TRANSACTIONS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA

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CONTENTS

TRANSACTIONS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA.

VOL. XVIII.

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE FRESHWATER ALGAE OF AFRICA.*

7. *Freshwater Algae (exclusive of Diatoms) from Griqualand West.*

By F. E. Fritsch

and

Florence Rich.

(Communicated by Miss E. L. Stephens.)

(With 32 figures in the Text.)

A. Introductory Remarks.

There appear to have been no previous accounts of any kind dealing with the algal vegetation of Griqualand West, although in the second paper of this series a few samples from parts of the Modder and Orange Rivers, within the adjacent Orange Free State, were included.† Griqualand West is situated in the interior of South Africa, and the average altitude of the country exceeds 4000 ft. above sea-level, the maximum being about 4200 ft. Towards the south it falls to about 3600 ft. The Kaap Plateau consists largely of dolomite, but the lower country in the East is of Dwyka shale and conglomerate. Miss Wilman writes, however, that " in the shale there occur quantities of secondary limestone, so that there is plenty

* From the Botanical Department, East London College, University of London. The last two papers of this series were published in these Transactions (xii, 1925, p. 277; xiii, 1925, p. 49).

† *Cf.* Annals of the South African Museum, ix, 1918, p. 487. It is possible that some of these samples were actually collected in Griqualand West.

of lime in the soil and in the small waters. The large rivers (Harts, Modder, Orange, Riet, Vaal) are comparatively fresh, and the water is even soft after freshets." It may be mentioned in this connection that, in quite a number of samples, the Algae were more or less densely encrusted with carbonate of lime. January is the hottest (average temperature, 90° F.) and wettest (rainfall, 2–4 in.) month, whilst July is the coolest (temperature, 60–70° F.) and driest (rainfall under 0·5 in.).

The bulk of the collections upon which the present report is based come from the divisions of Barkly West, Kimberley, and Herbert in the eastern part of the country. It is scarcely likely that the collections are at all representative of the districts from which they were obtained, since the 200 odd tubes seem to have been collected essentially from some twenty localities. There is considerable duplication, that has made the working out of the samples very laborious. Moreover, many species (especially among the unicellular and colonial forms) were only encountered as isolated specimens, that were found merely by chance, which is probably due to the collections being made at times when such forms were not at their maxima.

In view of this it is scarcely feasible to offer many remarks of a general character, and comparison with other parts of South Africa is inadvisable. The bulk of the collections were naturally made during the wet summer period, and the influence of the relatively high temperature is to be seen in the important part played by Myxophyceae (especially Oscillatoriaceae and Nostocaceae) in many cases. Very few of the samples are from subaerial habitats. On the open veld round Kimberley *Nostoc commune* appears to be a prominent feature (samples 667, 803), being "found best after light rains near small scrub bushes." The samples sent us from the walls of the Hol River ravine (1355, 1356) consisted in the main of species of *Phormidium*, which are probably submerged or at least covered with spray in the wet season, and are thus not subaerial Algae in the true sense. The complete absence of Stigonemataceae and the very scanty representation of Rivulariaceae and Scytonemataceae is a result of the absence of suitable subaerial habitats.*

One of the best collecting grounds appears to be constituted by the more or less isolated and stagnant pools that are left at various points in the beds of the rivers during the drier period of the year, and from these a number of the samples were gathered. Their algal flora is rather diverse, but the essential forms are various Chlorococcales, *Geminella ordinata, Rhizoclonium hieroglyphicum, Sphaeroplea Wilmani* n. sp., diverse species of *Stigeoclonium, Oedogonium, Spirogyra*, and *Zygnema*, a few Desmids, *Vaucheria ornithocephala, Microcoleus chthonoplastes, Nodularia tenuis, Anabaena vaginicola*

* According to Miss M. Wilman and Miss E. L. Stephens there are no habitats in Griqualand West suitable for the growth of subaerial Algae.

n. sp., *Merismopedia* spp., *Gomphosphaeria lacustris.* The *Rhizoclonium* and *Stigeoclonium* are probably members of the true river flora, but forms like *Cladophora* and *Phormidium Retzii*, which are present in samples from the actual flowing water of the Vaal River and are typical river Algae, have not been found in these pools. No red Algae were met with in any of the samples.

Rhizoclonium is widely distributed, but in many cases seems to occur where there are springs or the water is flowing. A very large number of samples contain Zygnemaceae, mainly species of *Spirogyra*, although *Zygnema* is frequent; the abundance of Zygnemaceae is to be ascribed to the fact that so many of the samples are from stagnant water. Desmids are poorly represented, with only four genera, and their paucity is perhaps a result of the presence of lime. Very noticeable is the remarkable scarcity of Heterokontae, and especially of *Tribonema*; *Ophiocytium* is altogether unrepresented. Similarly the common genus *Microspora* is lacking, and no *Bulbochaete* has been found. These features may be of real significance as characterising the algal flora. The relative abundance of Euglenineae and of *Phacotus lenticularis*, usually associated with Myxophyceae, in some of the samples, is suggestive of organic contamination. Of Chlorococcales only species of *Scenedesmus* are at all frequent, and their occurrence is possibly due to the same cause.

The following table gives the representation of the principal groups :—

	Total Sp.	New Sp.	New Varieties.	Total Genera.	New Records.
Volvocales . . .	8	3	..	6	5
Chlorococcales . .	37	1	2	14	23
Ulotrichales . . .	8	2	..	6	4
Chaetophorales . .	10	..	..	5	6
Oedogoniales . . .	8	..	..	1	6
Zygnemaceae . . .	19	2	4	3	12
Desmidiaceae . .	26	1	5	4	15
Siphonales . . .	2	..	..	1	1
Heterokontae . .	3	1	..	3	2
Peridinieae . . .	4	..	..	2	4
Euglenineae . . .	11	1	3	4	9
Myxophyceae . .	46	5	2	20	23
Totals . . .	182	16	16	69	110

As points of special taxonomic interest attention may be drawn to the widespread occurrence of *Pediastrum integrum* var. *Pearsoni*, the occurrence of *Sphaeroplea*, of which a new species (*S. Wilmani*) * is described, in various samples, the discovery of a new species of *Centritractus*, the highly peculiar *Phacus anomala* n. sp., and the description of a new genus of spore-producing Myxophyceae (*Rhaphidiopsis*), apparently a member of the Rivulariaceae.

Many of the samples were rich in Diatoms, as is to be expected in view of so many of them being derived from river waters. It is proposed to deal with these Diatoms in a separate communication.

We are greatly indebted to Miss E. L. Stephens who has transmitted the collections to us, and by the elimination of some of the duplicates has reduced the labour involved in dealing with them. She has also supplied valuable information. We are also indebted to the Council for Scientific and Industrial Research for a grant which enabled the second author to take part in this work.

B. Enumeration of the Samples.

The following list of samples serves as a key to the collections, the numbers only of the samples being cited in the subsequent systematic portion. The collections were chiefly made over a period extending from July 1916 to November 1923, and a considerable number of different collectors were concerned (Miss M. Wilman, J. C. Moran, C. Elliott Young, J. H. Power, Miss A. Parker). The majority of the samples were, however, collected under the auspices of the McGregor Museum, Kimberley, by Miss M. Wilman, Director of the Museum, and unless some other name is mentioned in the following enumeration the sample is of her collecting. The numerous Diatoms, as above mentioned, will be dealt with in a later communication, but the principal genera present in the different samples are cited in some cases for the sake of completeness. The numbers of the samples here given refer to the general collection of South African Algae.

600. Bottom of ditch, almost black, Kenilworth, Jan. 1921. (*Phacotus lenticularis*, *Euglena* sp., *Spirulina major*, *Nostoc* sp., *Nodularia spumigena*, diverse Diatoms.) *Cf.* 617.

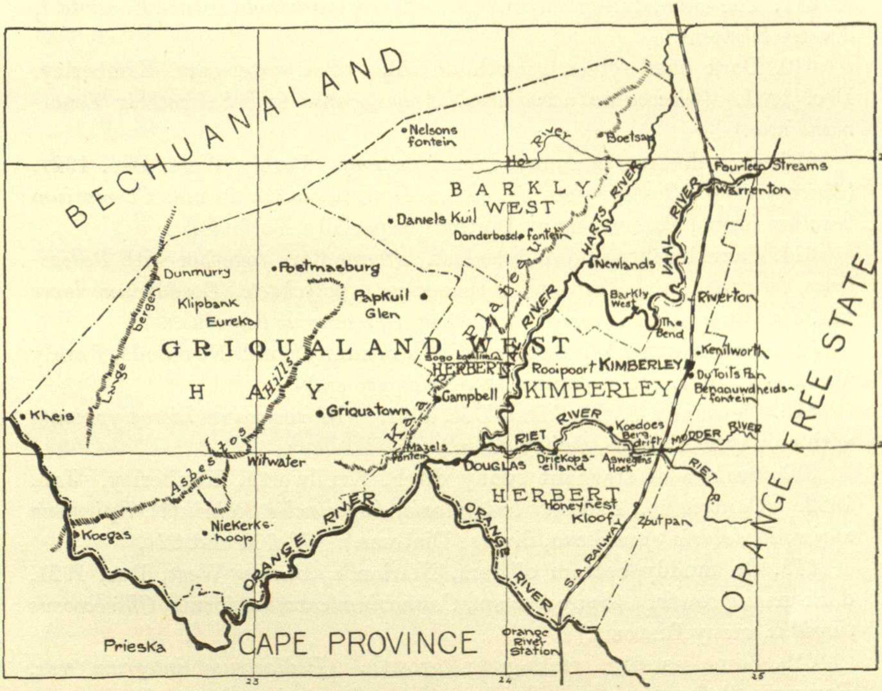
601. Sage-green growth on margins of pools in mid-stream, Riet River, at Aswegen's Hoek, Kimberley Division. (*Geminella ordinata*, *Rhizoclonium hieroglyphicum*, *Oedogonium Braunii*, *O. Pisanum*, *O. rufescens*, *O. suecicum*, *Zygnema* sp., *Spirogyra protecta* var. *inflata* nov. var., *Cosmarium perpusillum*, *Cosmarium subprotumidum* subsp. *simplex* var. *β*

* Since completing this paper another sample collected by Mr. J. H. Power from a spring at Niekerk's Hoop, Hay, has been received. This contains a further new species of *Sphaeroplea* (*S. tenuis*) which is described in a paper on the genus in Annals of Botany, xliii, 1929, pp. 10, 18.

forma, *Merismopedia glauca, Microcoleus chthonoplastes, Anabaena vaginicola* n. sp., *Nodularia tenuis*, Diatoms abundant.)

602. Sandy margins of a pool in mid-stream, Riet River, at Aswegen's Hoek, July 1921, brick-red growth. Red colour probably due to Bacteria. (Diverse Diatoms.)

603. From bottom of pool in mid-stream, same locality, July 1921, dull-green growth. (*Rhizoclonium hieroglyphicum, Oedogonium* sp., *Zygnema* sp., *Spirogyra* sp., *Merismopedia glauca, Gomphosphaeria lacustris.*)



Map of Griqualand West showing the principal localities from which collections have been made, for which the authors are indebted to Mr. V. C. Ortlepp.

604. On twigs in pool in mid-stream, same locality and date, bright-green growth. (*Sphaerocystis Schroeteri, Scenedesmus quadricauda, Coelastrum microporum, Rhizoclonium hieroglyphicum, Oedogonium* sp., *Spirogyra* sp., *S. protecta* var. *inflata* nov. var., *Zygnema* sp., *Cosmarium botrytis* var. *depressum, C. perpusillum, C. subprotumidum* subsp. *simplex* var. *β, Merismopedia glauca, Gomphosphaeria lacustris,* diverse Diatoms.)

605. On mud on the tops of submerged stones in isolated pools in middle of river, same locality and date. (Brown growth due to Diatoms.)

606. Same as 602.

607. Dark bottle-green growth on walls of museum tank, in shade, Kimberley, Aug. 1921. (*Gloeocapsa aeruginosa, Phormidium molle.*)

608, 609. Puddles on muddy banks of river, in sunshine, Vaal River, at "The Bend," Kimberley, Aug. 1921, brown or dark-green growth. (*Spirogyra subaffinis* n. sp., Diatoms.)

610. Puddles in sun, at river side, Vaal River, at "The Bend," Aug. 1921, bright-green growth. (*Spirogyra rugulosa* var. *africana* nov. var., *Surirella.*)

611. The same, dull-green growth. (*Spirogyra adnata* forma, *S. velata* ?, diverse Diatoms.)

612. Dark bottle-green growth on sides of a water-cart, Kimberley, Dec. 1921. (*Gloeocapsa aeruginosa, Aphanocapsa* sp., *Schizothrix Lenormandiana.*)

613. Free-floating in sunny dam, Newlands, Barkly West, Dec. 1921. (*Spirogyra* sp., *Oeodogonium* sp., *Tetraëdron minimum* forma, *Cosmarium vexatum* forma, *C. laeve,* many Diatoms, especially *Navicula.*)

614. Same locality and date as last. (Same flora together with *Pediastrum integrum* var. *Pearsoni, Aphanochaete polychaete, Cosmarium laeve* var. *distentum, Merismopedia tenuissima, Chroococcus turgidus.*)

615. Free-floating, olive-green growth in sunny pond, Newlands, Barkly West, Dec. 1921. (*Oedogonium* sp., *Spirogyra* sp.)

616. Newlands, Barkly West, Dec. 1921. (*Rhizoclonium hieroglyphicum* with epiphytic diatoms, *Spirogyra* sp.)

617. Surface of stagnant sunny ditch, Kenilworth, Kimberley, Jan. 1922. (*Carteria* sp., *Phacotus lenticularis, Lepocinclis Steinii* (?), *Spirulina major, Nodularia spumigena,* diverse Diatoms.) *Cf.* 600 and 624.

618. On muddy bottom of dam, Newlands, Barkly West, Dec. 1921, dark-green growth. (*Spirogyra* sp., *Cosmarium vexatum* forma, *Chroococcus turgidus,* many Diatoms.)

619. Same as 615, grass-green growth. (*Pediastrum integrum* var. *Pearsoni, Oedogonium* sp., *Spirogyra* sp., *Cosmarium laeve, C. vexatum* forma, *Chroococcus turgidus,* diverse Diatoms.)

620. Bright-green growth on twigs in sunshine, Newlands, Barkly West, Dec. 1921. (*Spirogyra* sp., Diatoms.)

621. Grass-green growth on surface of liquid manure, Museum, Kimberley, Dec. 1921, sunshine. (*Chlamydomonas africana* n. sp., *C. pulvisculus, C. truncata* n. sp., *Polytoma africana* n. sp.)

622. Dark-green growth on twig in sunny dam, Newlands, Barkly West, Dec. 1921. (*Pediastrum integrum* var. *Pearsoni, Spirogyra* sp., *Cosmarium vexatum* forma, *Chroococcus turgidus, Anomoeoneis sphaerophora.*

623. Bottle-green growth on stones on bottom of water-course, New-

lands, Barkly West, Dec. 1921. (*Spirogyra* sp., *Phormidium subincrustatum* n. sp., few Diatoms.)

624. Almost black growth on bottom of ditch, Kenilworth, Kimberley, Jan. 1922. (*Phacotus lenticularis, Euglena* sp., *Spirulina major, Nodularia spumigena, Phormidium autumnale,* few Diatoms.) *Cf.* 600 and 617.

625. Pale yellow-green growth on surface of water, Kenilworth dam, Kimberley, Jan. 1922. (*Chlamydomonas* sp., *Phacotus lenticularis, Cosmarium laeve, Nodularia spumigena, Phormidium autumnale, Amphora,* etc.)

626 and 627. Greenish-brown growth in sun on surface of a stagnant furrow, Kenilworth, Kimberley, Jan. 1922. (*Spirogyra* sp., *Euglena* sp., *Spirulina major, Nodularia spumigena,* diverse Diatoms.)

628. Same as 625, but no *Phacotus.*

629. Grass-green growth on *Zannichellia* along banks of Vaal River, Riverton, in sunshine, March 1922. (*Cladophora* sp.)

630. Same as 626, but no *Spirogyra.*

631. Floating in water, salt pan, Zout Pan, near Honeynest Kloof, 1918. (*Oscillatoria tenuis.*)

632. From freshwater pools near the pan at Zout Pan, Honeynest Kloof, 1918. (*Pediastrum integrum* var. *Pearsoni, Scenedesmus arcuatus, S. quadricauda, Rhizoclonium hieroglyphicum, Cosmarium laeve,* numerous Diatoms, esp. *Synedra* and *Denticula.*)

633. Sediment at bottom of jar in which material from 632 was kept. (Same flora, together with *Cosmarium papkuilense.*)

634. At junction of Riet and Modder Rivers, 1918. (*Chlamydomonas* sp., *Phacotus lenticularis, Rhizoclonium hieroglyphicum, Coleochaete scutata, Cosmarium vexatum* forma, *Epithemia.*)

635. Mine Dam, Kimberley, June 1919, coll. Moran. (*Tetraëdron minimum* forma, *Scenedesmus bijugatus, Oedogonium* sp., *Closterium peracerosum* var. *arcuatus* n. var., *Cosmarium laeve, C. papkuilense* forma, *C. sexangulare* var. *subangulare, Peridinium inconspicuum, Merismopedia tenuissima, Aphanocapsa* sp., *Chroococcus turgidus, Phormiduum ambiguum* forma, *Lyngbya nigra,* epiphytic Diatoms.)

636. Campbell Sluit and the dam into which it leads, 1918. (*Spirogyra* sp., many Diatoms, esp. *Synedra.*)

640 and 641. From jars of Vaal River water, collected for an exhibition in 1892, Kimberley, July 1916, coll. Moran. (*Palmella*-stage of *Chlamydomonas.*)

642. Bright-green growth attached to stones, twigs, etc., dam in Public Gardens, Kimberley, Aug. 1916, coll. Moran. (*Ankistrodesmus falcatus* var. *spirilliformis, Scenedesmus armatus, Ulothrix tenerrima, Stigeoclonium amoenum* forma, *Oedogonium plagiostomum* var. *gracilius, Euglena oxyuris* forma *minor, Lepocinclis texta* forma, *Phacus longicauda* var. *torta* forma,

Trachelomonas volvocina, Dactylococcopsis rhaphidioides, Oscillatoria tenuis, Lyngbya aerugineo-coerulea, few Diatoms.)

643. Same as 642, but with *Spirogyra* sp.

644. Dark-green, free-floating growth in pit on open veld filled with rain-water (usually dry), Kimberley, March 1917, coll. Moran. (*Eudorina elegans, Sphaeroplea annulina, Cosmarium subprotumidum* subsp. *simplex* var. *β* forma, *Oscillatoria tenuis, Amphora.*)

645. Attached to stems of grass below water, in pit on open veld filled with rain-water, Kimberley, March 1917, coll. Moran. (Same as 644, together with *Pandorina morum, Cosmarium Blyttii, C. subundulatum* var. *minor* n. var.)

646. Same as 645, together with *Cosmarium papkuilense* and *Amphora.*

647 and 648. Bluish-green growth on stones and straws, De Beers Power Station, Blanckenbergs Vlei, Kimberley, Nov. 1917, coll. Moran. (*Chaetophora tuberculosa,* many Diatoms.)

649. Bluish-green growth on stones, Du Toits Pan, Kimberley, Nov. 1917, coll. Moran. (*Chaetophora tuberculosa, Oedogonium* sp., *Cosmarium quadrum* var. *distentum* n. var., *Amphora, Navicula cryptocephala.*)

650. Bright-green growth on living water-weeds, Du Toits Pan, Kimberley, Nov. 1917, coll. Moran. (*Oedogonium* sp., *Closterium Venus, Cosmarium quadrum* var. *distentum* n. var., *Amphora,* etc.)

652. Blue-green scum on mud of pool after rain (usually dry), roadside, Kimberley, May 1918, coll. Moran. (*Phormidium autumnale.*)

653. Blue-green growth among water-weeds, pool on veld, overflow from pond fed by spring-water, Alexandersfontein, Kimberley, June 1918, coll. Moran. (*Tetraëdron minimum* forma, *Spirogyra velata, Closterium spetsbergense* var. *africanum* n. var., *Cosmarium quadrum* var. *distentum* n. var., *C. scrobiculatum* n. sp., numerous Diatoms.)

654 and 655. Same locality. (*Spirogyra velata,* Diatoms.)

656. The same, but growth bright green. (Same as 653, together with *Sphaerocystis Schroeteri, Pediastrum integrum* var. *Pearsoni, Scenedesmus bijugatus, S. quadricauda, Coelastrum microporum, Spirogyra inflata, Cosmarium laeve* var. *distentum* n. var., numerous Diatoms.)

657 and 658. Bright-green growth on submerged stones and grass stems in pools of muddy water from pulsator, De Beers Mines, Kimberley, July 1918, coll. Moran. (*Spirogyra* sp., *Anabaena* sp.)

659. Same as last. (*Nostoc piscinale.*)

660. Bright-green fringe on buoy, Vaal River, Riverton, Oct. 1918, coll. Moran. (*Cladophora* sp., with Diatoms.)

661. Dull blue-green skin on mud, water furrow, Vaal River, Riverton, Oct. 1918, coll. Moran. (*Stigeoclonium* sp., *Phormidium autumnale,* numerous Diatoms, esp. *Nitzschia.*)

662 and 663. Blue-green growth on tree-stump, at and below water-level, Vaal River, Riverton, Oct. 1918, coll. Moran. (*Phormidium retzii.*)

664. On rotten log in Vaal River, Riverton, Oct. 1918, coll. Moran. (*Cladophora* sp., *Phormidium retzii.*)

665. Scum on drain from laboratory sinks, De Beers Laboratory, Kimberley, March 1922, coll. Moran. (*Ulothrix bipyrenoidosa* n. sp. above, *Phormidium molle* below.)

666. Bright-green, short fringe on side of concrete tank, at and below the water-level, Vaal River, Riverton, Oct. 1918, coll. Moran. (*Stigeoclonium tenue, Oedogonium* sp., *Phormidium papyraceum.*)

667. On bare open veld at Alexandersfontein, Kimberley, March 1922, coll. Moran. " Found best after light rains near small scrub bushes, unattached to any object ; green and gelatinous when wet, a thin, crisp, brittle skin when dry." (*Nostoc commune.*) *Cf.* 803.

668. Free-floating in duck pond at Alexandersfontein Hotel, Kimberley, March 1922, coll. Moran. (*Microcystis flos-aquae, Calothrix parietina.*)

669. Among water weeds, pond and swamp on veld at Alexandersfontein, Kimberley, March 1922, coll. Moran. Fed by spring, never dry. (*Pediastrum tetras, Spirogyra* sp.)

670. From drinking-water stand, adhering to brickwork, under trees, at Alexandersfontein Hotel, Kimberley, March 1922, coll. Moran. (*Stigeoclonium aestivale.*)

671. Same as 669, but free-floating, blue-green. (*Oscillatoria formosa, O. princeps, O. sancta, O. tenuis.*)

672. Same as 670, but dark-green scum on thin layer of mud covering bricks. (*Phormidium autumnale, P. corium.*)

673. Black and blue-green scum on wet ground near watering-pipe under trees at Alexandersfontein Hotel, Kimberley, March 1922, coll. Moran. (*Pediastrum clathratum* var. *punctatum, Oscillatoria sancta, Schizothrix penicillata,* Diatoms.)

674. Dark-green and brown growth on stones, subjected to drip from tap, under trees, Transvaal Road, Kimberley, March 1922, coll. Moran. (*Chlorococcum humicolum.*)

675. On overflow pipe from drinking-water stand, Market Square, Kimberley, March 1922, coll. Moran. (*Chlorella vulgaris.*)

676. Bright-green growth on débris from trees, moistened by dripping water-tap, under trees, Public Gardens, Kimberley, March 1922. (*Stigeoclonium* sp.)

