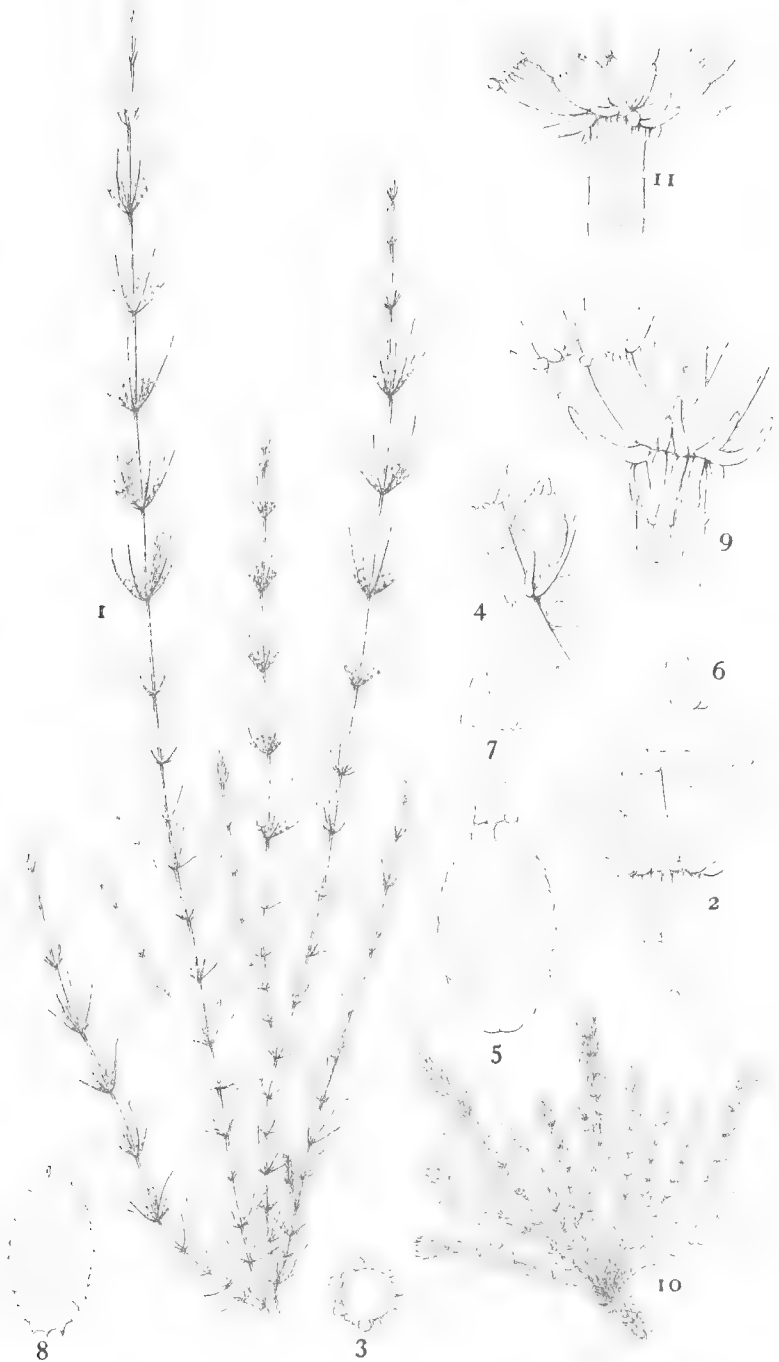
Plate 44

PLATE XLIV.

Chara delicatula Agardh.

FIG.

1. Plant, natural size, from New Forest, Hants.
2. Portion of stem, showing spine-cells, stipulodes and base of whorl. \times c. 30.
3. Transverse section of stem. \times c. 30.
4. Fertile branchlet-node. \times c. 20.
5. Oogonium. \times c. 35.
- 6, 7. Coronulæ. \times c. 45.
8. Oospore. \times c. 35.
9. Var. *barbata* Ganterer. Stem-node showing elongated stipulodes. \times c. 30.
10. Var. *annulata* (*C. annulata* Wallm.). Plant, natural size, from Shetland.
11. Base of whorl of the same showing tumid branchlet-segments. \times c. 30.



CHARA DELICATULA

PLATE XLV.

FOSSIL CHAROPHYTA.

Figs. 1-10 *Clavator Reidii* J. Groves from Middle Purbeck Beds of Dorsetshire. (Reprinted, except 2, 4 and 5, by kind permission of the Royal Society, from its 'Proceedings' B, vol. 89, 1916.)

FIG.