677. Floating in still water in sunshine, Newlands, Barkly West, Aug. 1921, coll. Elliott Young. (*Spirogyra decimina.*)

678 and 679. Attached to soil or floating in still water of sunny pool

in Vlei, Newlands, Barkly West, Aug. 1921, coll. Elliott Young. (*Spirogyra decimina.*)

680. Attached to stick, in running water from spring in Vlei, in sun, Newlands, Barkly West, Aug. 1921, coll. Elliott Young. (*Rhizoclonium hieroglyphicum, Tribonema bombycinum* f. *minor*, diverse Diatoms, esp. *Synedra.*)

681. Floating in still water of sunny hole in Vlei, Newlands, Barkly West, Aug. 1921, coll. Elliott Young. (*Chlorococcum* sp., abundant Diatoms.)

682. Attached to grass in still water in sun, Newlands, Barkly West, Aug. 1921, coll. Elliott Young. (*Oedogonium Pisanum, Mougeotia* sp., *Spirogyra* sp., *Tribonema bombycinum* f. *minor, Chroococcus turgidus, Lyngbya subaestuarii* n. sp., *Nostoc* sp., *Surirella, Synedra.*)

683. Floating in still water, in shade, in river, Newlands, Barkly West, Sept. 1921, coll. Elliott Young. (*Zygnema peliosporum, Zygnema* sp., *Spirogyra decimina*, some Diatoms.)

684. Same as last, but in sunshine. (*Zygnema peliosporum*, fruiting.)

685. Attached to stick in river, in shade, Newlands, Barkly West, Sept. 1921, coll. Elliott Young. (*Zygnema* sp., *Spirogyra subaffinis* n. sp., *Vaucheria ornithocephala, Synedra.*)

686. Pale blue-green sheet, attached to wall of running sluit, in shade, Newlands, Barkly West, Sept. 1921, coll. Elliott Young. (*Phormidium tenue.*)

687. Attached to stick in running sluit, in sun, Newlands, Barkly West, Sept. 1921, coll. Elliott Young. (*Spirogyra decimina, Mougeotia* sp., *Vaucheria geminata, Chroococcus turgidus*, some Diatoms.)

688. Same as 683, but in sun. (*Pandorina morum, Spirogyra decimina.*)

689. Floating in still water in sun, Top Dam, Newlands, Barkly West, Sept. 1921, coll. Elliott Young. (*Pediastrum integrum* var. *Pearsoni, Spirogyra decimina, Cosmarium laeve*, diverse Diatoms.)

690, 691. Attached to stick in running water, Newlands, Barkly West, Sept. 1921, coll. Elliott Young. (*Spirogyra decimina.*)

693. Bottle-green growth attached to stick in still water in sun, Harts River, Newlands, Barkly West, Aug. 1922, coll. Elliott Young. (*Rhizoclonium hieroglyphicum, Spirogyra nitida.*)

694. Floating in still water, Harts River, Newlands, Barkly West, Aug. 1922, coll. Elliott Young. (*Spirogyra longata, S. nitida.*)

695. Attached to soil in running water in sun, Harts River, Newlands, Barkly West, Aug. 1922, coll. Elliott Young. (*Spirogyra longata, S. nitida, S. Spreeiana, S. varians, Synedra*, etc.)

696. Same as last, but still water, grey-green. (*Spirogyra* sp., many Diatoms.)

697. Same as 695, but still water and shade. (*Spirogyra nitida, Synedra, Gyrosigma.*)

698. The same, floating in still water in sun. (*S. nitida, Spirogyra* sp., *Synedra, Gyrosigma.*)

699. Attached to rock in running water in shade, Harts River, Newlands, Barkly West, Aug. 1922, coll. Elliott Young. (*Spirogyra longata, S. nitida.*)

700. Floating in running water in sun, Harts River, Newlands, Barkly West, Aug. 1922, coll. Elliott Young. (*Spirogyra decimina, S. Spreeiana* (?), *S. varians, Closterium peracerosum* var. *arcuatus, Cosmarium Blyttii, C. botrytis* var. *depressum, C. papkuilense, C. vexatum* forma, diverse Diatoms.)

701. Attached to soil in still water in sun, Harts River, Newlands, Barkly West, Aug. 1922, coll. Elliott Young. (*Spirogyra cataeniformis, Cosmarium laeve,* many Diatoms.)

703. Dull-green growth attached to side of water-tin, in shade, Newlands, Barkly West, Sept. 1922, coll. Elliott Young. (*Phormidium autumnale, P. inundatum.*)

704. Brown growth on wall of well, in shade, Newlands, Barkly West, Sept. 1922, coll. Elliott Young. (Diatoms, esp. *Synedra.*)

705. The same, bottle-green growth. (*Spirogyra* (*rivularis* ?), *Xenococcus Kerneri, Synedra.*)

706. The same, blue growth. (*Oscillatoria splendida* var. *attenuata.*)

708. The same, dark-green growth. (*Spirogyra* sp., *Synedra.*)

709. Running stream in sun, half-way between Alexandersfontein and Benauuwdheidsfontein, Kimberley Division, Aug. 1921, coll. Power. (*Spirogyra varians, Navicula radiosa,* etc.)

710 and 712. In furrow in sun, Mazelsfontein, Herbert, March 1922, coll. Power. (*Scenedesmus bijugatus, Spirogyra cataeniformis, Mougeotia* sp., *Cosmarium botrytis* var. *depressum, Oscillatoria princeps, Synedra.*)

711. In furrow, Mazelsfontein, Herbert, March 1922, coll. Power (same as last, together with *Cosmarium laeve, Closterium acerosum.*)

713 and 714. On weeds in an irrigation furrow, in sun, Douglas, March 1922, coll. Power. (*Spirogyra inflata, Cosmarium laeve* var. *pseudo-octangularis* n. var., *Palmella*-stage of *Euglena.*)

715 and 716. Attached to weeds in sun in Vaal River, Riverton, March 1922, coll. Power. (*Cladophora* sp., *Spirogyra* sp.)

717. Water-course, Mazelsfontein, Nov. 1921, coll. Mrs. Anderson. (*Scenedesmus bijugatus, Zygnema* sp., *Spirogyra* sp., *Merismopedia glauca,* diverse Diatoms.)

726. Brownish-yellow floating mass above weeds in Koedoesberg drift, Kimberley Division, July 1922. (*Pediastrum tetras, Oocystis solitaria* var. *apiculata, Scenedesmus quadricauda, Oedogonium* sp., *Spirogyra* sp.,

Cosmarium Blyttii forma, *C. papkuilense*, *C. perpusillum*, *C. subtumidum* var. *circulare*, *C. vexatum* forma, *Gomphosphaeria lacustris*, numerous Diatoms.)

727–731. Donderboschfontein, Barkly West, Sept. 1922, coll. Power. (*Oedogonium* sp., *Spirogyra* sp., *Mougeotia* sp., Diatoms, esp. *Synedra*.)

732. Donderboschfontein, " The sunny fountain," Barkly West. (*Oedogonium* sp., *Mougeotia* sp., *Oscillatoria splendida*, *Synedra*.)

733. Sage-green to brown growth on weeds in river, Koedoesberg drift, Kimberley, July 1922. (*Rhizoclonium hieroglyphicum*, *Oedogonium* sp., *Spirogyra* sp., *Closterium Leibleinii*, *Cosmarium granatum*, *C. papkuilense*, *C. vexatum* forma, *Merismopedia glauca*, *Gomphosphaeria lacustris*, *Oscillatoria sancta*, many Diatoms.)

734. Pool in river bed, on twigs in sun, Driekops Eiland, Riet River, Herbert, July 1922. (*Oocystis solitaria* var. *apiculata*, *Scenedesmus quadricauda*, *Stigeoclonium glomeratum* forma, *Oedogonium* sp., *Cosmarium subprotumidum* subsp. *simplex* var. *β* forma, *Merismopedia tenuissima*, *Spirulina major*, *Gomphosphaeria lacustris*, many Diatoms.)

735. Yellowish-brown growth on surface of weeds in Riet River, Koedoesberg drift, Kimberley Division, July 1922. (Same flora as 726, together with *Phacotus lenticularis*, *Oocystis Borgei*, *Sphaerocystis Schroeteri*, *Tetraëdron minimum* f. *apiculata*, *Rhizoclonium hieroglyphicum*, *Cosmarium botrytis* var. *depressum*, *C. sexangulare* var. *subangulare*.)

736. Brown growth on weeds in running water, Koedoesberg drift, Riet River, July 1922. (Same as last, but with *Pediastrum integrum* var. *Pearsoni*, *Closterium Leibleinii*, numerous Diatoms.)

737. Sage-green to brown growth on sandy bottom of pools, Riet River, at Driekops Eiland, Herbert, July 1922. (*Pediastrum clathratum*, *Scenedesmus quadricauda*, *Spirogyra longata*, *Zygnema* sp., *Merismopedia glauca*, *Spirulina major*, *Nodularia tenuis*, *Surirella*, *Gyrosigma*.)

738. On twigs in puddles, Driekops Eiland, Riet River, July 1922. (*Pediastrum clathratum*, *Merismopedia tenuissima*, a few Diatoms.)

739. On weeds on surface of water, Koedoesberg drift, Kimberley, July 1922. (*Spirogyra* sp.)

740. Brownish-yellow growth on surface, over matted weeds, Koedoesberg drift, July 1922. (Same as 726 and 735, together with *Pediastrum Sturmii* var. *echinatum*, *Coelastrum proboscideum*, *Aphanochaete repens*, *Oedogonium calcareum*, *O. inversum*, *Spirogyra Spreeiana*, *Cosmarium angulosum* var. *concinnum*, *C. granatum*, *Closterium Leibleinii*, many Diatoms.)

741. Sides and bottom of a stream, Koedoesberg drift, Kimberley Division, July 1922. (*Rhizoclonium hieroglyphicum*, *Spirogyra* sp., Diatoms.)

742. Sunny pools in Riet River at Driekops Eiland, Herbert, July 1922. (*Spirogyra* sp., Diatoms.)

743. Green to brown growth on under surfaces of stones in pools, Riet River at Driekops Eiland, Herbert, July 1922. (*Phacotus lenticularis, Ankistrodesmus nitzschioides* var. *spiralis, Scenedesmus obliquus, S. quadricauda, Stigeoclonium glomeratum* forma, *Spirogyra* sp., *Closterium Leibleinii, Cosmarium perpusillum, C. subprotumidum* and subsp. *simplex* var. α and var. β, *Merismopedia glauca, Spirulina major*, many Diatoms.)

745. Free-floating in pools, Driekops Eiland, Riet River, Herbert, July 1922. (*Stigeoclonium* sp., *Spirogyra* sp.)

746. On surface of running water, Koedoesberg drift, July 1922. (*Spirogyra* sp.)

748 and 749. Stagnant sunny pools, Driekops Eiland, Riet River, May 1922, coll. Parker. (*Sphaerocystis Schroeteri, Pediastrum clathratum, Actinastrum hantzschii, Dictyosphaerium pulchellum, Scenedesmus acuminatus, Uronema confervicolum, Stigeoclonium* sp., *Oedogonium* sp., *Closterium Leibleinii, Spirulina major*, many Diatoms.)

750. On stone in running stream in sun, Driekops Eiland, Riet River, May 1922, coll. Parker. (*Phacotus lenticularis, Spirulina major*, Diatoms and sponge spicules.)

751. On rushes in stagnant sunny pool, Driekops Eiland, Riet River, May 1922, coll. Parker. (*Uronema confervicolum, Stigeoclonium* sp., *Spirogyra* sp., *Oedogonium pisanum* (?), some Diatoms.)

752 and 754. From sides of tub containing water, in sun, Kimberley, June 1922. (*Gloeocapsa aeruginosa, Schizothrix lardacea.*)

753, 755, and 756. Grass-green growth in sunny sluit, Sogo Location, Herbert, June 1922. (*Spirogyra reticulata* forma, *Spirogyra* sp., *Debarya africana* var. *polymorpha* n. var., *Cosmarium laeve* var. *distentum*, Diatoms.)

757. Same as 753, together with *S. Spreeiana.*

758 and 759. The same, the last also with *Pediastrum integrum* var. *Pearsoni.*

760. Same locality and date. (Diatoms only.)

782. Reddish-purple growth in pool of still water in Harts River, floating in sun, Newlands, Sept. 1922, coll. Elliott Young. (*Pediastrum integrum* var. *Pearsoni, Sphaeroplea Wilmani* n. sp., *Zygnema peliosporum, Z. fertile* n. sp., *Debarya africana* var. *polymorpha* n. var., *Spirogyra fluviatilis*, few Diatoms, *Cymbella, Epithemia.*) *Cf.* 820.

803. On veld, Alexandersfontein, Kimberley, Feb. 1922, coll. Parker. (*Nostoc commune.*)

805. Pale-green, free-floating growth in pool in pit after rain, usually dry, Kimberley, May 1918, coll. Moran. (*Euglena* sp.)

806. From bottom of furrow supplying Du Toits Pan, Kimberley, Jan. 1923. (*Phormidium autumnale.*)

807. On weeds in Du Toits Pan, Kimberley, Jan. 1923. (*Rhizoclonium*

hieroglyphicum, *Oedogonium* sp., *Spirogyra* sp., *Phormidium autumnale*, *P. valderianum*, *Spirulina major*.)

808–810, 812, and 817. From bottom of furrow supplying Du Toits Pan, Jan. and Feb. 1923. (*Stigeoclonium fasciculare*, *Phormidium autumnale*, *P. valderianum*, *Spirulina major*, Diatoms.)

811. On margin of Du Toits Pan, Kimberley, Jan. 1923. (*Rhizoclonium hieroglyphicum*, *Oedogonium* sp., *Microcystis flos-aquae*, *Nodularia spumigena* var. *vacuolata* n. var., Diatoms.)

813 and 814. Same as 811 (also on rootlets of water-weeds). (Same flora with *Botryococcus protuberans* and *Phormidium autumnale*.)

815. From rapidly flowing water in furrow supplying Du Toits Pan, Kimberley, Feb. 1923. (*Stigeoclonium fasciculare*, *Oedogonium* sp., *Oscillatoria amphibia*, *Phormidium tenue*, *P. autumnale*, *Spirulina major*, *Nodularia spumigena* var. *vacuolata* n. var., Diatoms.)

816. Brown growth on weeds on margin, Du Toits Pan, Jan. 1923. (*Stigeoclonium fasciculare*, *Oedogonium* sp., *Nodularia spumigena* var. *vacuolata*, Diatoms.)

818. Same as 806, together with *Oedogonium* sp. and *Nodularia spumigena* var. *vacuolata* n. var.

819. Grass-green growth on rootlets and stone from bottom of sunny puddle, Public Garden, Kimberley, Jan. 1923. (*Stigeoclonium fasciculare*.)

820. Light-purple and green growth, Newlands, Sept. 1922. (*Pediastrum integrum* var. *Pearsoni*, *Sphaeroplea Wilmani* n. sp., *Zygnema fertile* n. sp., *Z. peliosporum*, *Spirogyra fluviatilis* forma, *S. lutetiana*, *S. Spreeiana*, *Cymbella*.) *Cf.* 782.

821. Free-floating, sage-green growth in irrigation canalicula, Kenilworth, near Kimberley, Jan. 1923. (Diatoms only.)

822. From sides of evaporating tank in sun, Kenilworth Observatory, near Kimberley, Jan. 1923. (*Phacotus lenticularis*, *Micractinium* spp., *Oocystis* spp., *Tetraëdron minimum* forma, *Coelastrum reticulatum*, *Dictyosphaerium pulchellum*, *Chaetosphaeridium globosum*, *Ulothrix* sp., *Cosmarium meneghinii* forma, *C. Blyttii*, *C. papkuilense*, *C. vexatum*, *Staurastrum* spp., *Chroococcus turgidus*, *Microcystis flos-aquae*, *Merismopedia glauca*, *Lyngbya constricta*, *Plectonema notatum* var. *africanum*, *Trachelomonas volvocina*, Diatoms (*Rhopalodia*, etc.))

823. In sun at bottom of irrigation canalicula, Kenilworth, Kimberley, Jan. 1923. (*Phormidium autumnale*, *Cyclotella*, etc.)

824. From bottom of evaporating tank, in sun, Kenilworth, Kimberley, Jan. 1923. (*Lyngbya constricta*, *Cosmarium vexatum*, Diatoms.) *Cf.* 822.

825. Dark-green growth from shallow sunny furrow, Newlands, Dec. 1922. (*Phacotus lenticularis*, *Pediastrum* spp., *Scenedesmus acuminatus*, *S. protuberans* n. sp., *Crucigenia tetrapedia* var. *apiculata* n. var., *Closterium*

exiguum, *Centritractus africana* n. sp., *Euglena intermedia* var. *brevis* n. var., *Phacus pyrum*, *Oscillatoria formosa*, *Phormidium autumnale*, *Rhaphidiopsis curvata* n. gen. et sp., Diatoms.)

826. Same as last, but only with *Scenedesmus protuberans* and *Phormidium autumnale*.

827. Free-floating in irrigation furrow, Newlands, Barkly West, Dec. 1922. (*Rhizoclonium hieroglyphicum*, *Spirogyra* sp., *Zygnema* sp., many Diatoms.)

828. Much the same as 825.

831. Brownish-green growth adhering to cement dam, Riverton, Oct. 1922, coll. Power. (*Stigeoclonium aestivale* forma, *Oedogonium* sp.)

832. Red growth, Riverton, Vaal River, Kimberley, 1922, coll. S. Tapscott. (*Tetrasporidium* sp.??, resting *Euglena*.)

833. Dark-green coating in fountain of running water, slightly shaded by trees, Klip Bank, Hay, July 1922, coll. H. E. Louw. (*Scenedesmus arcuatus*, *Coelastrum microporum*, *Spirogyra* sp., *Phacus orbicularis* var. *minor* n. var., *Dactylococcopsis fascicularis*, *Nodularia spumigena*, many Diatoms.)

834. On the Eureka dam, Hay, Oct. 1922, coll. H. E. Louw. (*Cosmarium laeve*, *Achnanthes*, and other small Diatoms.)

835. Floating in still water in sun, Harts River, Newlands, Oct. 1922, coll. Elliott Young. (*Spirogyra cataeniformis*, Diatoms.) *Cf.* 840.

836 and 837. Attached to stone out of water, Harts River, Newlands, Oct. 1922, coll. Elliott Young. (*Zygnema peliosporum*, *Spirogyra cataeniformis*, *S. lutetiana*, *Rhopalodia*, etc.)

838. Floating in running water in sun, water furrow, Newlands, Nov. 1922, coll. Elliott Young. (*Rhizoclonium hieroglyphicum*, *Spirogyra* sp., *Synedra*.)

839. Same place, etc., but attached. (Same flora.)

840–842. Floating in still water in sun, Harts River, Newlands, Oct. 1922, coll. Elliott Young. (*Zygnema peliosporum*, *Spirogyra cataeniformis*, *Mougeotia* sp. (*Debarya* ?), *Rhopalodia*, etc.) *Cf.* 782 and 835.

843. The same. (Same flora together with *Rhizoclonium hieroglyphicum*, *Closterium Leibleinii*, *Cosmarium Blyttii*.)

844. Floating in sun in water-tank, Newlands, Feb. 1923, coll. Elliott Young. (*Pandorina morum*, *Eudorina elegans*, *Phacotus lenticularis*, *Scenedesmus* spp., *Pediastrum* spp., *Oocystis natans*, *Ankistrodesmus falcatus* var. *spirilliformis*, *Selenastrum minutum*, *Dictyosphaerium pulchellum*, *Coelastrum proboscideum*, *Crucigenia tetrapedia* var. *apiculata*, *C. triangularis*, *Centritractus africana* n. sp., *Euglena oxyuris* f. *minor*, *Phacus* spp., *Lepocinclis* spp., *Merismopedia tenuissima*, *Phormidium autumnale*, *Rhaphidiopsis curvata* n. gen. et sp., Diatoms.) *Cf.* 825.

845. Free-floating in sluit of running water in sun, Newlands, Feb. 1923, coll. Elliott Young. (*Pediastrum integrum* var. *Pearsoni*, *Zygnema* sp., *Cosmarium sexangulare* var. *subangulare* forma, *Synedra*.)

853. Free-floating in sunny reservoir, Honeynest Kloof, Nov. 1923. (*Pediastrum integrum* var. *Pearsoni*, *Scenedesmus* spp., *Phacus orbicularis* var. *minor* n. var., Diatoms.)

854 and 860. Bottom of a clear-water furrow, in sun, Honeynest Kloof, Nov. 1923. (*Scenedesmus* spp., *Phormidium autumnale*, *Nitzschia*.)

855. Bright-yellow growth, local, on the limestone floor of a duck-pond, in sun, Honeynest Kloof, Nov. 1923. (*Scenedesmus arcuatus*, *S. quadricauda*, Diatoms.)

856. Free-floating in reservoir, Honeynest Kloof, Nov. 1923. (*Rhizoclonium hieroglyphicum*, *Scenedesmus arcuatus*, Diatoms.)

857. Walls of a muddy duck-pond, in shade, Honeynest Kloof, Nov. 1923. (*Scenedesmus* spp., *Phormidium incrustatum*, Diatoms.)

858. Same as 856, but from bottom of reservoir. (No *Rhizoclonium*.)

859. Mats on running water in fountain, in sun, Honeynest Kloof, Nov. 1923. (*Pediastrum integrum* var. *Pearsoni*, *Scenedesmus* spp., *Rhizoclonium hieroglyphicum*, Diatoms.)

861. In running water in fountain, in sun, Honeynest Kloof, Nov. 1923. (*Scenedesmus* spp., *Spirogyra* sp., Diatoms.)

862. Surface of muddy-water furrow, in sun, Honeynest Kloof, Nov. 1923. (*Scenedesmus arcuatus*, *Phormidium* sp., Diatoms.)

868. Sides of cattle trough, The Glen, Hay, Feb. 1923. (*Pediastrum integrum* var. *Pearsoni*, *Oocystis elliptica*, *O. rupestris* f. *acuminata*, *Ankistrodesmus convolutus* var. *minutus*, *Selenastrum minutum*, *Scenedesmus armatus* and var. *spinosus* n. var., *Cosmarium* spp., *Chroococcus turgidus*, *Merismopedia tenuissima*, *Schizothrix lateritia*, many Diatoms.)

869. Surface of stream, Dunmurry Kloof, Langebergen, Hay, Feb. 1923. (*Dictyosphaerium pulchellum*, *Scenedesmus incrassatulus*, *Oedogonium* sp., *Penium minutissimum*, Diatoms.)

870. Grass-green growth in sunny stream, Dunmurry Kloof, Langebergen, Hay, Feb. 1923. (*Scenedesmus incrassatulus*, *Ulothrix tenerrima*, *U. zonata*, *Sphaeroplea Wilmani* n. sp., *Oedogonium varians*, *Oedogonium* sp.)

871. Free-floating on surface of trough, Papkuil, Hay, March 1923. (*Spirogyra* sp., *Oscillatoria chalybea*, many Diatoms.)

872. Surface of drinking-trough, Rooi Poort, Kimberley, March 1923. (*Scenedesmus bijugatus*, *Aphanocapsa* sp., *Chroococcus minutus*, *Phormidium autumnale*, *P. valderianum*, *Achnanthes*, etc.)

1354. From puddle in Hol River, shaded in morning, Klein Boetsap, Barkly West, Aug. 1925. (*Spirogyra Reinhardi* var. *africana* n. var., many Diatoms.)

1355. Walls of Hol River ravine, Klein Boetsap, Aug. 1925. (*Vaucheria* sp., *Phormidium corium.*)

1356. Side of Hol River ravine, Klein Boetsap, Aug. 1925. (*Phormidium tenue*, *P. valderianum*, many Diatoms.)

New records for South Africa (*i.e.* the region south of the Zambesi) are indicated by an *, placed before the species or variety, in the subsequent systematic portion. There are 110 new records (see table on p. 3).

C. Systematic Enumeration of the Species Observed.*

I. ISOKONTAE.

Group 1. VOLVOCALES.

Series I. CHLAMYDOMONADALES.

(2) CHLAMYDOMONADACEAE.

Genus Chlamydomonas, Ehrenberg.

1. * *Chlamydomonas africana*, Fritsch and Rich, nov. nom. (Syn.: *C. dorsiventralis*,† Fritsch and Rich, Ann. of Bot., xli, 1927, p. 94, fig. 2). (Fig. nostr. 1, *A–D.*)

C. cellulis parvis evidenter dorsiventralibus, membrana tenui postice incrassata, papilla apicali (" Hautwarze ") nulla, sed ciliis (paullo brevioribus quam corpore cellulae) e rostro conspicuo cytioplasmatis ortis; cellulis e planitie cilium visis subsymmetricis angusto-oblongis vel ovoideis vel raro fere subcircularibus, marginibus lateralibus subparallelis vel plus minusve convexis, fine posteriore rotundato vel obtuse acuminato, e planitie altera perpendiculari visis asymmetricis altero margine plano altero convexo utroque fine obtuse rotundatis, ciliis saepe faciem deplanatam approximatis; chromatophora singula parietali totam longitudinem cellulae fere complenti, in forma laminae valde curvatae marginibus irregularibus fere in media facie deplanata cellulae conniventibus, pyrenoide singulo in media cellula aut paullo posteriore, faciem convexam cellulae contiguo. Multiplicatio saepe in 2, rarius in 4 partes fit, cellulis duabus filialibus frequenter inversis, altera in planitie cilium altera in planitie perpendiculari dispositis.

* The classification followed is that of West and Fritsch, " British Freshwater Algae, etc.," Cambridge, 1927.

† A *Chlamydomonas dorsiventralis* has already been described by Pascher.

Long. cell., 7–12 μ ; lat. cell., 5–6, 5 μ.

Sample 621 (not uncommon).

The cells of this small species appear more or less symmetrical when viewed in the plane of the cilia (Fig. 1, *A*, *B*), but in the plane at right angles to this they are markedly dorsiventral, with one flattened and one convex surface (Fig. 1, *D*) ; as a general rule the two cilia are situated nearer to the flattened face. The chloroplast is in the form of a curved parietal plate, occupying the greater part of the length of the cell and extending round most of the circumference, the two somewhat irregular edges of the plate meeting at about the middle of the flattened surface of the individual (Fig. 1, *A*). The pyrenoid usually lies at about the middle of the length of the cell or slightly posterior, and is lodged in the part of the chloroplast adjacent to the convex surface of the cell (Fig. 1, *D*). It thus appears median when the cells are viewed in the plane of the cilia, but lateral when the cells lie in the plane at right angles to this. The cilia are slightly shorter than the body and arise from a conspicuous protoplasmic beak, but there is no beak on the cell-membrane itself. The membrane is prominently thickened at the posterior end of the cell, which is usually bluntly pointed. An eye-spot has not been recognised.

Asexual reproduction is effected by division of the contents of the resting individuals into two or, more rarely, four parts. When two daughter-individuals are produced they commonly lie with their anterior ends facing in opposite directions, and while one individual presents its dorsal or ventral surface to the observer, the other is seen in side-view (Fig. 1, *C*).

This species may be compared with *C. elegans*, G. S. West (Journ. of Bot., 1915, p. 77), and especially with *C. asymmetrica*, Korschikoff (*cf.* Pascher, Volvocales, Süsswasserfl. Deutschlands, Oesterreichs, etc., iv, 1927, p. 280), which has quite a similar chloroplast, but differs in the shape of the cell, the presence of a truncate beak at the front end, the thin cell-membrane, and the possession of a conspicuous eye-spot.

2. * *Chlamydomonas pulvisculus* Ehrenb. (*C. ehrenbergii*, Gorosch., Bull. soc. imp. nat. Moscou, 1890, p. 128 ; Wille, Nyt Mag. f. Naturvidensk., xli, 1903, p. 143).

Sample 621 (rather rare).

3. * *Chlamydomonas truncata*, Fritsch and Rich, *loc. cit.*, p. 96, fig. 3. (Fig. nostr. 1, *E–I*.)

C. cellulis symmetricis plerumque oblongis, papilla apicali nulla, fine posteriore rotundato, fine anteriore truncato, membrana in parte posteriore et anteriore paullo incrassata, in lateribus tenui ; ciliis e extremitate anteriore rotundata cytioplasmatis ortis, divergentibus, membrana in margine anteriore truncato ubi cilia exeunt incrassationibus duabus punctiformibus praedita ; chromatophora basali crateriformi, pyrenoide

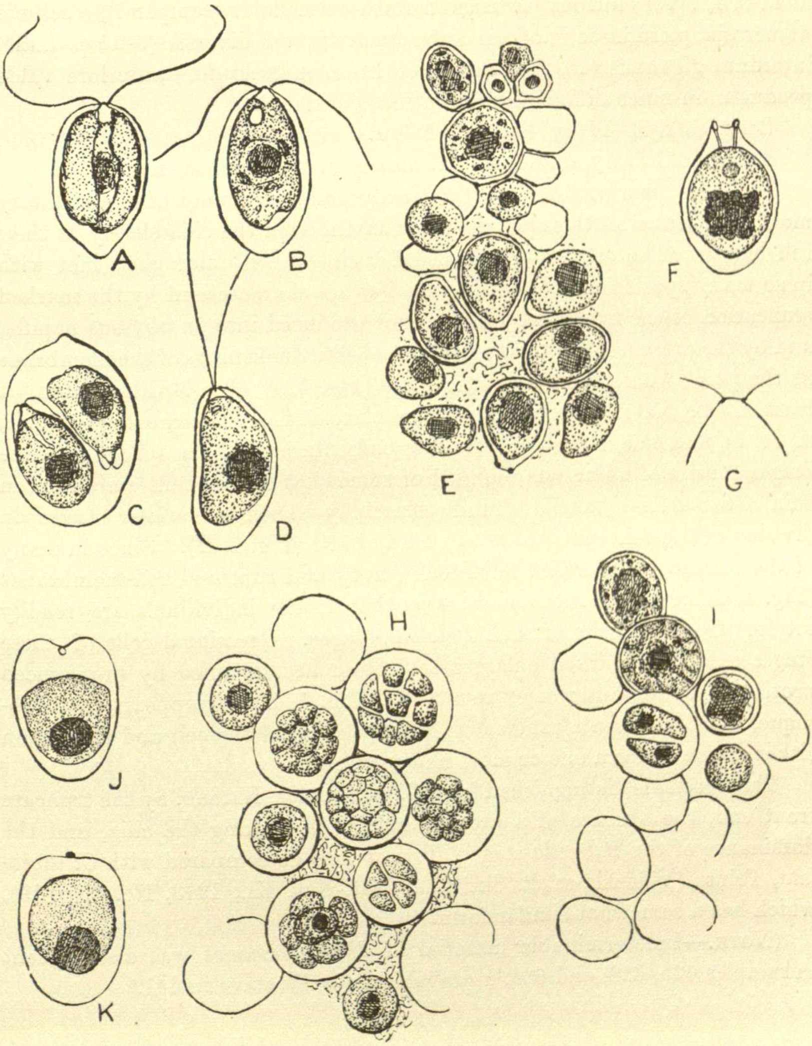


Fig. 1.—*A–D*, *Chlamydomonas africana*, Fritsch and Rich; *A*, seen from the flattened ventral surface; *B*, from the convex dorsal surface; *C*, stage in division; *D*, side-view. *E–I*, *C. truncata*, Fritsch and Rich; *F*, ordinary individual; *G*, front end of another individual enlarged; *E*, *H*, *I*, *Palmella*-stages, in *E* showing the form of the normal individual, *H* stages in division, and *I*, empty cells from which the contents have escaped after division. *J*, *K*, *Carteria* sp. (?) (*cf.* p. 22). (*A–D* × 2000; *E*, *H*, *I* × 750; *F* × 1500; *J*, *K* × 900.)

magno angulari singulo mediano in parte basali incrassata. Multiplicatio fit in 2, 4, 8 vel pluribus partibus in statu palmelloide (semper ?), e cellulis numerosis plerumque globosis subaequalibus vel diversis (6–15 μ latis), interdum giganteis (18–21 μ longis et 14–16 μ latis) fine anteriore valde producto, in muco diffluenti nidulantibus constanti.

Long. cell., 10–14 μ ; lat. cell., 6–9 μ.

Sample 621 (very abundant, but mostly in the *Palmella*-stage).

We have been unable to obtain really good specimens of the ordinary motile individual of this species, never having seen the cilia clearly at their full length. The cells have the usual basin-shaped chloroplast met with in so many species of *Chlamydomonas*, but are characterised by the marked truncation of the front end, which is not produced into an obvious papilla, and by the presence of two prominent bead-like thickenings of the membrane at the point where the two cilia emerge (Fig. 1, *F*, *G*). Multiplication, at least in this material, invariably takes place in the *Palmella*-stage (Fig. 1, *E*, *H*, *I*), and this is probably another characteristic of the species. These stages consist of numerous rounded or somewhat oblong cells embedded in thin structureless mucilage and commonly showing various stages in division of the contents into few or many parts (Fig. 1, *H*). Since in many of the masses more or less numerous empty and ruptured cell-membranes (Fig. 1, *I*) were encountered, it seems that motile individuals are readily set free from the cells of such *Palmella*-stages. Occasional cells of these stages exhibited marked enlargement, often accompanied by pronounced protrusion of the anterior extremity (*cf.* Fig. 1, *E*) ; it appears that subsequently the contents contract to the back end of the cell and thereupon either divide or form one or more new membranes.

This species is distinguished from *C. pulvisculus*, Ehrenb. by the truncate front end, the absence of a protoplasmic beak bearing the cilia, and the dominance of the *Palmella*-stage. It may also be compared with *C. urceolata*, Printz (Vidensk.-selsk. Skrift., i, Mat.-Nat. Kl., 1913, No. 6, p. 19), which has a somewhat similar form.

(Note.—Indeterminable material of *Chlamydomonas* was also present in samples 625, 628, and 634, a probable *Palmella*-stage in 641.)

Genus Polytoma, Ehrenberg.

1. * *Polytoma africanum*, Fritsch and Rich, nov. nom. (Syn. : *P. caudata* *, Fritsch and Rich, *loc. cit.*, p. 92, fig. 1.) (Fig. nostr. 2, *A–E*.)

P. mediocris, cellulis symmetricis elongato-obovatis, fine anteriore rotundato, fine posteriore obtuse acuminato, saepe caudiformi ; membrana in parte posteriore et anteriore valde incrassata, in lateribus tenui, papilla

* A *Polytoma caudatum* has already been described by Korschikoff.

apicali nulla ; cytioplasmate obovato vel interdum oblongo, postice rotundato, antice cum rostro parvo ubi cilia 2 subcrassa tam longa quam corpore cellulae oriuntur, cum granulis amylaceis magnis oblongis numerosis in parte peripherica ; nucleo magno rotundato in parte centrali ; stigma nulla (?). Multiplicatio per motum in 2, 4, 8, vel 16 partes fit, planitie divisionis primae obliqua, cellulis filialibus primum oblongis membrana ubique tenui.

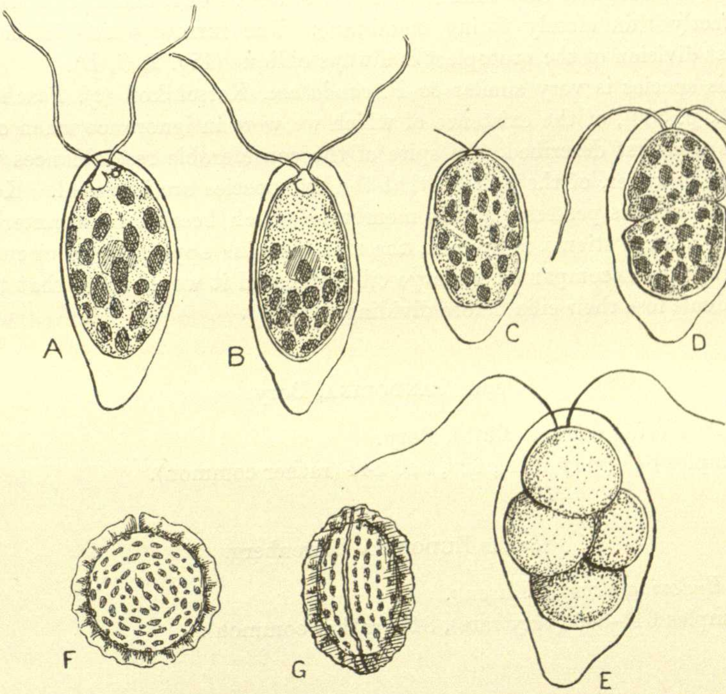


FIG. 2.—*A–E*, *Polytoma africanum*, Fritsch and Rich ; *C* and *D*, early stages in division ; *E*, later stage. *F*, *G*, *Phacotus lenticularis* (Ehrenb.), Stein ; *F*, front-view ; *G*, seen from the edge. (All × 1500.)

Long. cell., 15–20(–24, 5) μ ; lat. cell., 6–10(–15) μ ; cell. filial., 9–12 μ long. et 5–6 μ lat.

Sample 621 (rather common).

The shape of the mature individuals of this species is elongate-obovate, with a bluntly pointed posterior end which is commonly somewhat set off as a tail (Fig. 2, *B*), and now and again is turned a little to one side (Fig. 2, *A*). The protoplast itself, however, is oblong and broadly rounded at each end. The membrane is very strongly thickened at the posterior end and markedly, though not quite so strongly, at the anterior end (Fig. 2, *A*, *B*). There is no beak on the membrane, but the two rather coarse cilia arise from a small protoplasmic beak. As a general rule the whole of the peripheral portion of the protoplast is filled with large oblong starch-grains (Fig. 2, *A*), although occasionally they were met with only in the posterior half (Fig. 2, *B*). The large spherical nucleus lies about in the middle of the cell.

Division always takes place during movement and leads to the production of 2–16 daughter-individuals. The latter are oblong, and at first have a perfectly thin closely fitting membrane. The furrow which initiates the first division of the protoplast is always oblique (Fig. 2, *C*, *D*).

This species is very similar to *P. caudatum*, Korschikoff (*cf.* Pascher, *loc. cit.*, p. 389), of the existence of which we were in ignorance when our species was first described. In spite of the considerable resemblances we are not, however, of the opinion that the two species are identical. Korschikoff's species possesses a thin membrane which bears a small anterior papilla, a large stigma is present, the starch-grains appear to be circular and are often accompanied by large oil-drops, and it would seem that the individuals lose their cilia before dividing.

Genus Pandorina, Bory.

1. *Pandorina morum* (Müll.), Bory.

Samples 645 (very rare), 688, and 844 (rather common).

Genus Eudorina, Ehrenberg.

1. *Eudorina elegans*, Ehrenb.

Samples 644–646 (very rare), 844 (rather common).

Genus Carteria, Diesing.

(Note.—In sample 617 there occurred a member of Chlamydomonadaceae which is possibly a species of *Carteria*. The cells (15–19 μ long; 10, 5–15 μ broad) were oblong, with a flattened or even emarginate front end (very rarely faintly convex), from the middle of which a slight papilla arose (Fig. 1, *J*, *K*). The protoplast was usually confined to the back part or to the middle of the cell, the wall apparently being strongly thickened and mucilaginous. The chloroplast was not clearly distinguishable, but appeared to be cup-shaped and had a single median pyrenoid; in one or two cases it gave the impression of being ribbed. The nucleus lay in front of the pyrenoid. No cilia could be recognised and therefore the assignation to *Carteria* is uncertain, but there are some resemblances to *C. bullulina*, Playfair and *C. alpina*, Schmidle.)

(4) PHACOTACEAE.

Genus Phacotus, Perty.

1. * *Phacotus lenticularis* (Ehrenb.), Stein (Fig. 2, *F*, *G*).

Samples 600, 617, 624, 625, 634, 735, 740, 743, 750, 822, 825, 844 (common in 822, rather common in 617 and 634, otherwise rare).

Long. cell., 13–17 μ; lat., 14 μ; crass., 10 μ.

The rugosity of the membrane is entirely determined by the calcification and disappears completely after treatment with hydrochloric acid. There is usually a slight elevation of the membrane at the point where the cilial aperture occurs (Fig. 2, *F*). It would seem that the two valves are merely held together by mucilage, and there is always visible a slight narrower or wider gap between the two edges, which sometimes appear a little undulate or rough (Fig. 2, *G*); there is often a well-defined longitudinal row of dots on either side of the line of junction of the valves. There is no evidence of a thickening of the margins where they meet. Division into four and eight individuals was observed.

Series III. TETRASPORALES.

(1) PALMELLACEAE.

Genus Sphaerocystis, Chodat.

1. *Sphaerocystis Schroeteri*, Chod.

Samples 604, 656, 735, 749, 822 (in all cases rare).

Genus Tetrasporidium, Moebius.

In sample 832 there occurred a practically pure growth composed of a palmelloid Alga and numerous resting cells of an *Euglena*, each surrounded by a wide, altogether hyaline mucilage-envelope, the two together forming a thin membranous film of delicate, but quite firm, consistency. The innumerable spherical cells of the Alga (diam., 9–13 μ) were aggregated within structureless mucilage showing a somewhat granular character at most points. Their distribution within the mucilage was not even; at some points they were closely packed, though apparently usually lying in a single layer, at other points they were loosely aggregated. Over considerable stretches the mucilage formed a continuous film, but at other points there were oblong or irregular spaces (Fig. 3, *B*), apparently bounded by a relatively firm contour. Moreover, over a great part of the surface the film was raised into a polygonal network of ridges (Fig. 3, *A*) formed by relatively narrow strands of mucilage harbouring often only one single irregular row of densely placed spherical cells (*cf.* Fig. 3, *B*). Over parts of the surface the meshes of this network were empty, but at other points each was occupied by one or two of the large resting-cells of the *Euglena.*

In the absence of all information as to the mode of occurrence of the material, it is impossible to know how to interpret this structure. Is the palmelloid phase normally of the form here depicted and have the resting *Euglenae* merely sought out the hollows between the network of ridges, or were the *Euglenae* the first to settle down and has the palmelloid phase merely covered them and grown down as ridges between the contiguous

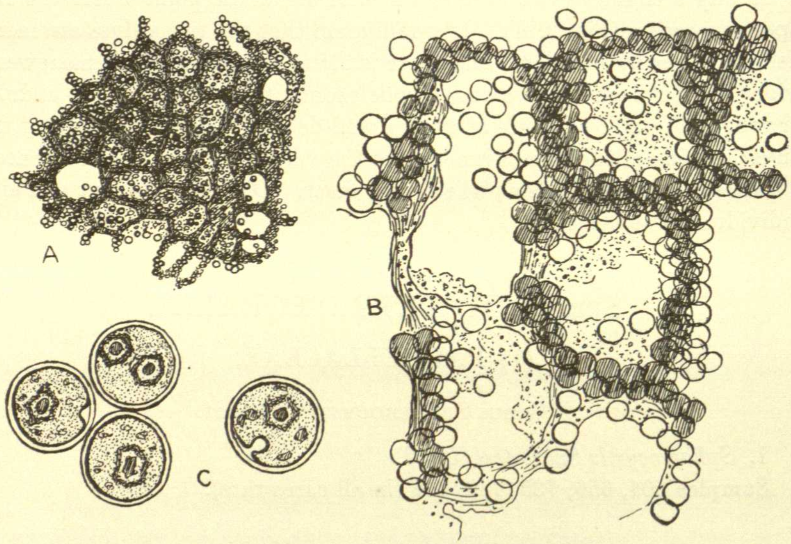


FIG. 3.—*Tetrasporidium* sp. (?). *A*, small part of a film (slightly magnified); *B*, part of the same enlarged to show the arrangement of the cells (× 300); *C*, single cells (× 1200).

Euglena-cells ? If the latter explanation is correct, we may be merely dealing with a *Palmella*-stage of *Chlamydomonas,* if the former we are confronted with what is certainly a new species and possibly a new genus. It should be mentioned that the correspondence between the *Euglena*-cells and the meshes of the network of the palmelloid stage was far from universal; in fact not at all uncommonly the *Euglena*-cells appeared to overlie (or underlie ?) the ridges. There is a remote resemblance to *Tetrasporidium javanicum,* Moebius (Ber. Deutsch. Bot. Ges., xi, 1893, p. 122) in the perforate character of the mucilage-film and the obvious Isokontan nature of the cells, and it is possible that we are dealing with another species of the same genus.

The cells were usually completely spherical, with a firm well-defined membrane, and contained one or frequently two large pyrenoids (Fig. 3, *C*) ; generally abundant starch was present. There was often a small excavation on one side of the protoplast. Very few division-stages were seen, the products being grouped in twos or fours, but over most of the film the arrangement of the cells was quite haphazard.

Group 2. CHLOROCOCCALES (Protococcales).

Series I. ZOOSPORINAE.

Family 1. CHLOROCOCCACEAE.

Genus Chlorococcum, Fries.

1. * *Chlorococcum humicolum* (Naeg.), Rabenh. (Syn. : *Cystococcus humicola*, Naeg.)

Sample 674 (common, intermingled with Diatoms and Myxophyceae).

Diam. cell., 8–27 μ.

(An indeterminable species of *Chlorococcum* was not uncommon in sample 681.)

Family 3. HYDRODICTYACEAE.

Genus Pediastrum, Meyen.

1. *Pediastrum Boryanum* (Turp.), Menegh. var. *longicorne*, Reinsch. forma *granulata*, Brunnthaler, in Pascher, Süsswasserfl. Deutschlands, Österreichs, etc., 1915, p. 101.

Sample 825 (rare).

2. *Pediastrum clathratum* (Schröt.), Lemm. ; Brunnthaler, *op. cit.*, p. 94.

Samples 673 (var. *punctatum*, Lemm.), 737, 738, 748, 844 (in all cases rare).

3. *Pediastrum duplex*, Meyen var. *reticulatum*, Lagerh. ; Brunnthaler, *op. cit.*, p. 95.

Samples 825 and 844 (rare).

4. *Pediastrum integrum*, Naeg. var. *Pearsoni* (G. S. West), Fritsch, Trans. Roy. Soc. S. Africa, ix, 1921, p. 11. (Syn. : *P. Pearsoni*, G. S. West, Ann. S. Afr. Mus., ix, 1912, p. 79.)

Samples 614, 619, 622, 632, 633, 656, 689, 736, 782, 820, 833, 845, 853, 859, 868 (common in 632 and 633, rather common in 868, otherwise rare).

5. * *Pediastrum Sturmii*, Reinsch var. *echinulatum* (Wittr. and Nordst.), Lemm. ; Brunnthaler, *op. cit.*, p. 93.

Sample 740 (only one specimen seen).

6. *Pediastrum tetras* (Ehrenb.), Ralfs.

Samples 669, 726, 735, and 740 (rare).

Series II. AUTOSPORINAE.

Family 2. CHLORELLACEAE.

Genus Chlorella, Beijerinck.

1. * *Chlorella vulgaris*, Beij. (?).

Sample 675 (abundant).

The material formed a very dense stratum owing to close crowding of the daughter-cells, which were in part angular as a result of mutual compression. The mature cells were 5–6 μ in diameter.

Genus Trochiscia, Kützing.

1. * *Trochiscia reticularis* (Reinsch), Hansgirg, Prodr. d. Algenfl. v. Böhmen, ii, 1892, p. 241.

Sample 822 (rare).

Diam. cell., 20–26 μ.

Genus Micractinium, Fresenius.

(*Golenkinia*, Chod.; *Richteriella*, Lemm.)

1. * *Micractinium pusillum*, Fresen. (Syn.: *Richteriella botryoides* (Schmidle), Lemm.)

Sample 822 (rare). Recorded from the plankton of Lake Nyassa (Schmidle).

2. * *Micractinium radiatum* (Chod.), Wille. (Syn.: *Golenkinia radiata*, Chod.)

Sample 822 (rare).

Family 3. OOCYSTACEAE.