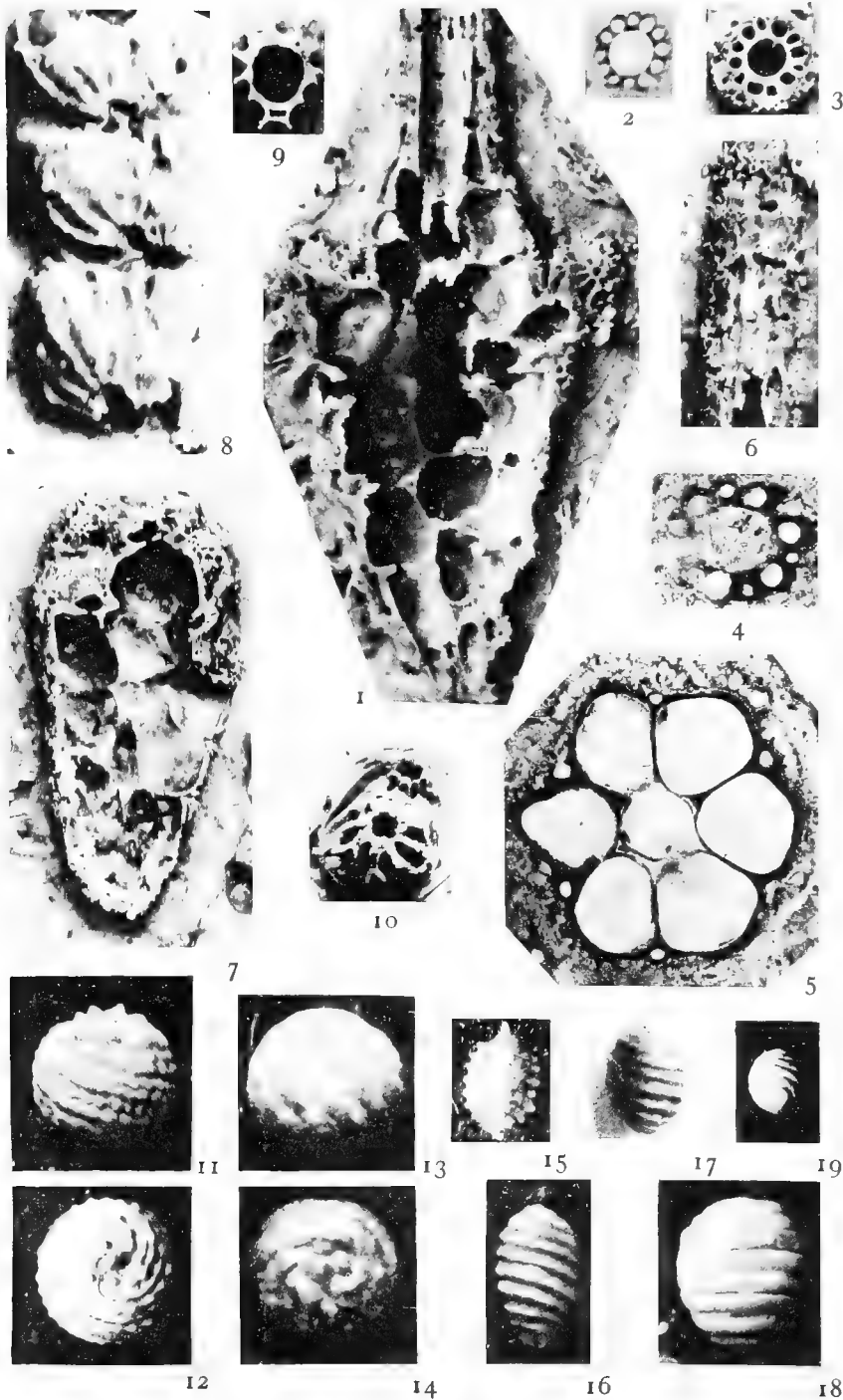
1. Nearly axial section through stem-node with much enlarged cells, showing also bases of spreading branchlets and traces of groups of small club-shaped outgrowths.
- 2, 3. Transverse sections of stems, showing condition of cortex in the internodes, when primary and secondary cortical-cells are of nearly equal diameter.
4. Oblique section of stem below node, the primary cortical-cells of which have begun to increase in diameter.
5. Transverse section of stem, quite close to the node, showing very much enlarged primary cortical-cells, the secondary cells retaining their original diameter and being forced outwards.
6. Portion of stem showing groups of club-shaped processes.
7. Nearly axial section of swollen node, thought to be at the apex of the stem, the branchlets apparently growing nearly upright.
8. Three "fruits" attached to branchlet showing exterior of utricles.
9. Transverse section of "fruit" showing portions of supposed adnate bract-processes.
10. Utricle seen from above with section of apex.

Figs. 11-19. Fossil fruits from the Lower Headon Beds of Hordle Cliffs, S. Hants. (Reprinted, except 17 and 19, by kind permission of the Geological Society, from its 'Quarterly Journal,' vol. 77, iii, 1921.)

FIG.

- 11, 12. *Chara caelata* Reid & Groves.
- 13, 14. *C. Wrightii* Salter.
15. *C. vasiformis* R. & G.
16. *C. strobilocarpa* R. & G.
17. *C. polita* R. & G.
18. *C. helicteres* Brongn.
19. *Tolypella headonensis* R. & G.

All the figures are reproduced from photographs by Clement Reid. Fig. 8 \times 40, the rest \times 20.



FOSSIL CHAROPHYTA

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