Genus Oocystis, Naegeli.

1. ? * *Oocystis Borgei*, Snow; Printz, Nyt Mag. f. Naturvidenskab., li, 1913, p. 173, Tab. IV, figs. 1, 2. (Syn.: *O. gigas*, Arch. var. *Borgei* (Snow), Brunnthaler.)

Samples 735 and 822 (rare).

Colonies: 22–26 × 19–22 μ.

2. * *Oocystis elliptica*, W. West; Printz, *loc. cit.*, p. 182, Tab. IV, fig. 33.

Sample 868 (rather rare).

Only isolated cells, 19–21 μ long and 12–14 μ broad. This species has been recorded from Angola and Madagascar.

3. * *Oocystis natans* (Lemm.), Wille; Printz, p. 174, Tab. IV, figs. 10, 11.

Sample 844 (rare).

Mainly isolated cells, also a few 4-celled colonies ; cells with a number of parietal chloroplasts, each with a pyrenoid.

4. *Oocystis rupestris*, Kirchn. ; Printz, p. 174, Tab. IV, figs. 7–9.

Sample 822 (rare).

Mostly isolated cells (13 × 9 μ) ; colonies, 19 × 16 μ.

Forma *acuminata* nov. forma (Fig. 4, *A–D*).

Differt a typo apicibus cellularum plus minus acuminatis, non incrassatis, chromatophoris duabus cum pyrenoide in quaque cellula, cellulis plerumque singulis. Dimens. cell., 14–19 × 8, 5–10 μ.

Sample 868 (rather common).

This form was characterised by the pointed apices of the cells, which were mostly isolated ; occasional groups of four or eight were found closely packed together (Fig. 4, *C*, *D*), although the enveloping membrane of the parent-cell was indistinguishable.

5. * *Oocystis solitaria*, Wittr. var. *apiculata* (W. West), Printz, p. 185, Tab. V, figs. 50–53. (Syn. : *O. apiculata*, W. West.)

Samples 726, 734, 735, 736, 740 (rare).

Long. cell., 24–25 ; lat., 12–14 μ.

The type is already known from South Africa and Madagascar.

Genus Tetraëdron, Kützing.

1. ? * *Tetraëdron caudatum* (Corda), Hansg. var. *incisum*, Lagerh. ; Brunnthaler, *op. cit.*, p. 151.

Sample 601 (only one specimen seen).

2. *Tetraëdron minimum* (A. Br.), Hansg. forma *apiculatum*, Reinsch ; Brunnthaler, *op. cit.*, p. 148.

Samples 614, 622, 635, 656, 735, 740, and 822 (in all cases rare).

In sample 822 the type was also encountered.

Family 4. SELENASTRACEAE.

Genus Ankistrodesmus, Corda.

(*Rhaphidium*, Kützing.)

1. * *Ankistrodesmus convolutus*, Corda var. *minutus* (Naeg.), Rabenh. ; Brunnthaler, *op. cit.*, p. 190.

Sample 686 (rather common).

The type has been recorded from Angola.

2. *Ankistrodesmus falcatus* (Corda), Ralfs var. *spirilliformis*, G. S.

West, Brit. Freshw. Algae, 1904, p. 224. (Syn.: *Rhaphidium polymorphum*, Fresen. var. *spirale*, W. & G. S. West.)

Samples 642 (rare) and 844 (rather common).

3. *Ankistrodesmus nitzschioides*, G. S. West, Journ. Linn. Soc., Bot., xxxviii, 1907, p. 140, Pl. V, fig. 18.

Var. * *spiralis*, Printz, Vidensk.-selsk. Skrift., Mat.-nat. Kl., i, 1913, No. 6, p. 97, Tab. VII, figs. 220–223.

Sample 743 (isolated).

The type was recorded from the plankton of Lake Tanganyika.

Genus Actinastrum, Lagerheim.

1. * *Actinastrum Hantzschii*, Lagerh., Öfvers. K. Vet.-Akad. Förhandl., 1882, No. 2, p. 70.

Samples 749 and 751 (rather rare).

Genus Selenastrum, Reinsch.

1. **Selenastrum minutum* (Naeg.), Collins; Brunnthaler, *op. cit.*, p. 182. (Syn.: *Rhaphidium minutum*, Naeg.)

Samples 844 and 868 (rather rare, cells usually isolated).

Family 5. DICTYOSPHAERIACEAE.

Genus Dictyosphaerium Naegeli.

1. *Dictyosphaerium pulchellum*, Wood, Smithsonian Contrib., xix, No. 241, 1872, p. 84, Pl. X, fig. 4.

Samples 749, 822, and 844 (in all cases rare), 869 (common).

Diam. cell., 7 μ.

Family 6. COELASTRACEAE.

Genus Crucigenia, Morren.

(*Staurogenia*, Kützing.)

1. *Crucigenia Tetrapedia* (Kirchn.), W. & G. S. West. (Syn.: *Tetrapedia emarginata*, Schröd.)

Var. * *apiculata* nov. var. (*Lemmermannia emarginata*, Chodat, Mem. Herb. Boiss., No. 17, 1900, pp. 5, 6.) (Fig. 4, *E–G*.)

Differt a typo utroque angulo coenobii quadricellularis apiculato et apiculo simile in medio coenobio. Diam. coenob. 4-cell., 8–10 μ.

Sample 844 (not uncommon).

This variety is characterised by the presence of a dot-like thickening at each of the four corners of the 4-celled coenobium ; a similar thickening occurs at the centre (Fig. 4, *E*). It has not proved possible to determine the nature of these thickenings, but they probably represent thickenings of the corners of the cells. In a number of the coenobia the outer margins of the cells were not distinctly concave, sometimes even being flat or convex (Fig. 4, *F*). The majority of the coenobia were 4-celled, but occasional 16-celled groupings were found (Fig. 4, *F*) ; in these the two outer cells of each group of four were invariably larger than the two inner ones.

The same form appears to have been observed by Playfair (Proc. Linn. Soc. New S. Wales, xxxvii, 1912, Pl. LVI, fig. 3), who refers this species to

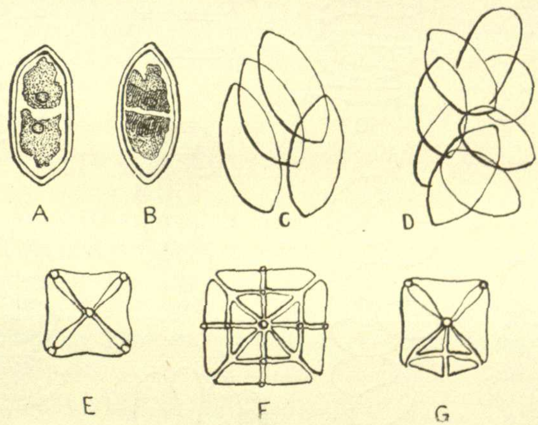


FIG. 4.—*A–D, Oocystis rupestris,* Kirchn. forma *acuminata* nov. forma. *E–G, Crucigenia Tetrapedia* (Kirchn.), W. & G. S. West var. *apiculata* nov. var. (× 1500.)

Pediastrum tetras. The only comment one can make is that such a reference is typical of the author's lack of a critical knowledge of the forms with which he deals.

2. * *Crucigenia triangularis,* Chodat, Algues vertes d. l. Suisse, 1902, p. 206, fig. 148.

Sample 844 (rare).

Dimens. coenob. 4-cell., 13, 5 × 12 ; diam. cell., 5 μ.

Genus SCENEDESMUS, Meyen.

1. * *Scenedesmus arcuatus,* Lemm. ; Smith, Trans. Wisconsin Acad., xviii, 1916, p. 449 ; Brunnthaler, *op. cit.*, p. 167. (Fig. nostr. 5, *E–I*.)

Samples 632, 633, and 833 (not uncommon), 853–862 (mostly very common).

Long. cell., 10–20 μ ; lat., 5–10 μ. The coenobia were in part very irregular, being either 4- or 8-celled and the cells often not showing the typical 2-ranked arrangement (Fig. 4, *F*, *G*, *I*). Many of them were partly dissociated, a feature upon which Chodat comments in his recent monograph (Rev. Hydrologie, iii, 1926, p. 168). Var. *disjunctus*, Borge is recorded by Hodgetts from Stellenbosch.

2. * *Scenedesmus armatus* (Chod.), G. M. Smith, *loc. cit.*, p. 460. (Syn. : *S. hystrix*, Lagerh. var. *armatus*, Chod.)

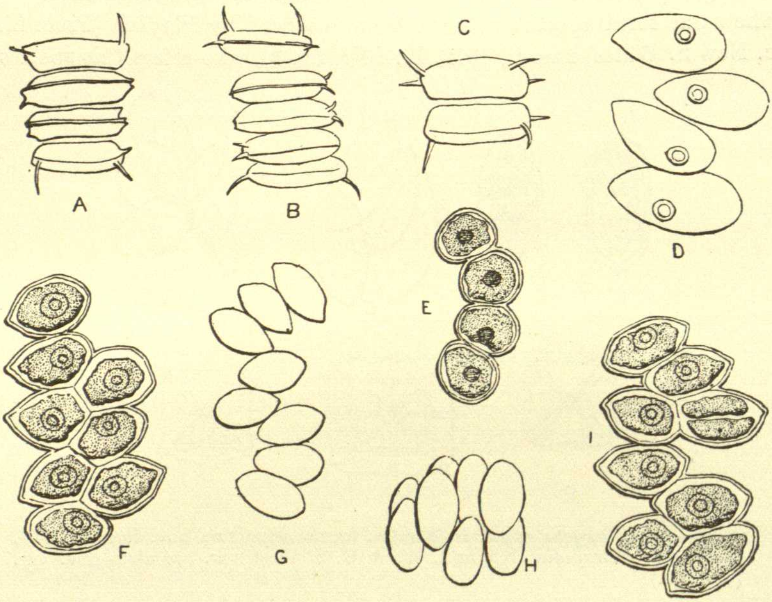


FIG. 5.—*A–C*, *Scenedesmus armatus* (Chod.), G. M. Smith var. *spinosus* nov. var. *D*, *S. bijugatus* (Turp.), Kütz. forma. *E–I*, *S. arcuatus*, Lemm. formae diversae ; *E*, end-view ; *F*, *G*, and *I* show irregular disposition of the cells. ($\times$ 1000.)

Samples 642, 643, 868, and 844 (rare in the last).

Long. cell., 9–11 μ ; lat., 3·5 μ.

The specimens in 642 showed in great part the typical cell-form (with acute apices) as depicted by Chodat (Algues vertes, p. 215, fig. 140), but the spines of most individuals were more or less sharply curved. A few 8-celled coenobia were seen. The same sample contained var. *bicaudatus* (Gugliellmetti), Chod. (*loc. cit.*, 1926, p. 204 ; *S. hystrix*, Lagerh. var. *bicaudatus* (Gugliellmetti), Printz) in which only one spine is present on each terminal cell, the two spines occupying opposite angles. Specimens were, however, also present with two spines (one often stronger than the other) on one terminal cell and only one spine on the other, which renders it probable that var. *bicaudatus* is to be regarded as a reduced form of the type. None of the forms with oblong cells figured by G. M. Smith (*loc. cit.*, Pl. XXIX, figs. 90–93) was observed. In sample 868 specimens occurred agreeing with var. *exaculeatus,* Chod. (*loc. cit.*, 1926, p. 203).

Var. * *spinosus* nov. var. (Fig. 5, *A–C*).

Differt a typo spinis parvis diverse evolutis in polis cellularum aliquarum vel omnium ; coenobiis 2–4- vel raro 8-cellularibus. Long. cell., 10–12 μ ; lat., ca. 4 μ.

Sample 868.

The coenobia of this variety possess the longitudinal ridges and curved external spines of the type, but one or both ends of the cells bear supernumerary small spines (Fig. 5, *A–C*). The latter were developed in very varied strength and number and were often difficult to decipher. It is not clear whether they always occur at both ends of the cells.

3. *Scenedesmus acuminatus* (Lagerh.), Chodat, Algues vertes, 1902, p. 211, fig. 88. (Syn. : *S. falcatus,* Chod. ; *Selenastrum acuminatum,* Lagerh.)

Samples 749 and 825 (rare).

Some of the coenobia had 8 cells exhibiting a biseriate arrangement, as figured by Printz (Kgl. Norske Vidensk. Selsk. Skrift., 1915, No. 4, Tab. V, fig. 230).

4. *Scenedesmus bijugatus* (Turp.), Kütz. ; Brunnthaler, *op. cit.*, p. 167 ; Smith, *loc. cit.*, p. 441.

Samples 635, 656, 710–712, 717, and 872 (rare in all but 717).

In most of the samples there occurred a form with curious large cells (21 μ long, 9 μ wide), most of them more or less ovoid in shape, one pole rounded and the other pointed (Fig. 5, *D*). The cells, moreover, were alternately arranged as in var. *alternans* (Reinsch), Borge, but did not possess the cell-shape of this variety. Such forms come rather close to *S. obliquus* (Turp.), Kütz.

5. * *Scenedesmus incrassatulus,* Bohlin, Bih. K. Sv. Vet.-Ak. Handl., xxiii, Afd. iii, No. 7, 1897, p. 24 ; Smith, *op. cit.*, p. 440.

Samples 869, 870 (rather rare).

Long. cell., 25–27 μ ; lat. cell., 8 μ.

6. *Scenedesmus obliquus* (Turp.), Kütz. ; Brunnthaler, *op. cit.*, p. 163.

Sample 743 (rare).

7. * *Scenedesmus protuberans* n. sp. (Fig. 6).

Coenobiis e cellulis rectis 4 vel raro 8 serie simplici non alternante dispositis ; cellulis externis paullo longioribus margine exteriore in media parte convexa polos versus concava, margine interiore recta, polis rotundatis plus minus protractis et leviter capitatis aculeo singulo solido elongato et curvato munitis; cellulis medianis apicibus acutis vel subtruncatis, interdum cum spinis minutis praeditis; pyrenoide magno rotundato, plerumque in media cellula.

Long. cell., 25–34 μ; lat. cell., 6–7 μ; long. acul., 25–35 μ; lat. coenob. 4-cell., 28–29 μ.

Samples 825 and 844 (common in last).

The coenobia of this very distinct and handsome species are distinguished by the greater length of the external cells, which have protruded apices; the latter bear long curved setae and are usually separated from the body of the cell by a slight constriction (Fig. 6, *A–D*). The setae

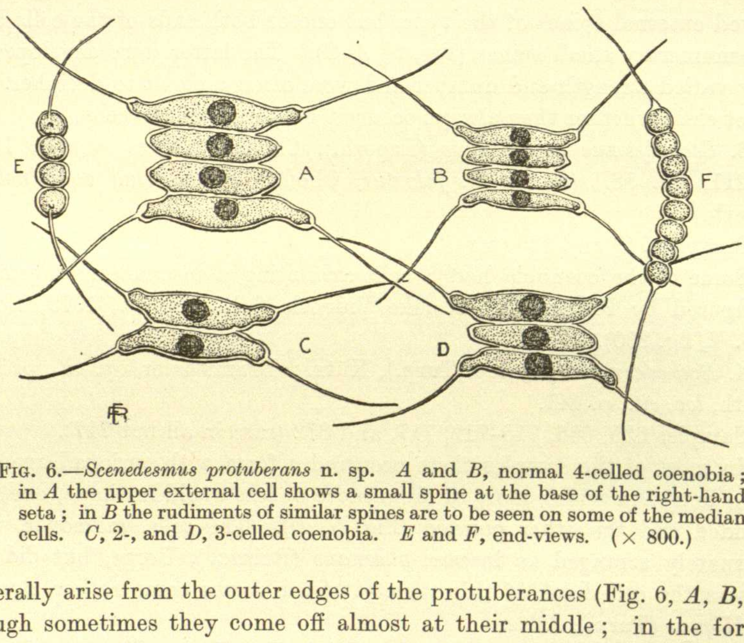


Fig. 6.—*Scenedesmus protuberans* n. sp. *A* and *B*, normal 4-celled coenobia; in *A* the upper external cell shows a small spine at the base of the right-hand seta; in *B* the rudiments of similar spines are to be seen on some of the median cells. *C*, 2-, and *D*, 3-celled coenobia. *E* and *F*, end-views. (× 800.)

generally arise from the outer edges of the protuberances (Fig. 6, *A*, *B*, *D*), though sometimes they come off almost at their middle; in the former case there is often a minute spine on the inner edge of the protuberance (Fig. 6, *A*, *E*). The median cells of the coenobia have acute or somewhat truncate apices, and the cell-wall at these points often shows slight granular thickenings which may be also developed as minute spines (Fig. 6, *A*, *B*); of these there is one when the apex is acute, but two or more when the apex is truncate.

S. protuberans may be compared with *S. opoliensis*, Richter, *S. tropicus*, Crow, and *S. aristatus*, Chod. It resembles the last (Chodat, *loc. cit.*, 1926, p. 210) to some extent in the shape of the external cells of the coenobium, but the constituent cells in *S. aristatus* are far more loosely connected and the median cells of quite a different character.

8. *Scenedesmus quadricauda* (Turp.), Bréb.; Brunnthaler, *op. cit.*, p. 165; Smith, *loc. cit.*, p. 473.

Samples 604, 632, 656, 726, 734–737, 743, 822, 853–861 (rare except in 726 and 853–861).

Long. cell., 10–18, 5 μ; lat. cell., 4–7 μ.

Genus COELASTRUM, Naegeli.

1. *Coelastrum microporum*, Naeg.; Brunnthaler, p. 195.

Samples 604, 656, 833 (rare in all).

2. * *Coelastrum proboscideum*, Bohlin; Brunnthaler, p. 196.

Samples 740 and 844 (rare).

3. * *Coelastrum reticulatum* (Dang.), Senn; Brunnthaler, p. 198.

Sample 822 (rare). Recorded from the plankton of Lake Nyassa (Schmidle).

Group. 3. ULOTRICHALES.

SERIES I. EU-ULOTRICHALES.

(1) ULOTRICHACEAE.

Genus ULOTHRIX, Kützing.

1. * *Ulothrix bipyrenoidosa* n. sp. (Fig. 7, *A–C*).

U. cellulis interdum plus minus quadratis, sed saepe elongatis, 2–3plo longioribus quam latis, filis inter cellulas nonnunquam leviter constrictis; membrana tenui, septis tenuissimis et saepe inconspicuis. Chromatophora plerumque totam cellulam replenti laminaeformi, angulis leviter rotundatis, plerumque pyrenoidibus duobus, uno in utroque fine et saepe diagonaliter positis, sed interdum alterutro duplicato ita ut pyrenoides duo in utroque fine sunt. Diam. cell., 7–9 μ; long. cell., 8–17 μ.

Sample 665 (common).

The characteristic feature of this species is the frequent presence of two pyrenoids, one at either end, and often diagonally placed, within the plate-shaped chloroplast (Fig. 7, *A*). Not uncommonly one or both of the pyrenoids is duplicated (Fig. 7, *B*, *C*), so that there is a pair of them at either end. This seems to mark a stage in division, the chloroplast subsequently splitting across the middle, and, as the two halves enlarge, the pyrenoids come to lie in opposite corners. In some of the cells this regular disposition of the pyrenoids is not to be noted.

2. *Ulothrix tenerrima*, Kütz.; Heering, Suesswasserfl., vi, 1914, p. 32, figs. 28–30.

Samples 642, 643, and 870 (very common in the first).

3. * *Ulothrix zonata*, Kütz.; Heering, *op. cit.*, p. 35, figs. 35, 36.

Sample 870 (common).

The forms present in this sample belonged to this "species-aggregate," the filaments being of very varied width (20–64 μ) and the longitudinal walls of the threads, especially of the wider ones, being strongly thickened and lamellose. Many of the threads showed stages in zoospore-production, whilst others contained mature aplanospores, one or several in each cell, 12–14 μ broad, and with a slightly thickened membrane.

Genus Uronema, Lagerheim.

1. *Uronema confervicolum*, Lagerheim, Malpighia, i, 1887, p. 517; forma (Fig. 7, *D–F*).

Samples 749 and 751 (common in the last).

The threads were rather variable as regards total length and width (diam. fil., 4–8, 8 μ) and as regards length of cell. Some that had the characteristic pointed apex comprised 50–100 cells, whilst others were quite short and much resembled the original figures of Lagerheim. The cells were either quadrate or one and a half to three times as long as broad (Fig. 7, *D–F*); empty cells that had liberated zoospores were not uncommon, but these were always of the elongate type. The basal cells were in all cases quite simple, and no traces of the adhesive disc figured by Lagerheim were seen.

In the same samples there occurred numerous elongate unbranched threads, not differing in any respect from the short ones with an acuminate apical cell, though lacking the latter. It can only be concluded that these had arisen from the ordinary *Uronema*-threads by fragmentation. These facts favour Gaidukov's view that *Uronema* is but a stage in the development of certain species of *Ulothrix*.

Genus Geminella, Turpin.

(*Hormospora*, de Bréb.)

1. * *Geminella ordinata* (W. & G. S. West), Heering, *op. cit.*, p. 41. (Syn.: *Hormospora ordinata*, W. & G. S. West.)

Sample 601 (rather rare).

Diam. cell., 6 μ; diam. vag., 19–21 μ. The cells were not so far apart as in the figure (p. 157) in British Freshwater Algae (1927). Many of the cells had recently divided, the daughter-cells being grouped in pairs; each member of a pair was more or less hemispherical, with the flattened faces contiguous. Undivided cells were rounded at both ends and about one and a half times as long as broad.

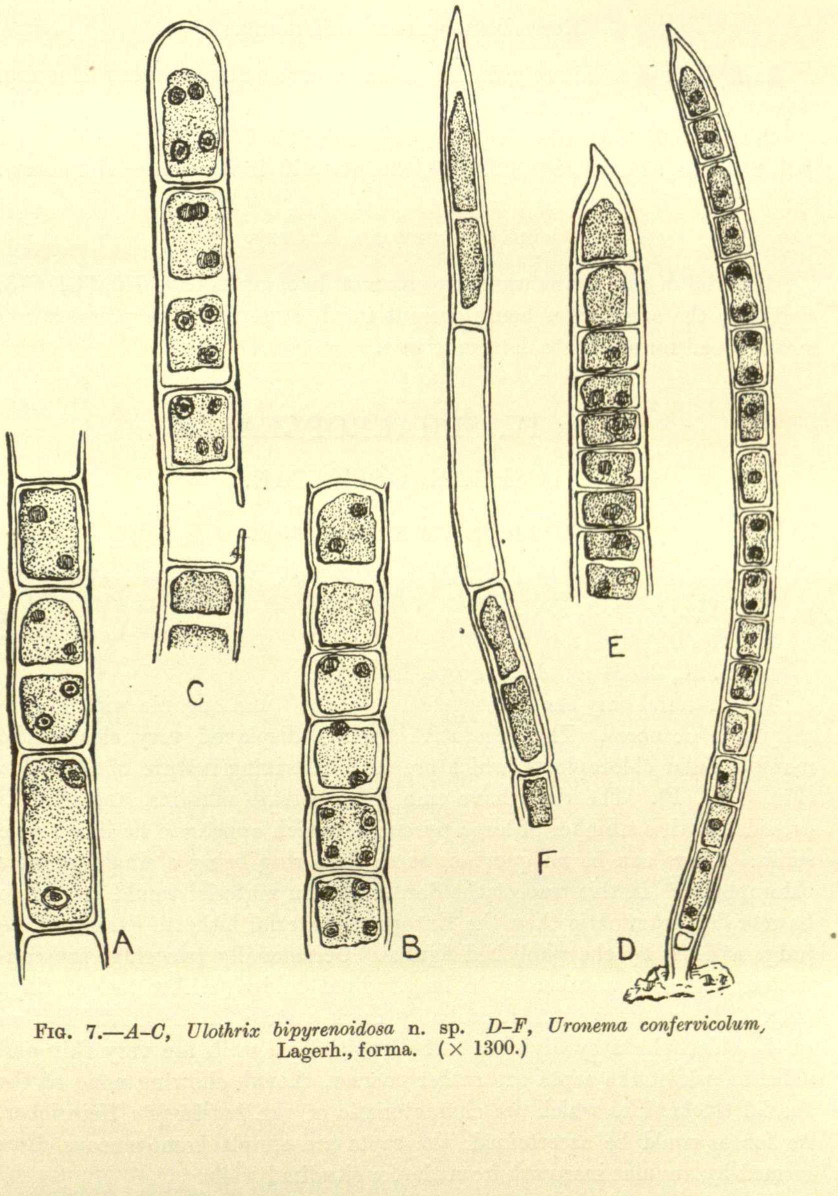


FIG. 7.—*A–C, Ulothrix bipyrenoidosa* n. sp. *D–F, Uronema confervicolum,* Lagerh., forma. (× 1300.)

Series III. CLADOPHORALES.

(1) CLADOPHORACEAE.

Genus Rhizoclonium, Kützing.

1. *Rhizoclonium hieroglyphicum*, Kütz. emend. Stockmayer; Heering, Suesswasserfl., vii, 1921, p. 20.

Samples 601, 603, 604, 616, 632, 634, 680, 693, 733, 735, 736, 740, 741, 807, 811, 813, 814, 827, 838, 839, 843, 856, and 859 (in most cases abundant).

Genus Cladophora, Kützing.

Material of this genus was very common in samples 629, 660, 664, 715, and 716, the same form being present in all cases, but the preservation was too bad for adequate determination.

Series IV. SPHAEROPLEALES.

(1) SPHAEROPLEACAE.

Genus Sphaeroplea, Agardh.

1. *Sphaeroplea annulina* (Roth), Ag.; Fritsch, Ann. of Bot., xliii, 1929, p. 22. (Fig. nostr. 8, *A–G*.)

Samples 644–646 (rare in 645).

Diam. fil., 24–34 μ; diam. oosp., 19–36 μ.

The material only showed vegetative "cells" and oogonia with practically ripe oospores. The vegetative threads displayed very clearly the many annular chloroplasts, which are such a striking feature of this Alga (Fig. 8, *A*, *B*). The rings have smooth or serrate margins, and each is provided with a number of large pyrenoids which appear to lie in a single series. There can be no question as to each ring being a single annular chloroplast; * in this respect the South African material would appear to be more diagrammatic than the European material hitherto examined, to judge at least by the published figures. Occasionally two rings are connected with one another by a longitudinal bridge, whilst forked rings (Fig. 8, *B*) are frequent and probably mark a stage in the multiplication of the chloroplasts by division. The longitudinal walls are very thin and delicate, whilst the septa are rather coarser, though showing none of the special thickenings which are characteristic of var. *crassisepta* Heinricher. As far as could be ascertained, the septa are simple homogeneous discs formed by annular ingrowth from the longitudinal walls.

* *Cf.* West and Fritsch, British Freshwater Algae, 1927, p. 173, and Fritsch, *loc. cit.*, p. 8.

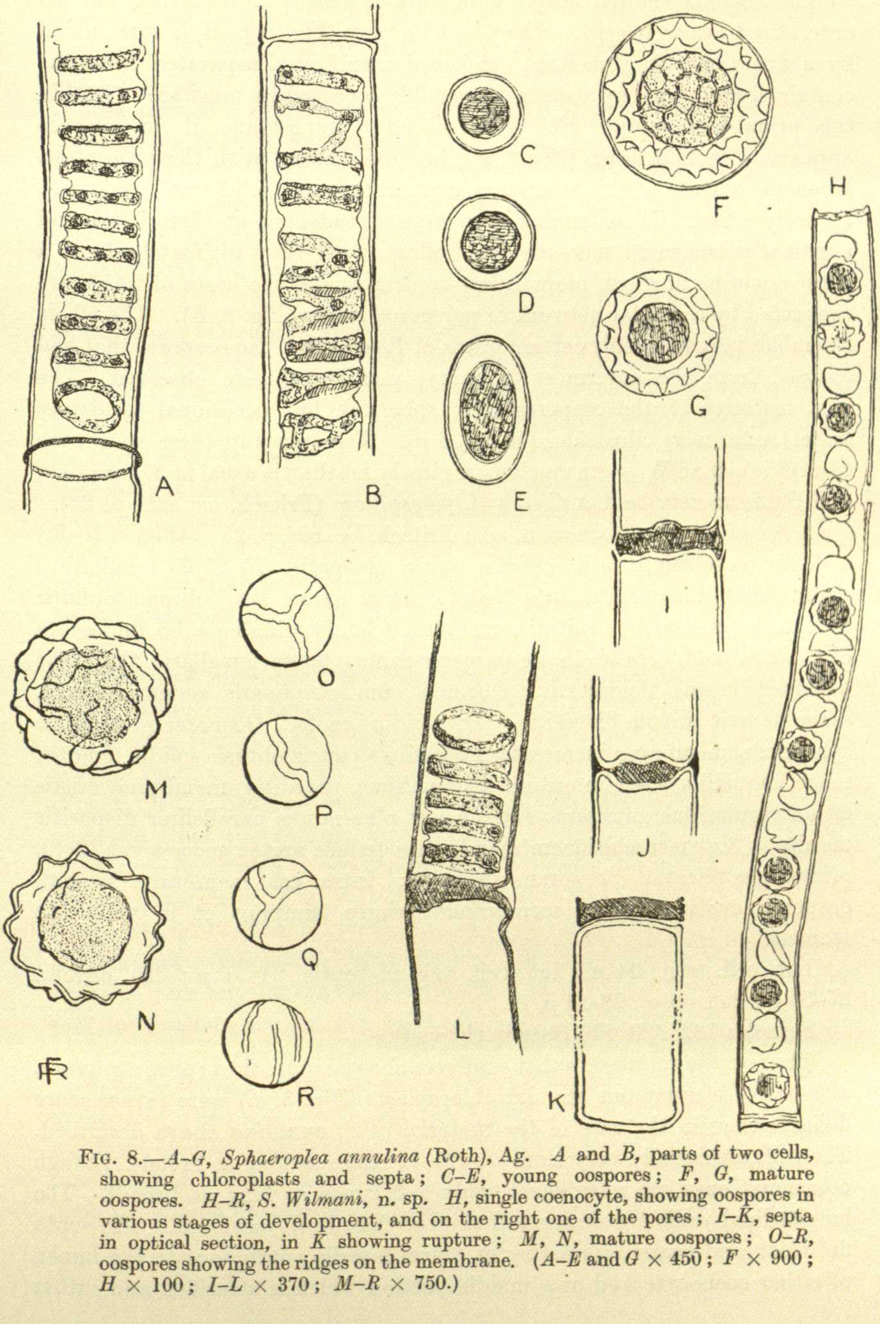


FIG. 8.—*A–G*, *Sphaeroplea annulina* (Roth), Ag. *A* and *B*, parts of two cells, showing chloroplasts and septa; *C–E*, young oospores; *F*, *G*, mature oospores. *H–R*, *S. Wilmani*, n. sp. *H*, single coenocyte, showing oospores in various stages of development, and on the right one of the pores; *I–K*, septa in optical section, in *K* showing rupture; *M*, *N*, mature oospores; *O–R*, oospores showing the ridges on the membrane. (*A–E* and *G* × 450; *F* × 900; *H* × 100; *I–L* × 370; *M–R* × 750.)

The oogonia showed oospores in various stages of maturity, but no unfertilised ova were seen. The young oospore (Fig. 8, *C–E*) is surrounded by a firm, smooth, somewhat thickened membrane, separated from the contained protoplast by a space presumably occupied by mucilage. Within this primary membrane the thick secondary membrane of the oospore appears to be laid down (Fig. 8, *F*), in close contact with the protoplast. Upon the surface of this secondary membrane small solid teeth appear at an early stage. These gradually enlarge, broadening at their bases and apparently becoming more or less hollow, until they ultimately form a dense covering of short, more or less conical spines, the bases of which are connected by a regular network of polygonal ridges (Fig. 8, *F*). The whole resembles very markedly certain forms of *Trochiscia*. No oospores that had escaped from the outermost (primary) membrane were observed. The vast majority of the oospores were spherical, but occasional (generally larger) ones were ellipsoidal (46 × 36 μ). The spines in these specimens from Griqualand West are much more closely set than is usual in *S. annulina*, and the form may be described as f. *polyspinosa* (Fritsch, *loc. cit.*, p. 23).

2. * *Sphaeroplea Wilmani* n. sp.; Fritsch, *loc. cit.*, p. 23. (Fig. 8, *H–R*.)

Filis vegetativis latis, cellulis valde elongatis, 25–27plo longioribus quam latis, raro brevissimis 2–3plo long. quam lat., chromatophoris numerosis annularibus usitatis, membrana longitudinali paullo incrassata et robusta, septis crassis in media parte minus densis lamellatis utrobique a lamella firma delimitatis. Oogonia cum oosphaeris numerosissimis, saepe in serie singula dispositis. Antheridia ignota. Oosporae plus minus sphaericae, membrana incrassata processibus paucis obtusis solidis remotis, saepe aequalibus, sed interdum inaequalibus, praeditis, membrana cristis latis irregularibus aut forma reticuli aut plus minus paralleliter dispositis munita. Post fecundationem membranae tenues arctae successivae (2–3), plerumque plicatae, oosporam induunt; intra eas membrana matura oosporae evolvit, postea membranae priores rumpunt et in vicinitate manent.

Lat. cell. veg., 34 μ; lat. cell. veg. in septis, 24–31 μ; lat. oogon., 27–35 μ; lat. oosp., 23–24 μ.

Samples 782, 820, 870 (rare in the last).

The few vegetative cells that were seen showed quite the typical structure, although the numerous annular chloroplasts (Fig. 8, *L*) were rather more delicate than in the case of the material of *S. annulina* above described. The cells are usually very elongate (25–27 times as long as broad), though occasional ones are very short (only 2–3 times as long as broad). The longitudinal walls are firmer and thicker than in *S. annulina*. The septa are thick and coarse, consisting of a firm lamella contiguous to the lumen of either coenocyte and of a middle portion which is stratified and rather less dense (Fig. 8, *I*, *J*). The material has not permitted of an exact conclusion as to their mode of development. The bounding lamellae, which appear to be continuous with the inner layers of the longitudinal walls, are probably deposited subsequently on either side of the first-formed middle portion. Fragmentation of the threads apparently easily occurs at the septa (Fig. 8, *K*), and this seems to be due to rupture of the outer layer of the longitudinal wall at the level of the septum (Fig. 8, *I*). Unfortunately it has been impossible to observe any of the septa from the surface, so that their detailed structure is uncertain, but they seem to be homogeneous and there are no clear indications of an origin from ingrowing processes, as in *S. africana* (see Fritsch, Ann. S. Afr. Mus., ix, 1918, p. 527). In rare cases the septa or the longitudinal walls show knob-like projections, such as are figured by Heinricher for *S. annulina* var. *crassisepta*.

The oospores, which are nearly always spherical, very commonly lie in a single series completely filling the oogonium (Fig. 8, *H*); more rarely do they occur in a double series. The definitive external membrane of the mature oospore is provided with a smaller number of processes than in *S. annulina*; moreover, the processes are blunt and *solid* with rounded tips and are rather remote from one another (Fig. 8, *N*). The ridges on the membrane are quite irregular, are by no means always connected with the processes, and commonly seem to be quite independent of them (Fig. 8, *O–R*). They are much more strongly developed than in *S. annulina* and often have the character of wings. The mature membrane arises within a whole series (2–3) of delicate primary membranes which are usually conspicuously folded (sometimes with a crenulated edge ?); some of them, already shed, lie empty at the sides of the maturing oospores (Fig. 8, *H*), whilst one or more still closely invest the latter and, when observed from the surface, give the impression of an irregularly folded membrane protruded in places by the developing processes on the mature oospore-membrane (Fig. 8, *M*). The processes on the latter, although frequently quite even, are sometimes distinctly unequal, giving the oospore a somewhat asymmetrical appearance. Altogether, with the complicated series of thin enveloping membranes, the structure of the oospore is not easy to decipher.

This species differs from *S. annulina* in the usual occurrence of the oospores in a single series, in the oospores being provided with a smaller number of processes which are blunt and solid and not connected by regularly arranged ridges, in the development around the oospores of a succession of primary membranes which are successively shed, and in the more prominent development of the irregular ridges between the processes.

Group 4. CHAETOPHORALES.

(1) CHAETOPHORACEAE.

Genus STIGEOCLONIUM, Kützing.*

1. * *Stigeoclonium aestivale* (Hazen), Fritsch (*Myxonema aestivale*, Hazen, Mem. Torrey Bot. Club, xi, 1902, p. 205, Pl. XXXIII, figs. 1–3).

Samples 670 and 672 (very common in the former).

The specimens agreed well with Hazen's diagnosis, although at some points the branching was rather more profuse than his figures show. The branches are all alternate, although in the lower parts of the plants, where the long laterals are developed as strongly as the main axis, the branching appears to be dichotomous. This is possibly a little-branched form of *S. fasciculare*, Kütz.

Forma ramulis acutis, non setiferis.

Sample 831 (very common).

This little-branched form, with practically no opposite branches, seems best referable to this species, from which it only differs in the absence of hairs.

2. * *Stigeoclonium amoenum*, Kütz.; Hazen, *loc. cit.*, p. 199, Pl. XXIX; Heering, Suesswasserfl., vi, 1914, p. 83, figs. 115, 120.

Forma ramulis saepe alternantibus, interdum in setis prolongatis. Diam. ram. princip., 10–16 μ.

Samples 642, 643 (very common).

In many respects this material was quite typical, agreeing with the diagnoses given by Heering and Hazen. The main axes are composed of large, slightly barrel-shaped cells (diam., 10–16 μ), with thick walls and a very scanty chloroplast occupying only the middle of the cells; the latter are 2–8 times as long as broad. The branches of these main axes arise from smaller (and often narrower) angular cells and are commonly in pairs, though sometimes single; several pairs of branches often arise in close succession from adjacent cells, these regions of branching being separated by long stretches entirely devoid of branches. The branches originate approximately from the middle of the parent-cell. The finer branches are composed of cells completely filled by their chloroplasts, and, in this material, were usually single; moreover, many of them terminated in blunt hairs, although others ended with a pointed apex, such as is usually recorded for this species. It should be noted that Hazen figures a considerable number of alternate branchlets.

* In the present state of our knowledge of the "species" of this genus it is only possible to compare the many forms present in the samples with those described "species" which they most closely resemble.

3. * *Stigeoclonium fasciculare*, Kütz. ; Heering, *op. cit.*, p. 76, figs. 105, 108.

Samples 808, 815–819 (abundant except in the last).

These specimens on the whole agreed very well with the diagnosis given by Heering. The hairs, however, were not very elongate, and many of the smaller branches merely terminated in a blunt point. The branching is practically always alternate, the principal branches arising from their main axes in such a way as to give the impression of a dichotomy, while the ultimate branching is dense and tufted, with the branchlets arranged more or less parallel to their parent axes. Diam. main axes, 7–10 μ.

4. * *Stigeoclonium glomeratum* (Hazen), Fritsch (*Myxonema glomeratum*, Hazen, *loc. cit.*, p. 205, Pl. XXXIV), *forma* ?.

Samples 734 and 743 (very common).

Among the several species of the genus in which alternate branching predominates, that of Hazen seemed most closely to resemble the material in this sample. The most prominent respect in which the latter diverged was in the usual absence of hairs, the branches mostly tapering rather suddenly to a sharp point. Hazen's figure shows the cells, from which the branches arise, of the same length as the others ; although this was frequently the case in sample 734, some of the branch-bearing cells were distinctly abbreviated. One cannot get away from a suspicion that Hazen's species and the present form may be but varieties of *S. amoenum*, Kütz., in which opposite branching has been suppressed. Occasional opposite branches were indeed found in sample 743. Diam. main axis, 7–11 μ.

5. *Stigeoclonium tenue*, Kütz. ; Heering, *op. cit.*, p. 78.

Sample 666 (very common).

Cells of main axis, 9–10 μ broad. The branching was prevalently alternate, although occasionally opposite ; no hairs were developed. This is possibly the same as *S. aestivale*, forma in sample 831.

(*N.B.*—Indeterminable material of this genus was also present in samples 661, 676, 745, 749, and 751 (in the last possibly *S. falklandicum*, Kütz.).)

Genus Chaetophora, Schrank.

1. * *Chaetophora tuberculosa* (Roth), Agardh ; Heering, *op. cit.*, p. 95, figs. 141, 142.

Samples 647–649 (very common, attached to twigs).

The plants were rather young, and the determination is thus not quite certain.

Genus Aphanochaete, A. Braun.

1. * *Aphanochaete polychaete* (Hansg.), Fritsch, Ann. of Bot., xvi, 1902, p. 410. (*Herposteiron polychaete*, Hansg.)

Sample 614 (common, on *Oedogonium*).

2. *Aphanochaete repens*, A. Braun, Verjüng. in der Natur, 1851, p. 196. (*Herposteiron confervicola*, Naeg.)

Sample 740 (rare, on *Oedogonium*).

(3) COLEOCHAETACEAE.

Genus Coleochaete, de Brébisson.

1. *Coleochaete scutata*, Bréb.; Heering, *op. cit.*, p. 135.

Sample 634 (very rare, with oospores).

(4) CHAETOPELTIDACEAE.

Genus Chaetosphaeridium, Klebahn.

1. *Chaetosphaeridium globosum* (Nordst.), Klebahn; Heering, *op. cit.*, p. 144, fig. 198. (*Aphanochaete globosa*, Nordst.)

Sample 822 (not uncommon).

Group 5. OEDOGONIALES.

(1) OEDOGONIACEAE.

Genus Oedogonium, Link.

1. * *Oedogonium Braunii*, Kütz.; Hirn, Monogr. u. Iconogr. d. Oedogoniaceen, 1900, p. 194, Tab. XXXII, fig. 197.

Sample 601 (rather rare).

2. * *Oedogonium calcareum*, Cleve; Hirn, *op. cit.*, p. 78, Tab. I, fig. 9.

Sample 740 (rather common).

Lat. fil., 12–15 μ; lat. oogon., 31–37 μ; long. oogon., 29–31 μ.

The dimensions are slightly greater than those given by Hirn, but the specimens agreed in all other respects with his figures and description. The oogonia were usually single, rarely in pairs.

3. *Oedogonium inversum*, Wittr.; Hirn, *op. cit.*, p. 179, Tab. XXVIII, fig. 171.

Sample 740 (rare).

Lat. fil. plant. fem., 8–11 μ; lat. oogon., 31–34 μ.

This rare species, which is as yet only recorded from Europe, Africa, and Australia, is characterised by the basal operculum by means of which the oogonia open. The cells are slightly capitellate, and the basal cell is more or less hemispherical, not elongate. The threads were partly encrusted with carbonate of lime. Recorded from Great Namaqualand by G. S. West.

4. *Oedogonium Pisanum*, Wittr.; Hirn, *op. cit.*, p. 181, Tab. XXIX, fig. 175.

Samples 601 and 682 (common), 751 (?, rather rare, only one oogonium seen).

5. * *Oedogonium plagiostomum*, Wittr.; Hirn, *op. cit.*, p. 100.

Var. *gracilius* Wittr.; Hirn, *op. cit.*, p. 101, Tab. VI, fig. 40.

Samples 642, 643 (rather common).

Lat. fil., 19–20 μ; lat. oogon., 35–37 μ.

Since no ripe oospores were present, the determination is not quite certain. The cells were in great part exceptionally short, often only a little longer than broad, commonly one and a half times as long. The chloroplasts in these short cells usually had only a single pyrenoid. The oogonia were more or less obovate-globose, and always single, although adjacent oogonia were often separated by only one or two sterile cells. In the male threads the antheridia were 3-celled, and alternated with solitary vegetative cells.

6. * *Oedogonium rufescens*, Wittr.; Hirn, *op. cit.*, p. 76, Tab. I, fig. 4.

Sample 601 (rather rare).

7. * *Oedogonium suecicum*, Wittr.; Hirn, *op. cit.*, p. 82, Tab. II, fig. 15.

Sample 601 (rather rare, no male filaments).

8. * *Oedogonium varians*, Wittr. and Lund.; Hirn, p. 89, Tab. IV, fig. 23.

Sample 870 (rather rare).

Lat. fil., 12–15 μ; lat. oogon., 39–42 μ; lat. oospor., 32–37 μ.

(Note.—Sterile or indeterminate material of *Oedogonium* also occurred in the following samples: 603, 604, 613–615, 619, 635, 643, 649, 650, 666, 726–736, 740 (a broad form, lat. fil., 17–22 μ, with terminal oogonia, 54 μ wide, possibly a form of *O. acrosporum*, De Bary, but material infested with Chytridineae and not suitable for determination), 748, 749, 811, and 813 (a form with narrow filaments, 6–7 μ wide, cells 3–5 times as long, mostly young plants attached to *Rhizoclonium* by an elongate basal cell; oogonia ellipsoidal, singly, 16–17 μ wide, 23–28 μ long., with unripe oospores; possibly a very narrow form of *O. Pisanum*, Wittr.), 808, 813–816, 818, 831, 869, and 870.)

Group 6. CONJUGATAE.

(2) ZYGNEMACEAE.

Genus Debarya, Wittrock.

1. *Debarya africana*, G. S. West, Journ. Linn. Soc. Bot., xxxviii, 1907, p. 104,[1] Pl. V, figs. 3, 4.

Var. * *polymorpha* n. var. (Fig. 9).

Differt a typo zygosporis formae diversissimae, aut fere sphaericis aut transverse ellipticis aut (saepius) subrectangularibus marginibus omnibus vel aliquibus concavis, membrana gametangii non incrassata. Lat. fil., 17–19 μ; lat. zygosp. sphaeric., 48–54 μ; dimens. zygosp. rectang., 56 $\times$ 46, 58 $\times$ 37 μ; crass. membr. zygosp., 3, 5–8 μ.

Samples 753, 755–759, 782, and 820 (mostly very common).

As in the type, the zygospores occupy a very wide conjugation-canal

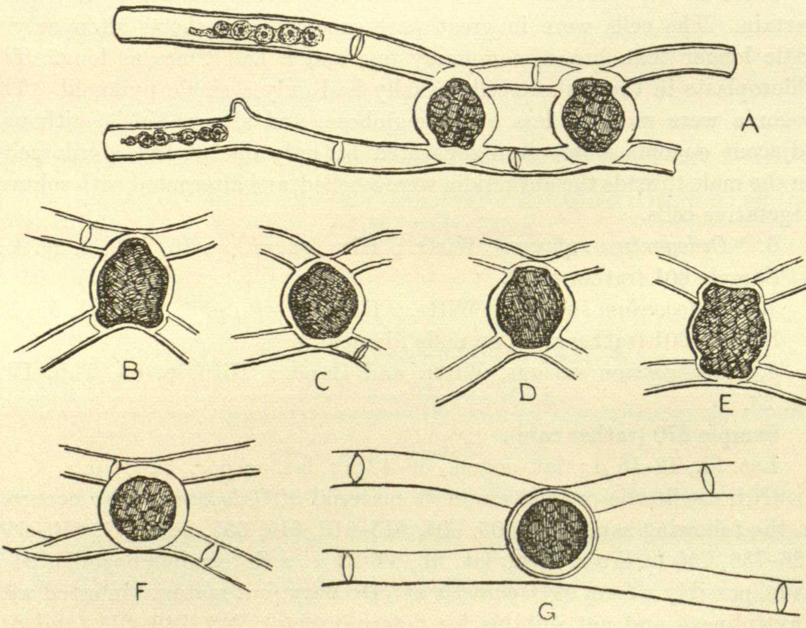


FIG. 9.—*Debarya africana*, G. S. West var. *polymorpha* nov. var. *A*, two threads in conjugation; *B–G*, various forms of zygospores. ($\times$ 260.)

and encroach appreciably upon the cavities of the conjugating cells (Fig. 9, *A* and *B*). A certain number are spherical (Fig. 9, *F*, *G*), and these often do not extend appreciably into the conjugating cells; others, however, are transversely elliptical (Fig. 9, *D*) or even subrectangular in optical section, the latter at times having the margins adjacent to the conjugating cells concave, whilst those adjacent to the canal are convex (Fig. 9, *E*). The subrectangular zygospores not infrequently have their thick membranes produced at the four corners to a more or less marked extent. The contents of the mature zygospores are yellowish-brown. Their membranes are exceedingly thick, looking white and opaque, with only a faint indication of stratification. Unlike the form described by West, there was no sensible thickening of the walls or septa of the conjugating cells, and no pits were observed in the septa.

Genus ZYGNEMA, Agardh.

1. * *Zygnema fertile* n. sp. (Fig. 10).

Filis vegetativis 20–22 μ latis, inter cellulas levissime constrictis, cellulis $2\frac{1}{2}$–5plo longioribus quam latis, membrana tenui, chromatophoris duabus stellatis formae vulgaris; conjugatione non observata, sed azygosporis saepe in cellulis omnibus filorum effusis; azygosporis in media cellula, qua hic unilateraliter vel utrinque inflata est, formatis, partibus ceteris cellularum muco gelatinoso lamellato replentibus; azygosporis maturis $1\frac{1}{3}$plo longioribus quam latis, ellipsoideis, interdum subdoliformibus polis pro-

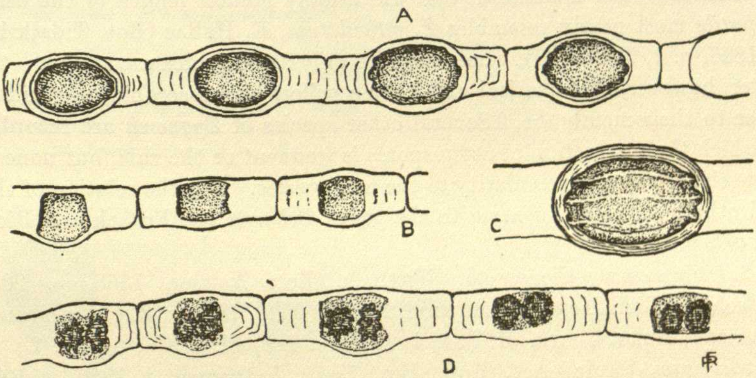


FIG. 10.—*Zygnema fertile* n. sp., from Barkly West. *A*, thread with mature azygospores; *B* and *D*, early stages in spore-formation; *C*, single spore, much enlarged. ($C \times 450$; the remainder $\times 260$.)

ductis, membrana hyalina lamellata, costis longitudinalibus pluribus praedita. Dimens. azygosp., 31×41, 31×43, 31×46, 32×49 μ.

Samples 782 and 829 (rather rare).

This species has already been described elsewhere (New Phytol., xxvi, 1927, p. 205), and Fig. 10 is reproduced from this source. The vegetative threads are recognisable because of a very slight (often scarcely perceptible) constriction between the cells; this feature becomes more pronounced as the spores develop and no doubt ultimately leads to the falling apart of the cells. No conjugation was observed, but in many threads an azygospore was forming or had formed in practically every cell. In the formation of these spores the contents contract to the centre of the cell which here becomes inflated, either on one or on both sides (Fig. 10, *A*, *D*), while the two ends gradually fill with white opaque mucilage, which often shows distinct strata parallel to the septa (Fig. 10, *A*, *D*). In the contracted protoplast an accumulation of fat is observable. The mature azygospores are encased in a firm, several-layered membrane and are provided with a number of longitudinal ridges which appear as knobs at the two ends (Fig. 10, *A*, *C*). They are usually appreciably longer than broad, and sometimes have slightly protruded ends. They completely fill the inflated portion of the cell (diam., 31–37 μ). Misshapen spores are not uncommon, but when symmetrically developed they are not unlike an individual of *Scotiella*. Threads with upwards of a hundred cells, all showing azygospores in a more or less advanced state of development, may be found.

The vegetative threads, although very similar to those of *Z. peliosporum*, Wittr. present in the same samples, were easily distinguished from them by their narrower dimensions and the usually greater length of the cells. *Z. fertile* most nearly resembles *Z. reticulatum*, E. Hallas (Bot. Tidsskrift, x, 1896, p. 1, Tab. I, II), where likewise only azygospores are known; the latter, however, are spherical and have a yellow-brown scrobiculate middle layer to their membrane. Several other species of *Zygnema* are recorded in which the production of azygospores is frequent or the rule, but none of them shows any close similarity to the new species. For the relation of this and other species of *Zygnema* to the genus *Debarya*, see Fritsch and Rich, *loc. cit.*, p. 207.

2. * *Zygnema peliosporum*, Wittrock, Bot. Notiser, 1868, p. 203; Fritsch and Rich, New Phytol., xxvi, 1927, p. 202. (Syn.: *Z. Collinsianum*, Transeau, Amer. Journ. of Bot., i, 1914, p. 289, Pl. XXV, figs. 1, 2; *Z. synadelphum*, Skuja, Act. Hort. Bot. Univ. Latviensis, i, 1926, p. 109.) (Fig. nostr. 11.)

Samples 683, 684, 782, 820, 836, 837, 840–843 (very common in all).

Diam. fil., 24–32 μ; diam. zygosp. sphaeric., 36–46 μ; dimens. zygosp. ellipsoid., 43 × 32, 44 × 32, 48 × 34, 48 × 36, 49 × 29, 49 × 27, 49 × 43, 51 × 37 μ.

The salient facts about this interesting material have already been communicated in the New Phytologist (*loc. cit.*). While in the samples gathered in 1921 (683, 684) the zygospores were invariably formed in one of the conjugating cells (Fig. 11, *F*), in the remainder, collected in 1922, they were in most cases situated in the canal (Fig. 11, *A*, *C*), although in sample 843 a few threads showing the other method of conjugation were found. There can be no question as to the identity of the material collected in the two years, since in both sets of samples the zygospores were prevalently spherical, although sometimes broadly ellipsoidal (Fig. 11, *E*), and had a thick stratified membrane, the middle layer of which was of a dark greenish-blue colour and provided with rather shallow and broad, fairly closely set scrobiculations (Fig. 11, *B*, *E*), while the outer layer was always colourless. The young zygospores often have a brownish colour. Conjugation between several filaments was not uncommon, but the two methods of conjugation were never observed in the same filament.

In view of these facts there can be no doubt that *Z. Collinsianum*, Transeau and *Z. synadelphum*, Skuja are mere forms of *Z. peliosporum*, Wittr., differing only in slight respects from Wittrock's species. See also Fritsch and Rich, *loc. cit.*, pp. 204, 208.

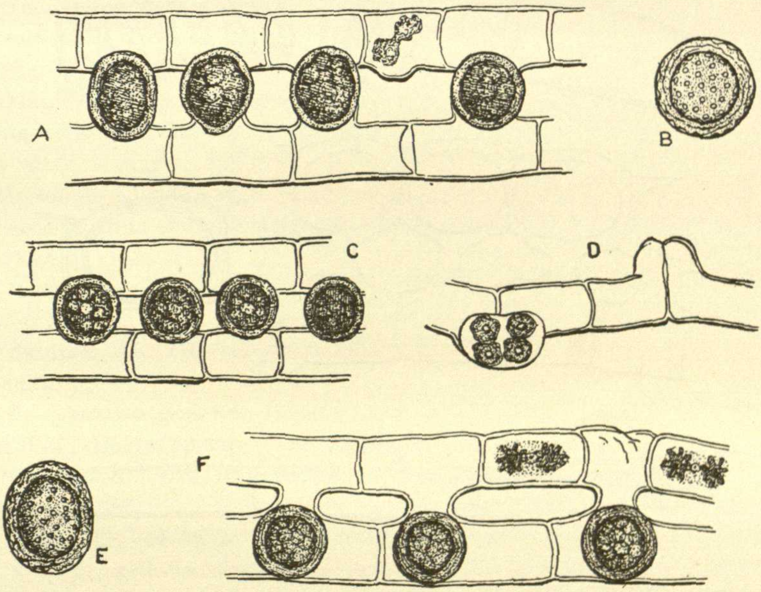


FIG. 11.—*Zygnema peliosporum*, Wittr. *A–D*, material collected in 1922 showing isogamous conjugation ; *B*, single zygospore ; *D*, lateral conjugation. *E*, *F*, material collected in 1921 showing anisogamous conjugation ; *E*, single zygospore. (*B* and *E* × 340 ; the remainder × 260.)

(NOTE.—Sterile material of *Zygnema* was also observed in the following samples : 601, 603, 604, 683 (very common), 685, 717, 737, 827, and 845.)

Genus SPIROGYRA, Link.

1. * *Spirogyra adnata* (Vauch.), Kütz. ; Borge, Suesswasserfl., ix, 1913, p. 27.

Forma filis 42–54 μ latis, cellulis vulgo duplo, interdum ad quadruplo longioribus quam latis, membrana non manifeste incrassata, chromatophoris 2, rarissime 3, anfractibus 1–3 (saepe 1½), pyrenoidibus conspicuis ; conjugatione scalariformi, cellulis copulantibus brevibus, fructiferis distincte sed non valde inflatis ; zygosporis late ellipticis polis rotundatis,

$1\frac{1}{2}$ plo longioribus quam latis, membrana hyalina laevi. Dimens. zygosp., 62×51, 64×46, 73×44, 75×50, 83×52, $91 \times 62\ \mu$ (Fig. 12, *A–C*).

Sample 611 (very common).

This material accorded more closely with the little known *S. adnata*

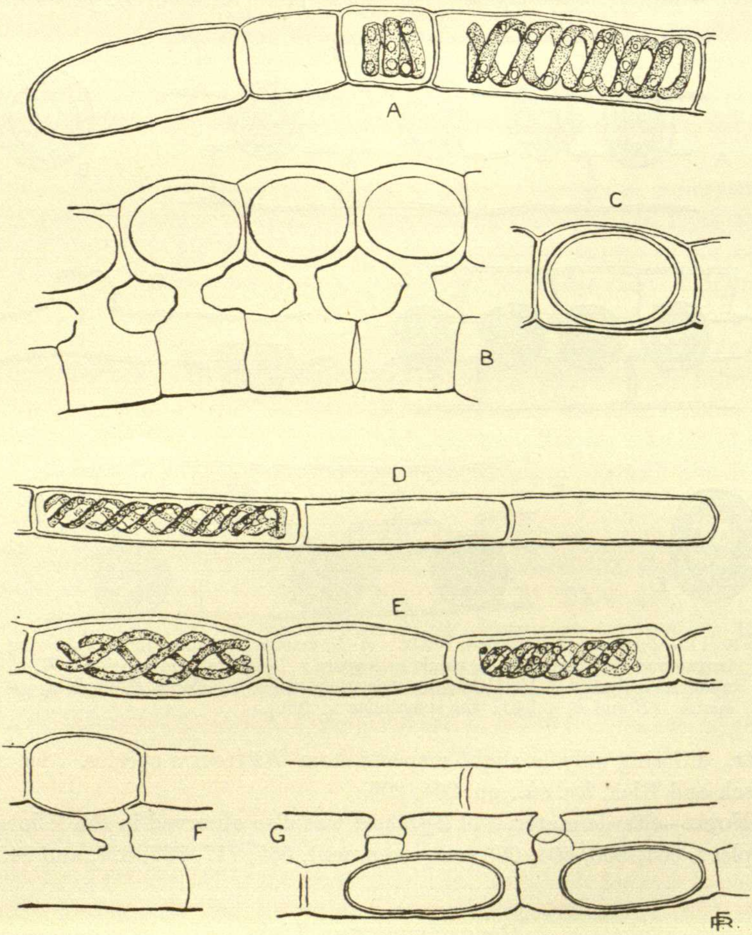


FIG. 12.—*A–C*, *Spirogyra adnata* (Vauch.), Kütz., forma. *D–G*, *S. fluviatilis*, Hilse, forma ; *E* and *G* are parts of the same filament. (All × 230.)

than with any other published species. The diagnoses given by Rabenhorst (Fl. Europ. Alg., iii, 1868, p. 242), Hansgirg (Prodr. d. Algenfl. v. Böhmen, i, 1886, p. 162), and Borge (*loc. cit.*) are all essentially the same, except that the last omits reference to the thick stratified cell-membranes mentioned by the two others. The only figure of this species with which we are familiar is that of Vaucher (Hist. d. Conferves d'eau douce, 1803, Pl. V, fig. 4), and this shows no thickened walls, nor does it altogether agree with the subsequent descriptions in other respects. Thus, the chloroplasts make only one turn in the cells, and the fructifying cells are not inflated (perhaps very slightly in the lower part of fig. *b'*).

In our material most of the cells were about twice as long as broad (occasionally up to 4 times as long), the cell-walls were not appreciably thickened, and the number of chloroplasts was mostly 2 (very rarely 3), making 1–3 turns (often only 1½) in each cell (Fig. 12, *A*). The fructifying cells (Fig. 12, *B*) were generally short and prominently, though not very strongly, inflated. The zygospores were broadly elliptical with rounded ends and a smooth hyaline membrane (Fig. 12, *C*). The differences from the published descriptions of *S. adnata* are thus not very marked.

2. *Spirogyra cataeniformis* (Hass.), Kütz.; Petit, Spirog. d. env. d. Paris, 1880, p. 17, Pl. III, figs. 9–12; Borge, *op. cit.*, p. 21.

Samples 701, 710–712 (few zygospores), 835–837, 840–843 (only fertile in 843).

3. *Spirogyra decimina* (Muell.), Kütz.; Petit, *op. cit.*, p. 25, Pl. VIII, figs. 1–3; Borge, *op. cit.*, p. 27, fig. 32.

Samples 677–679, 683, 687–691, 700 (in all very common, fertile only in 678 and 688).

Diam. fil., 44–52 μ; dimens. zygosp., 75×54, 75×55, 77×52, 95×60 μ; cellulis fructiferis rarissime leviter inflatis.

4. *Spirogyra fluviatilis,* Hilse; Borge, *op. cit.*, p. 27, fig. 33.

Forma filis 27–32 μ latis, chromatophoris 2–3 solum, zygosporis ovalibus, saepe elongatis, polis late rotundatis (dimens. 63×50, 65×40, 75×41, 79×42, 79×50, 107×43 μ), cellulis fructiferis et aliis filorum femineorum evidenter inflatis, plus minus doliformibus (Fig. 12, *D–G*).

Samples 782 and 820 (rare, few fertile threads).

This form differs from the type in narrower dimensions, in the presence of only two or three chloroplasts (making 1½–2½ turns) in the cells, and in the frequent elongate form of the zygospores (Fig. 12, *G*). The cells were thick-walled and 3–6 times as long as broad (Fig. 12, *D*). The cells of the female filaments were all prominently, though not very strongly, inflated, often being more or less barrel-shaped (Fig. 12, *E–G*). The zygospores were oval with bluntly rounded ends and smooth colourless membranes (Fig. 12, *G*); the contents of some were brownish. The cells harbouring the shorter zygospores (Fig. 12, F) were distinctly shorter than the vegetative cells. This form may possibly represent a separate variety or species, but the small amount of material did not admit of an adequate conclusion on this point.

5. *Spirogyra inflata* (Vauch.), Rabenh.; Petit, *op. cit.*, p. 7, Pl. I, figs. 4–6; Borge, *op. cit.*, p. 17, fig. 3.

Samples 656 (rare), 713 and 714 (fertile only in 713).

6. *Spirogyra longata* (Vauch.), Kütz.; Petit, *op. cit.*, p. 20, Pl. V, figs. 4, 5; Borge, *op. cit.*, p. 25, fig. 26.

Samples 694, 695, and 699 (not uncommon; diam. fil., 26–29 μ; zygosp., 56 × 37, 56 × 38 μ).

Sample 737 (common, diam. fil., 26–34 μ; zygosp., 30 × 62, 31 × 65, 35 × 54, 35 × 58, 36 × 49, 37 × 48 μ).

7. * *Spirogyra lutetiana*, Petit, *op. cit.*, p. 21, Pl. IV, figs. 9–13; Borge, *op. cit.*, p. 25, fig. 30.

Sample 820 (common), 836 (rare).

Diam. fil., 25–34 μ; dimens. zygosp., 43 × 37, 49 × 39, 63 × 37, 68 × 31, 80 × 32, 85 × 33 μ.

The majority of the fructifying cells were not swollen or only very slightly, but occasional ones were markedly inflated. The zygospores had thick yellow-brown membranes and varied very considerably in shape, though no absolutely spherical ones were encountered; they always completely occupied the width of the cell. A peculiarity noted in some of the female threads was the occasional appreciable inflation of the non-fructifying cells.

8. *Spirogyra nitida* (Dillw.), Link.; Petit, *op. cit.*, p. 28, Pl. X, figs. 6–10; Borge, *op. cit.*, p. 29, fig. 37.

Samples 693–695, 697–699 (very common in 695; sterile in 694, 697, and 698).

Rather a large form (diam. fil., 104–127 μ); zygospore-membranes barely yellow; dimens. zygosp., 124 × 89, 135 × 93, 139 × 83, 149 × 97, 162 × 96, 162 × 104, 170 × 109, 175 × 113, 178 × 110 μ.

9. *Spirogyra protecta*, Wood; Borge, *op. cit.*, p. 19, fig. 9. (*S. calospora*, Petit, *op. cit.*, p. 11, Pl. II, figs. 11–13.)

Var. * *inflata* nov. var. (Fig. 14, *A*, *B*).

Var. cellulis fructiferis saepe distincte in media parte inflatis, zygosporis minoribus polis semper acutis, conjugatione vulgo laterali. Diam. fil., 17–24 μ; dimens. zygosp., 25 × 55, 29 × 62, 29 × 63, 30 × 67, 31 × 62, 32 × 62, 35 × 69 μ.

Samples 601 and 604 (rather rare).

This variety is distinguished by smaller dimensions of vegetative threads and zygospores, by the often prominent inflation of the middle part of the fructifying cells (Fig. 14, *A*, *B*), by the pointed ends of the zygospores, and the frequent occurrence of lateral conjugation (Fig. 14, *A*, *B*). The middle layer of the zygospore-membrane is provided with numerous small, closely set scrobiculations which are rounded or slightly angular. The cells, which are up to thirteen times as long as broad, have a single chloroplast making several turns, and replicate end-walls are frequent.

10. *Spirogyra Reinhardi*, Chmiel.; Borge, *op. cit.*, p. 31, fig. 41; Borge, Arkiv f. Bot., i, 1903, p. 281, Tab. XV, figs. 8–11.

Var. * *africana* nov. var. (Fig. 13).

Differt a typo cellulis vegetativis saepe 3–4plo longioribus quam latis

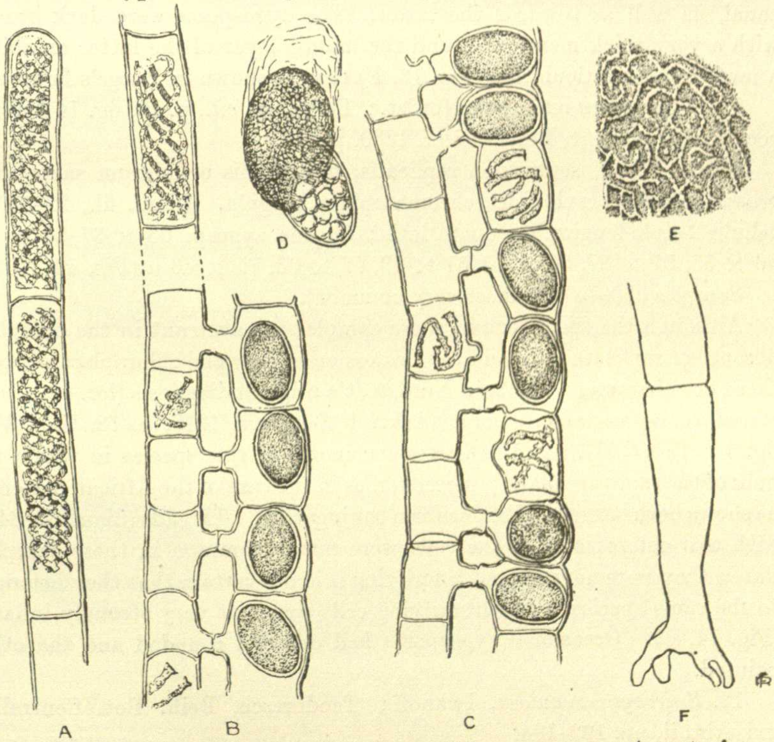


FIG. 13.—*Spirogyra Reinhardi*, Chmiel. var. *africana* nov. var. *A*, part of a vegetative thread; *B* and *C*, threads in conjugation; *D*, zygospore showing the three membranes; *E*, portion of middle zygospore-membrane, much enlarged; *F*, attaching cell. ($D \times 200$; the remainder $\times$ 130.)

(fructiferis brevioribus), cellulis fructiferis saepe paullo inflatis utrobique, membrana mediana zygosporae regularius reticulata.

Diam. cell. veg., 56–71 μ, $1\frac{1}{2}$–4plo long. quam lat.; dimens. zygosp., 55×73, 56×83, 62×89, 64×85, 64×94, 66×88 μ; dimens. cell. fructif., 61×56–73 μ.

Sample 1354 (abundant).

We have seen only Borge's figures (*loc. cit.*) of this species from South America and, since these only include fructifying threads, it is possible that the differences between vegetative and reproductive threads noted in this material also existed in his. The vegetative cells were frequently 3–4 times as long as broad and usually possessed 3 chloroplasts (sometimes 4 or 5), commonly making three turns, but more turns were observed in some of the longest cells (Fig. 13, *A*). The conjugating cells were, however, invariably much shorter (Fig. 13, *B* and *C*), often only as long as broad; moreover, they were slightly inflated on the side away from the conjugation-canal, as well as towards the latter. The zygospores were dark brown, with a very thick membrane, and the middle layer of the latter exhibited a more regular reticulation (Fig. 13, *E*) than is shown in Borge's figures.

11. * *Spirogyra reticulata*, Nordst.; Borge, *op. cit.*, p. 19, fig. 14; Wittrock and Nordstedt, Bot. Notiser, 1880, p. 118.

Forma minor, septis non replicatis, membranis cellularum saepe subcrassis, cellulis brevioribus, chromatophora singula. Diam. fil., 22–33 μ; cellulis 2–4plo longioribus quam latis; dimens. zygosp., 53 × 37, 54 × 35, 56 × 35, 57 × 37, 58 × 30, 61 × 29, 62 × 33, 75 × 46 μ (Fig. 14, *C*).

Samples 753–759 (in most very common).

Although the specimens in these samples are aberrant in the complete absence of replicate ends and the possession of only one chloroplast per cell, these are characters which, in Nordstedt's original diagnosis (*loc. cit.*), were stated to be variable. Borge (Arkiv f. Bot., xv, 1918, p. 78, Tab. VII, fig. 1; Tab. VIII, fig. 15) figures specimens of this species in which the bulk of the septa are plane; moreover, as in the case of the African material, he shows both lateral and scalariform conjugation. Threads (diam. 33–34 μ) with two chloroplasts in the cells were not uncommon in these samples, but as they were never found fructifying it is not certain that they belonged to the same species. The fructifying cells were not very strongly inflated (Fig. 14, *C*). Occasional zygospores had one end rounded and the other pointed.

12. *Spirogyra rugulosa*, Iwanoff; Teodoresco, Beih. Bot. Centralbl., xxi, Abt. ii, pp. 192–194.

Var. * *africana* nov. var. (Fig. 14, *D–F*).

Differt a typo cellulis minoribus, cellulis fructiferis utrobique inflatis. Diam. fil., 32–34 μ; zygosp., 35 × 55, 37 × 57, 38 × 55, 38 × 58, 39 × 56, 40 × 64 μ.

Sample 610 (very common, but few fertile threads).

We think that there is little doubt that the *Spirogyra* in sample 610 is a smaller form of *S. rugulosa*, as described by Teodoresco. The zygospores are characteristic (Fig. 14, *D*); the middle membrane is brown, with numerous fine punctulations or rugulations, appearing as a slight undulation in optical section. As far as we are aware, no good figure of this zygospore has yet been published, as Teodoresco only shows the spores in outline. Our specimens differed in possessing considerably narrower filaments and in the fact that the fructifying cells were slightly inflated on *both* sides, sometimes indeed more markedly on the side away from the conjugation canal than on that next to it (Fig. 14, *E*); the conjugation processes, too,

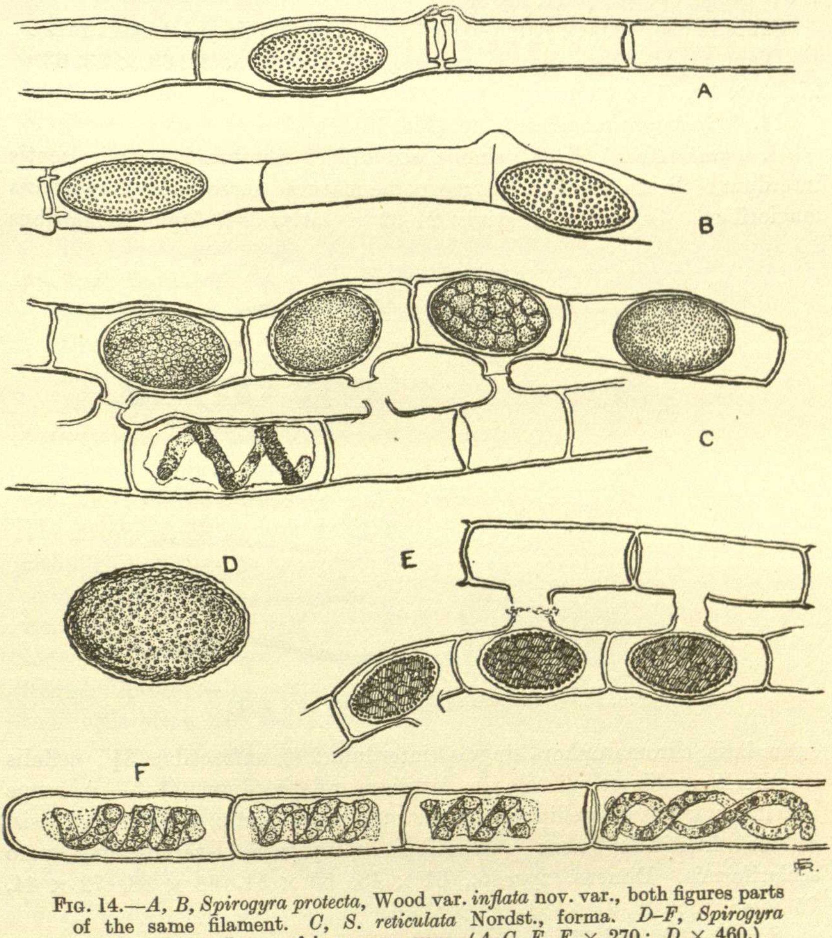


FIG. 14.—*A, B, Spirogyra protecta*, Wood var. *inflata* nov. var., both figures parts of the same filament. *C, S. reticulata* Nordst., forma. *D–F, Spirogyra rugulosa*, Iwanoff var. *africana* nov. var. (*A–C, E, F* × 270; *D* × 460.)

seemed to develop equally from both of the conjugating cells. In all other respects there was practically complete resemblance to the type.

As Teodoresco recognised, this species comes very near to *S. punctata*, Cleve, where, as in our form, the fructifying cells are inflated on both sides. But this species has very elongate cells with chloroplasts showing many turns, and the zygospores are yellow. It may be questioned, however, whether the differences are of specific rank, especially in view of the specimens here described. Another species which comes very close to *S. punctata* is *S. Hoehnii*, Borge (Arkiv f. Bot., xix, 1925, p. 13).

13. * *Spirogyra Spreeiana*, Rabenh.; Petit, *op. cit.*, p. 7, Pl. I, figs. 7–9; Borge, *op. cit.*, p. 17, fig. 5.

Samples 695, 700 (?), 737, 740, 757, 759, and 820 (in most cases rare).

Diam. fil., 22–25 μ; dimens. zygosp., 58 $\times$ 31, 62 $\times$ 33, 63 $\times$ 33, 63 $\times$ 27, 63 $\times$ 35, 71 $\times$ 33 μ.

14. * *Spirogyra subaffinis* n. sp. (Fig. 15).

S. affinis (Hass.), Kütz., similis, sed differt membranis crassis, septis interdum replicatis, membrana zygosporae maturae aureo-fusca, zygosporis longioribus. Cellulis vegetativis 24–32 μ latis, 3–4(–5)plo longioribus

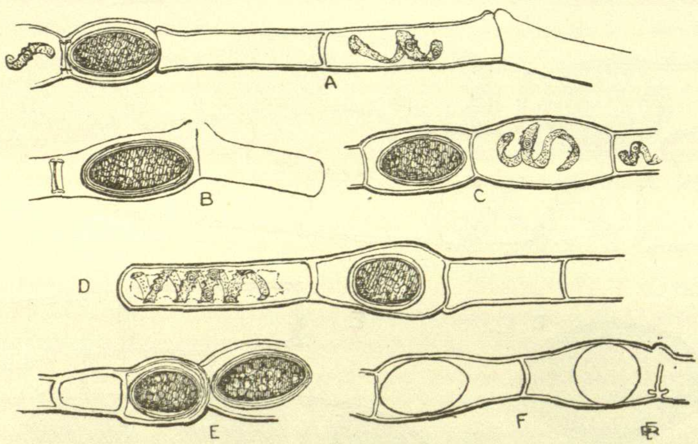


FIG. 15.—*Spirogyra subaffinis* n. sp. ($\times$ 200.)

quam latis, chromatophora singula (interdum 2 ?), anfractibus $3\frac{1}{2}$; cellulis fructiferis et aliis cellulis filorum fertilium inflatis (diam. 41–51 μ), saepe brevibus; zygosporis ellipsoideis finis plerumque acutis, interdum obtusis, cellulis fructiferis paene replentibus. Conjugatio lateralis, vel raro scalariformis. Dimens. zygosp., 61 $\times$ 43, 65 $\times$ 51, 68 $\times$ 38, 72 $\times$ 44, 75 $\times$ 48, 78 $\times$ 46, 97 $\times$ 39, 114 $\times$ 36 μ.

Samples 608 and 609 (common).

This species to a great extent copies the habit of *S. affinis* (Hass.), Kütz., from which it differs in the possession of thick cell-walls (especially in the fructifying threads, Fig. 15, *D*, *E*), the occasional presence of replicate end-walls (especially in cells containing zygospores, Fig. 15, *A*, *B*), the golden-brown colour of the mature zygospore-membrane, and the frequent greater length of the spore. The fructifying cells are usually short (Fig. 15), and are often completely filled by the spores; as a general rule cells of the fructifying threads other than those containing zygospores are likewise inflated (Fig. 15, *C*), although not the empty (male) cells adjacent to those containing zygospores.

A comparison may also be instituted with *S. Grevilleana* (Hass.), Kütz., which is distinguished by its usually longer cells with abundant replicate ends, the thin cell-membranes, the longer fructifying cells, and the usual occurrence of scalariform conjugation. The zygospores are very similar. In other words, the new species is like an *S. Grevilleana* with the habit of an *S. affinis*. Can it be a hybrid ?

15. *Spirogyra varians* (Hass.), Kütz. ; Petit, *op. cit.*, p. 19, Pl. IV, figs. 1–8 ; Borge, *op. cit.*, p. 23, fig. 21.

Samples 695, 700, 709 (only common in the last, but few zygospores).

16. * *Spirogyra velata*, Nordstedt, Act. Univ. Lund, ix, 1872, No. 9, pp. 1, 2 ; Borge, *op. cit.*, p. 25, fig. 29 ; Petit, *op. cit.*, p. 24, Pl. VII, figs. 1–5.

Samples 611 (?, rare), 653–656 (very common in 654, where fertile).

Diam. fil., 36–43 μ ; dimens. zygosp., 50 × 37, 60 × 38, 60 × 39, 63 × 44 μ.

The specimens differed from those described by Nordstedt in having slightly wider threads, but rather smaller zygospores. The latter, moreover, rarely showed the elongated form depicted by Nordstedt, being often only one and a half times as long as wide, with very broadly rounded ends. The scrobiculations were only clearly obvious in the oldest zygospores, although indicated in most of those that had acquired thick walls ; these scrobiculations were often more densely arranged than is shown by Nordstedt. The layer of the membrane bearing these scrobiculations often showed a brown tint. Another peculiarity of the material lay in the frequent presence of inflated vegetative cells in the female threads, and such cells often had thick walls. In most of these respects the material agreed very well with the figures and description of Petit (*loc. cit.*).

(Note.—Sterile *Spirogyra* filaments were also observed in samples 603, 604, 613–616, 618–620, 622, 623, 626, 627, 636, 643, 653, 657, 658, 669, 671, 682, 685 (*subaffinis* ?), 696–698, 705 (probably *S. rivularis*), 706, 708, 711, 713, 715–717, 726–731, 733, 735, 736, 739, 741–743, 745, 746, 751, 782, 807, 820, 827, 833, 861, and 871.)

(3) MOUGEOTIACEAE.

Genus Mougeotia, Agardh.

Only sterile filaments belonging to this genus were encountered, viz. in samples 682, 687, 710, 729–732, 756, 840, 841 (conjugating, but no zygospores). Some of these threads may, of course, belong to the genus *Debarya*.

(4) DESMIDIACEAE.

Genus PENIUM, de Brébisson.

1. *Penium minutissimum*, Nordst. ; W. & G. S. West, Monogr. Brit. Desm., Ray Soc., i, 1904, p. 81, Pl. VIII, figs. 20–23.

Sample 869 (rather common).

Long. cell., 14–16 μ ; lat., 7–8 μ.

All the individuals showed flat, almost parallel sides, and many exhibited a slight constriction.

Genus CLOSTERIUM, Nitzsch.

1. *Closterium acerosum* (Schrank), Ehrenb. ; W. & G. S. West, *op. cit.*, p. 146, Pl. XVIII, figs. 2–5.

Sample 711 (rather rare).

Long. cell., 307–370 μ ; lat., 37–43 μ.

The specimens had truncate apices, like those of var. *truncatum*, Gutwinski (Sprawozdan. kom. fiz. Ak. Umiej. Krakovie, zešč ii, xxvii, 1892, Tab. I, fig. 7), which the Wests regard as synonymous with the type.

2. * *Closterium exiguum*, W. & G. S. West, Trans. Linn. Soc. London, Bot., 2 ser., vi, 1901, p. 141, Pl. XVIII, figs. 17, 18.

Sample 825 (rather common).

Dist. inter apic., 73–83 μ ; diam., 4–6 μ.

3. *Closterium Leibleinii*, Kütz. ; W. & G. S. West, Monogr. Brit. Desm., i, 1904, p. 141, Pl. XVI, figs. 9–14.

Samples 733, 736, 740, 743, 749, 843 (in all cases rare).

Dist. inter apic., 129–175 μ ; diam., 21–30 μ.

4. *Closterium peracerosum*, Gay ; W. & G. S. West, *op. cit.*, p. 154, Pl. XIX, figs. 9–11.

Var. * *arcuatus* nov. var. (Fig. 16, *A*, *B*).

Cellulis in media parte leviter inflatis, a media parte ad polos gradatim attenuatis, margine ventrali in media parte subrecta, polos versus subito et distincte curvata ; polis suboblique truncatis et gracilissimis ; chromatophoris cum pyrenoidibus 3–5. Dist. inter apic., 176–212 μ ; lat., 18–21 μ.

Samples 635 and 700 (only common in the first).

If the individuals of this variety were supposed to be straightened out, they would possess to all intents and purposes the same form as a typical *C. peracerosum* or as var. *elegans*, G. S. West, although not as distinctly tumid in the middle as the latter. Curved forms of var. *aethiopicum*, W. & G. S. West have already been described (Fritsch, Ann. d. Biol. lacustr., vii, 1914, p. 44). Our specimens show some resemblance to a form of *C. littorale*, Gay figured by Strøm (Nyt Mag. f. Naturvidensk., lvii, 1919, Pl. II, fig. 13), but this is more robust and less strongly curved, though the ends of the cells are very similar to those of our form. It is evident that *C. peracerosum* and *C. littorale* are closely related species.

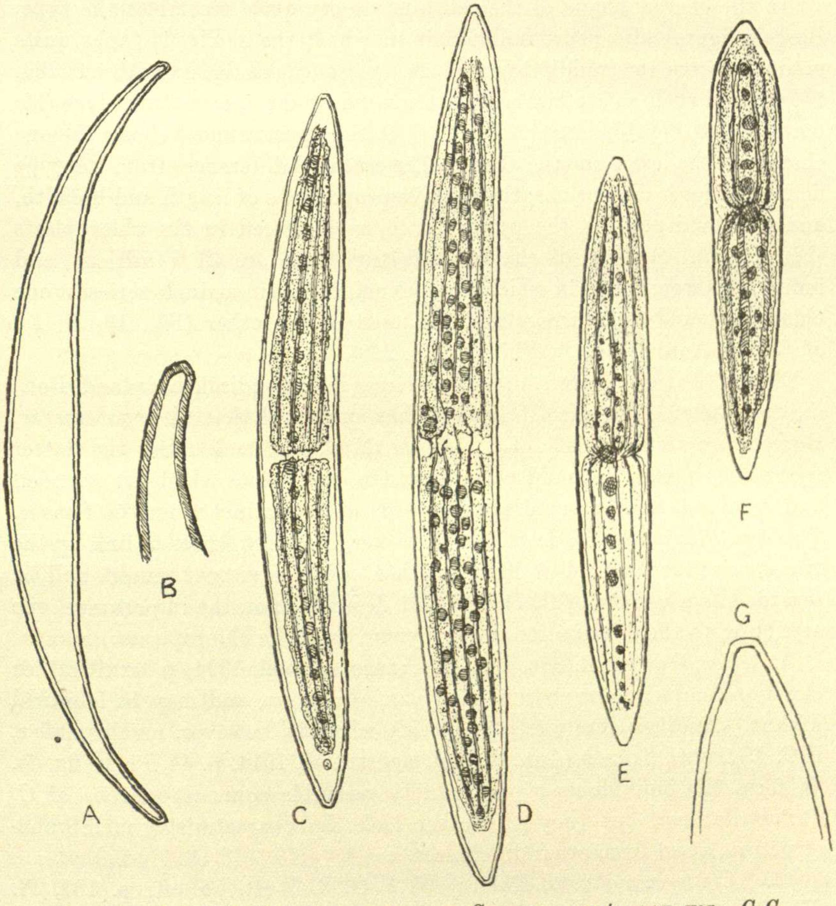


FIG. 16.—*A* and *B*, *Closterium peracerosum*, Gay var. *arcuatus* nov. var. *C–G*, *C. spetsbergense*, Borge var. *africanum* nov. var. ; *F*, a cell soon after division ; *G*, enlarged end. (*A* × 500 ; *C–F* × 170 ; *B* and *G* highly magnified.)

5. *Closterium spetsbergense*, Borge, Vidensk.-selsk. Skrift., Mat.-Nat. Kl., Kristiana, 1911, No. 11, p. 8, fig. 5.

Var. * *africanum* nov. var. (Fig. 16, *C–G*).

Cellulis margine ventrali quam in typo, vel plana vel leviter concava, 7½–8plo longioribus quam latis, polos truncatos versus sensim attenuatis aut prope polis (qui tum saepe levissime recurvati sunt) praecipue attenuatis ; chromatophoris cum ca. 8 costis longitudinalibus praeditis, pyrenoidibus vel 10–12 in serie axiali vel numerosis per chromatophoram sparsis ; membrana hyalina glabra. Dist. inter apic., 440–555 μ ; crass. cell., 54–75 μ.

Samples 653, 655, and 656 (common in the first).

In the general shape of the cell this variety quite resembles the type. Borge's figures also show individuals in which the semicells taper quite gradually from the middle towards the apices (*cf.* his fig. 5*a* with our Fig. 16, *C*), and such as are markedly attenuated at the apices themselves (his fig. 5*a'* ; our Fig. 16, *D*, *G*) ; in Fig. 16, *D*, the upper semicell shows the one character, the lower one the other. The essential differences from the type lie in the bigger dimensions, the relative proportions of length and breadth, and the tendency for the pyrenoids to be scattered in the chloroplasts (Fig. 16, *D*). As regards the latter feature there are all transitions, and individuals were found in which the pyrenoids were in a single series in one chloroplast and quite irregularly scattered in the other (Fig. 16, *E*, *F* ; *cf.* Carter, Ann. of Bot., xxxiii, 1919, p. 229).

Strøm (Naturw. Unters. d. Sarekgebirges in Schwedisch-Lappland, Bot., iii, Stockholm, 1923, No. 15, p. 466) has suggested that *C. spetsbergense*, Borge is an arctic variety of *C. Lunula* (Müll.), Nitzsch. But the latter species has a slightly tumid ventral margin, and apices which are rounded and recurved, and it would appear to be quite distinct from the former. The var. *africanum* here described, however, certainly serves to link up the two species, and looked at from another point of view it might well be regarded as a variety of *C. Lunula.* It depends upon the importance one attributes to the distribution of the pyrenoids in the chloroplasts.

C. affine, Gay (Bull. Soc. Bot. de France, xxxviii, 1891, p. xxxi) rather closely resembles some specimens of var. *africanum*, and may be identical with it. Another closely related species, which is, however, much smaller, is *C. Methueni*, Fritsch (Ann. d. Biol. lacustr., vii, 1914, p. 44, Pl. I, fig. 7). In form the individuals of our variety resemble some specimens of *C. Pritchardianum*, but they altogether lack the characteristic membrane-structure, apart from other differences.

6. * *Closterium Venus*, Kütz. ; W. & G. S. West, *op. cit.*, p. 137, Pl. XV, figs. 15–20.

Sample 650 (very rare).

Dist. inter apic., 80 μ ; lat., 10 μ.

Genus Cosmarium, Corda.

1. *Cosmarium angulosum*, Bréb. ; W. & G. S. West, *op. cit.*, iii, 1908, p. 93, Pl. LXXII, figs. 35, 36.

Var. *concinnum* (Rabenh.), W. & G. S. West, *op. cit.*, p. 94, Pl. LXXII, figs. 37, 38.

Sample 740 (very rare ; long., 13–14 μ ; lat., 11 μ ; ist., 3 μ).

2. * *Cosmarium Blytii*, Wille ; W. & G. S. West, *op. cit.*, p. 225, Pl. LXXXVI, figs. 1–14.

Samples 645, 646 (common ; long., 19–21 μ ; lat., 14–17 μ ; ist., 5–6 μ ; crass., 11 μ), 700 (rare, 18 × 15 μ ; crass., 10 μ), 726 (rather common, *forma* crenis marginalibus superioribus 2 plus minus emarginatis vel truncatis ; long., 20–21 μ ; lat., 16–17, 5 μ ; ist., 3, 5 μ ; crass., 10 μ), 740 (rather rare), 822 (rather common ; long., 19–20 μ ; lat., 16–19 μ ; ist., 6–7 μ ; crass., 12–13 μ), and 843 (rare).

Recorded by G. S. West from Angola.

3. *Cosmarium botrytis*, Menegh. ; W. & G. S. West, *op. cit.*, iv, 1912, p. 1, Pl. XCVI, figs. 1, 2, 5–15.

Var. * *depressum*, W. & G. S. West, *op. cit.*, p. 7, Pl. XCVII, fig. 6.

Samples 604, 700, 710–712, 735, 736, 740 (common only in the last).

Long. cell., 51–66 μ ; lat., 45–59 μ ; ist., 13–16 μ ; crass., 21–22 μ.

A large majority of the individuals seen quite agreed with Messrs. West's figures in general outline, but many were proportionally rather longer than broad. The side-view was quite circular ; in end-view a very faint median protuberance was evident in some specimens, but not in all. Messrs. West (*loc. cit.*, p. 7) suggest that *C. Hyacinthi*, Gutwinski (Sprawozd. kom. fiz. Ak. Umiej. Krakowie, zešć ii, xxvii, 1892, p. 70, Tab. II, fig. 30) is closely related to this variety, although it is very much smaller. *C. Hyacinthi* has a median protuberance in end-view, but it is more marked than any seen in our specimens.

4. *Cosmarium granatum*, Bréb. ; W. & G. S. West, *op. cit.*, ii, 1905, p. 186, Pl. LXIII, figs. 1–3.

Samples 733 and 740 (rare ; long., 35–36 μ ; lat., 24–27 μ ; ist., 6–7 μ).

5. *Cosmarium laeve*, Rabenh. ; W. & G. S. West, iii, 1908, p. 99, Pl. LXXIII, figs. 8–19.

Samples 613, 614, 619, 625, 628, 632, 635, 656 (with var. *distentum*, G. S. West), 689, 701, 711, 753, 822, 834, and 868 (common in 625, 632, 689, 701, and 834, elsewhere rare).

Long. cell., 23–31 μ ; lat., 14–20 μ ; ist., 4–6 μ ; crass., 14–15 μ.

This was the most widely distributed species of the genus. The numerous individuals seen exhibited considerable variation in the proportion of length to breadth and in the degree of convexity of the lateral margins of the semicells.

Var. *distentum*, G. S. West, Ann. S. Afr. Mus., ix, 1912, p. 86, fig. 48.

Samples 614, 656, 753, and 868 (in all cases together with the type, common in 656 and 868).

Long. cell., 24–28 μ ; lat., 19–22 μ ; ist., 4–6 μ ; crass., 13–15 μ.

The scrobiculations on the wall were sometimes plainly evident, in other cases the wall appeared quite smooth, the variety in this respect varying like the type.

Var. * *pseudo-octangularis* nov. var. (Fig. 17, *A*).

Semicellulis a fronte visis formae var. *octangularis* (Wille), W. & G. S. West, sed marginibus lateralibus e partibus duabus solum constantibus, iis inferioribus plus minus divergentibus, iis superioribus valde convergentibus, apice angusto, distincte retuso in media parte ; a latere visis leviter ellipticis ; a vertice ellipticis, sine tumore mediano. Long. cell., 16–18 μ ; lat., 14–17 μ ; ist., 4 μ ; crass., 7–8 μ.

Sample 713 (rather common).

The large number of individuals in this sample were very constant, except as regards the degree of divergence of the lower lateral margins. A few were also seen in which the apex was much broader than is shown in Fig. 17, A, *a*. Usually there was a slight thickening of the membrane where the retuseness occurs in the middle of the apex.

6. *Cosmarium Meneghinii*, Bréb. ; W. & G. S. West, *op. cit.*, p. 90, Pl. LXXII, figs. 29–32.

Forma marginibus omnibus evidenter retusis et interdum undulatione exigua in media margine superiore retusa. Long. cell., 14 μ ; lat., 12 μ ; ist., 3 μ ; crass., 10 μ (Fig. 17, *B*).

Sample 822 (very rare).

7. *Cosmarium papkuilense*,* G. S. West, Ann. S. Afr. Mus., ix, 1912, p. 87, Pl. I, fig. 40.

Samples 633, 646, 726, 733 (rare in all cases).

Forma typica, sed minor. Long. cell., 19–23 μ ; lat., 17–21 μ ; ist., 6–7 μ ; crass., 10 μ.

Samples 735, 736, 740, and 822 (rare except in the last).

Forma sinu minus aperto, seriebus verticalibus granulorum minus distinctis, sed granulis in series concentricas marginem parallelas evidenter dispositis. Long. cell., 26–29 μ ; lat., 23–26 μ ; ist., 6–8 μ ; crass., 15 μ (Fig. 17, *C*).

Samples 635 (very common), 700 (rare).

Cosmarium papkuilense, despite its single chloroplast and pyrenoid and the widely open sinus, is probably closely allied to *C. pseudobroomei*, Wolle ; the end-views are almost identical (*cf.* Fig. 17, *C*, *c*). Our specimens differed from the type in the fact that the two margins of the sinus did not as a rule diverge at once, but showed a subparallel course for a short distance (Fig. 17, *C*, *a*). As a general rule, too, the flat apex of the semicell was not as wide as in the individual figured by West, beginning to

* This species was called "*pappekuilense*" by G. S. West, but the place Pappekuil is now spelt Papkuil, so that the specific name should read "*papkuilense*."

slope off to the convex lateral margins rather gradually and not suddenly. The granules were never arranged in such strict vertical series as in West's figure, but, on the other hand, showed a marked concentric disposition, parallel to the margins of the semicells. The end-views, on the other hand, were just of the shape shown by West.

In 1913 Borge (Bot. Notiser, 1913, p. 13, Tab. I, fig. 6) published a new species of *Cosmarium* under the name of *C. hians*. This would appear to be

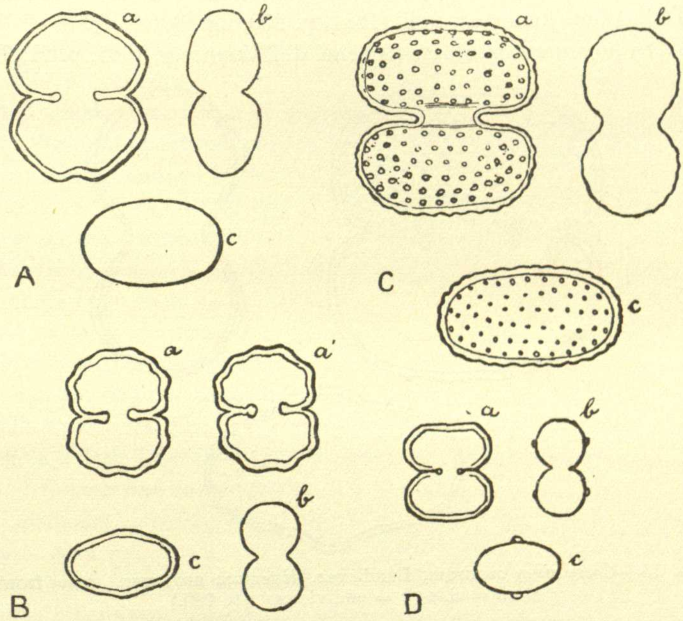


FIG. 17.—*A*, *Cosmarium laeve*, Rabenh. var. *pseudo-octangularis* nov. var. (× 1200). *B*, *C. Meneghinii*, Bréb., forma (× 1200). *C*, *C. papkuilense*, G. S. West, forma (× 940). *D*, *C. polygonum* (Naeg.), Arch. var. *hexagonum*, Grönbl. (× 1200). *a* = front-, *b* = side-, and *c* = end-views.

a form of *C. papkuilense*, as the differences between the two are quite insignificant.

8. *Cosmarium perpusillum*, W. West; W. & G. S. West, *op. cit.*, p. 88, Pl. LXXII, figs. 22, 23.

Samples 601, 604, 726, 740, 743 (rare in all cases).

The specimens observed were typical, except that the lateral angles were not very markedly protuberant. Long. cell., 17–18 μ; lat., 14–15 μ; ist., 3–4 μ.

9. *Cosmarium polygonum* (Naeg.), Arch.; W. & G. S. West, *op. cit.*, p. 76, Pl. LXXI, figs. 32–34.

Var. * *hexagonum*, Grönblad, Act. Soc. Fauna et Flora Fennica, xlix, 1921, p. 35, Pl. VII, figs. 24–26. (Fig. nostr. 17, *D*.)

Sample 868 (rare).

Long. cell., 11–12 μ ; lat., 10 μ ; ist., 2 μ ; crass., 5–7 μ.

In front-view this variety is more like a form of *C. pseudobiremum*, Boldt or *C. abbreviatum*, Racib., whilst side- and end-views are remarkably like var. *omphalum* (Schaarschm.), Racib. of *C. phaseolus*, Bréb. (= *C. bioculatum*, Bréb. var. *omphalum*, Schaarschmidt, Mat. Term. Közlemenyek Mag. Tud. Akad. Budapest, xviii, 1884, p. 270, fig. 9).

Cosmarium praecisum, Borge (Algenfl. d. Tåkernsees, 1921, p. 21, Tab. I,

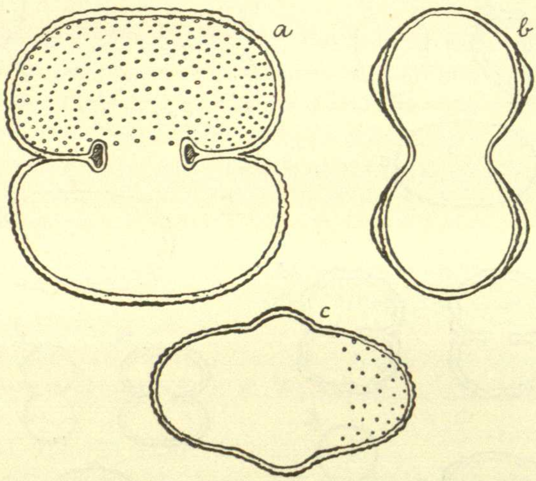


FIG. 18.—*Cosmarium quadrum*, Lund. var. *distentum* nov. var. *a* = front-, *b* = side-, *c* = end-views. (× 780.)

fig. 18), except for its rather larger dimensions, seems to be altogether identical with *C. polygonum* var. *hexagonum*, Grönbl., and both should perhaps be regarded as forms of *C. pseudobiremum*, Boldt (*cf.* also Strøm, Naturw. Unters. d. Sarekgebirges, iii, 1923, p. 478).

10. *Cosmarium quadrum*, Lund. ; W. & G. S. West, *op. cit.*, iv, 1912, p. 20, Pl. C, figs. 3–6.

Var. * *distentum* nov. var. (Fig. 18).

Semicellulis a fronte visis var. *minus* Nordst. similibus, sed granulis in series concentricas marginem parallelas dispositis, isthmo interne valde axi longitudinali dilatato ; a vertice visis ellipticis lateribus deplanatis parallelis polis rotundatis, tumore mediano manifesto. Long. cell., 45–54 μ ; lat., 44–51 μ ; ist., 13–16 μ ; crass., 19–20 μ.

Samples 649, 650, and 653 (not uncommon).

The front view of this variety is only distinguishable from small forms of the type (*e.g.* var. *minus*, Nordst.) in the fact that the granules are arranged in rather definite series concentric with the margin of the semicell, and that the inner edge of the isthmus is strongly dilated in the direction of the longitudinal axis (Fig. 18, *a*), somewhat as in the form described by Fritsch (Trans. Roy. Soc. S. Afr., ix, 1921, p. 44, fig. 19). It is, however, much more markedly characterised by the end-view, which, though in general outline like that of the type with flat parallel sides and rounded poles, shows a very distinct median protuberance which is developed to a slightly different extent in different individuals (Fig. 18, *c*). In the possession of this protuberance var. *distentum* approaches *C. Broomei*, Ralfs, but in the latter the protuberance is more prominent than in the specimens here recorded, and a comparison of Fig. 18, *c* with fig. 12, *b* or *d* on Plate C in Messrs. West's monograph will bring out the nature of the difference. The protuberance is confined to the median part of each semicell, and, as a result, the side-view of the latter has a different appearance, according as one focusses on the surface (circular) or on the middle part (rhomboidal, Fig. 18, *b*). In *C. Broomei*, on the other hand, as far as the published figures show, there is no such sharp demarcation between the non-inflated and the inflated parts of the end-view. Moreover, in this species the granules are arranged in vertical series, and are not so coarse.

In sample 653 the majority of the individuals showed rather rounded semicells, with a less plainly demarcated apex, and such individuals were on the whole a little larger than those in the other two samples.

11. * *Cosmarium scrobiculatum* n. sp. (Fig. 19).

C. mediocre, circ. 1, 1–1, 2plo long. quam lat., profundissime constrictum, sinu angusto-lineari ad extremum valde ampliato ; semicellulis a fronte visis rotundato-pyramidatis, apice subanguste truncato, angulis basalibus rotundatis, marginibus lateralibus valde convexis ; a latere visis subcircularibus, a vertice anguste ellipticis. Membrana incrassata, dense scrobiculata, scrobiculis rotundatis magnis, ca. 50 in marginem semicellulae, intra marginem plus minus radiatim et concentrice dispositis, in centro semicellulae in series breves verticales (?) ordinatis ; pyrenoidibus binis in semicellula unaquaque. Long. cell., 51–62 μ ; lat., 44–51 μ ; ist., 14–15 μ ; crass., 27 μ.

Samples 653 and 656 (not uncommon).

At first sight this species shows a superficial resemblance to *C. Pearsoni*, G. S. West, but it differs in the greater convexity of the lateral margins, the more pronounced truncation of the apex, the thick wall, and especially in the fact that the cells are not granulate, but scrobiculate (Fig. 19, *a'*). It is the last feature that lends this species its special character and serves to distinguish it from most other species of *Cosmarium* having the same form. The only one approaching it is *C. scrobiculosum*, Borge (Arkiv f.

Bot., i, 1903, p. 87, Pl. II, fig. 12), but here the cells are of quite a different shape and the scrobiculations not as deeply set in the wall. In *C. scrobiculatum* the outline of the wall, as seen in optical section, is practically altogether smooth. As we have seen no empty cells, we are a little doubtful about the distribution of the scrobiculations over the central part of the semicells.

12. *Cosmarium sexangulare*, Lund.; W. & G. S. West, *op. cit.*, iii, 1908, p. 81, Pl. LXXII, fig. 3.

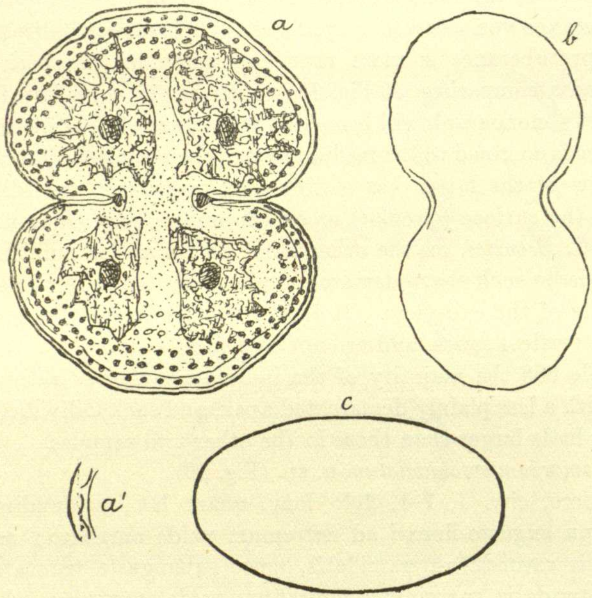


FIG. 19.—*Cosmarium scrobiculatum* n. sp., showing front- (*a*), side- (*b*), and end-views (*c*). *a'*, small part of wall in optical section. (× 940.)

Var. *subangulare*, Fritsch, Ann. S. Afr. Mus., ix, 1918, p. 553, fig. 28, *a*, *b*.

Sample 735.

Forma apice retuso distincto, sed marginibus lateralibus superioribus non e partibus duabus constantibus. Long. cell., 18, 5–20 μ; lat., 16–18 μ; ist., 3–4 μ; crass., 10 μ.

Samples 635 and 845 (common in the first).

13. *Cosmarium subprotumidum*, Nordst.; W. & G. S. West, *op. cit.*, p. 231, Pl. LXXXVI, figs. 19–21.

Sample 743 (rare).

Subsp. *simplex*, Fritsch, Trans. Roy. Soc. S. Afr., ix, 1921, p. 41, fig. 15.

Var. *a*. Long., 19–24 μ; lat., 18–21 μ; ist., 4, 5 μ.

Sample 743 (rare).

Var. β.

Forma marginibus lateralibus superioribus cristis truncatis duabus (Fritsch, *loc. cit.*, p. 42, fig. 15, III). Long. cell., 24–32 μ ; lat., 22–28 μ ; ist., 6–8 μ ; crass., 14 μ.

Samples 601 (rare), 644–646 (common), 734 (rare).

Forma crenis superioribus marginium lateralium majoribus (Fritsch, *loc. cit.*, p. 42, fig. 15, IV). Long. cell., 24–32 μ ; lat., 20–28 μ ; ist., 5–6 μ ; crass., 14 μ.

Sample 604 (rather rare).

Forma Fritsch, *loc. cit.*, fig. 15, II similis ; long. cell., 26–34 μ ; lat., 22–29 μ ; ist., 6–8 μ.

Sample 743 (rare).

In sample 601 specimens were seen with a well-marked median protuberance bearing distinct granules definitely arranged in a number of concentric series, but these granules were no larger than the others found on the surface of the semicell, nor were they separated by a smooth area from the intra-marginal granulation, the two being quite continuous.

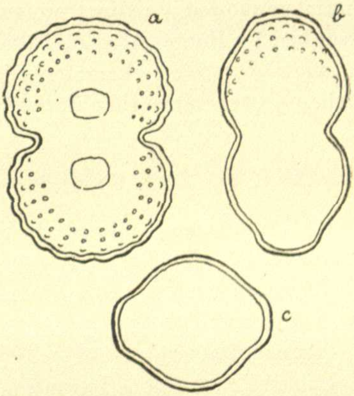


FIG. 20.—*Cosmarium subundulatum*, Wille var. *minor* nov. var. *a* = front-, *b* = side-, and c = end-views. (× 1000.)

14. *Cosmarium subtumidum*, Nordst. ; W. & G. S. West, *op. cit.*, ii, 1905, p. 192, Pl. LXIII, figs. 18–20.

Var. * *circulare*, Borge, *loc. cit.*, 1903, p. 97, Tab. III, fig. 22.

Samples 726 and 740 (rather rare).

Long. cell., 23–28 μ ; lat., 21–25 μ ; ist., 6–7 μ ; crass., 13 μ.

Some of the individuals showed a fairly well-marked flattening of the apex in front-view, but the side- and end-views were quite like those figured by Borge.

15. *Cosmarium subundulatum*, Wille ; W. & G. S. West, *op. cit.*, p. 151, Pl. LIX, figs. 13–15.

Var. * *minor* nov. var. (Fig. 20).

Differt a typo magnitudine minore, cellula minus profunde constricta, isthmo latiore ; semicellulis crassioribus, a vertice visis paene subcirculari-bus polis protrusis ; chromatophoris axilibus pyrenoide singulo ; a latere visis quam in typo. Long. cell., 32–36 μ ; lat., 21–24 μ ; ist., 14–15 μ ; crass., 16–20 μ.

Samples 645 and 646 (common).

This variety is especially distinguished by its end-view and the single pyrenoid in the chloroplast.

16. * *Cosmarium vexatum*, West ; W. & G. S. West, *op. cit.*, iii, 1908, p. 187, Pl. XCII, fig. 4.

Forma a vertice visa in media parte minus distincte inflata. Long. cell., 41–50 μ ; lat., 33–42 μ ; ist., 10–12 μ ; crass., 21–28 μ ; lat. apic., 15–18 μ.

Samples 613, 614, 618, 619, 622, 634, 700, 726, 733, 735, 736, 740, 822, 824 (rather common in 726 and 740, elsewhere rare).

Some of the specimens agreed in their front-view altogether with figs. 4 or 5 in Messrs. West's monograph, but—more especially in sample 740—a number showed a distinct protrusion of the apex, like that seen in a form described by Borge (Algenfl. Tåkernsees, 1921, p. 20, Pl. II, fig. 19). The end-view was often characterised by a less marked development of the median protuberance than in the type.

Genus Staurastrum, Meyen.

1. *Staurastrum alternans*, Bréb. ; W. & G. S. West, *op. cit.*, iv, 1912, p. 170, Pl. CXXVI, figs. 8, 9.

Forma semicellulis non alternantibus. Long., 20 μ ; lat., 18–19 μ ; ist., 7 μ (Fig. 21, *C–E*).

Sample 822 (rare).

Except for the non-alternation of the semicells, the specimens were in all respects typical (Fig. 21, *C–E*). The same sample contained small individuals of *Cosmarium papkuilense*, G. S. West (*cf.* p. 60), which has a front-view very similar to that of *Staurastrum alternans* (*cf.* Fig. 21, *A*). Individuals were found in which one semicell in end-view appeared oblong like that of *Cosmarium papkuilense*, whilst the other was triangular, as in a *Staurastrum alternans* (Fig. 21, *D*). It would thus seem probable that *Cosmarium papkuilense* is a non-staurastroid form of *Staurastrum alternans*.

2. * *Staurastrum paradoxum*, Meyen, West and Carter, *op. cit.*, v, 1923, p. 101, Pl. CXLV, figs. 1–5.

Sample 822 (rare).

Long. cell., 20–25 μ ; lat. c. proc., 31–35 μ ; ist., 7–8 μ.

3. * *Staurastrum polymorphum*, Bréb. ; West and Carter, *op. cit.*, p. 125, Pl. CXLIII, figs. 1–3.

Var. *munitum*, W. West ; West and Carter, *op. cit.*, p. 128, Pl. CXLIII, fig. 6.

Forma minor, lateribus e vertice visis interdum paullo concavis. Long. cell., 22–24 μ ; lat. c. proc., 24–26 μ ; ist., 8 μ (Fig. 21, *F*, *G*).

Sample 822 (rare).

Our specimens differed in the fact that the end-view often possessed slightly concave sides and that the clear area in the middle of the end-view was not so marked, owing to the series of denticulations around the angles

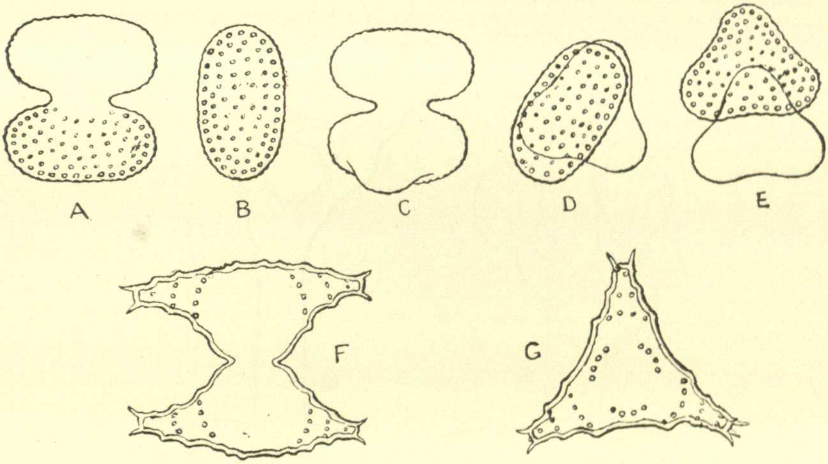


FIG. 21.—*A* and *B*, *Cosmarium papkuilense*, G. S. West, small form from sample 822. *C–E*, *Staurastrum alternans*, Bréb., forma; in fig. *D* one semicell is like the *Cosmarium*, the other like the *Staurastrum*. *F*, *G*, *S. polymorphum*, Bréb. var. *munitum*, W. West, forma. (*A–E* × 1100; *F*, *G* × 1400.)

extending further towards the centre, without being more numerous. The same feature was also recognisable in the front-view (Fig. 21, *F*), in which the apex was either quite flat or even slightly convex.

Group 7. SIPHONALES.

(1) VAUCHERIACEAE.

Genus VAUCHERIA, DC.

1. *Vaucheria geminata*, DC. emend. Walz; Heering, Suesswasserfl., vii, 1921, p. 89 (Fig. 22).

Sample 687 (very common).

Lat. fil., 44–90 μ.

The filaments were rather thick-walled and at many points encrusted with calcium carbonate, the incrustation being especially prominent around the oogonia containing mature oospores. In order to decipher their characteristics it was necessary to treat the material with hydrochloric acid. While many of the fertile branches were of the usual type, some were in so far extraordinary as they showed two or even three groups of sexual organs (Fig. 22). After the production of the first group growth had apparently often been carried on by a lateral branch (Fig. 22, *B*); in

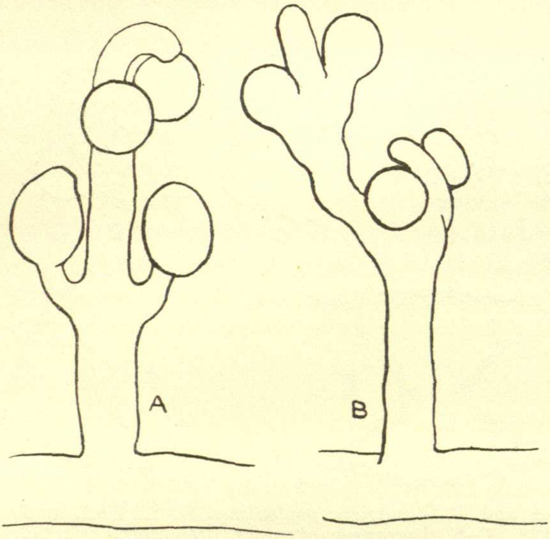


FIG. 22.—*Vaucheria geminata*, DC., forma. (× 100.)

other cases the median antheridium was replaced by a branch carrying on the growth (Fig. 22, *A*).

2. * *Vaucheria ornithocephala*, Ag.; Heering, *op. cit.*, p. 84, fig. 72.

Sample 685 (common).

(NOTE.—Indeterminable material of *Vaucheria* also occurred in sample 1355.)

II. HETEROKONTAE.

Group 1. HETEROCHLORIDALES.

SERIES III. HETEROCAPSALES.

Genus BOTRYOCOCCUS, Kützing.

1. * *Botryococcus protuberans*, W. & G. S. West, Trans. Roy. Soc. Edinburgh, xli, 1905, p. 507, Pl. VI, figs. 8, 9.

Samples 813 and 814 (rather rare).

Group 2. HETEROCOCCALES.

(1) CHLOROBOTRYDACEAE.

Genus CENTRITRACTUS, Lemmermann.

1. * *Centritractus africanus* n. sp. (Fig. 23).

C. corpore cellulae gracili, lateribus vel parallelis vel in media parte leviter concavis, apicibus acutis (uno interdum paullo dilatato) in spinam

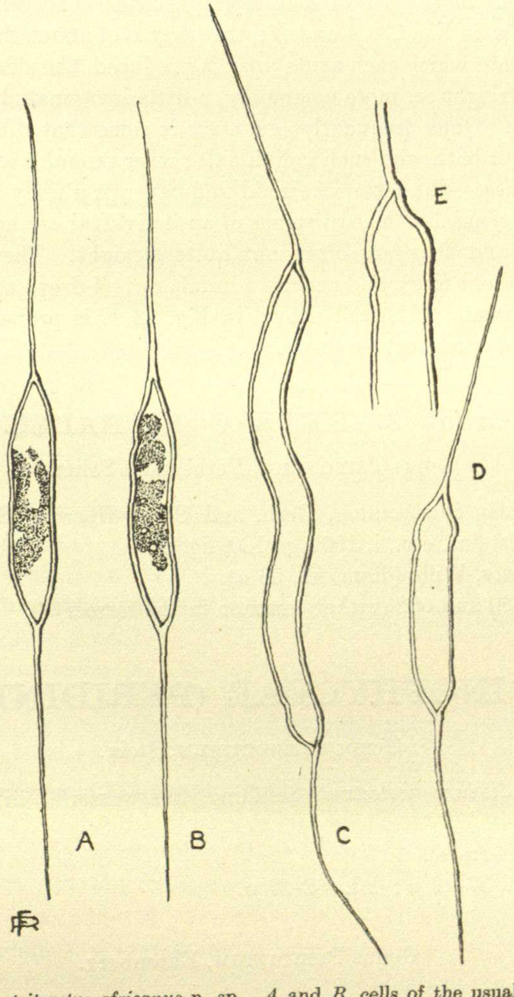


FIG. 23.—*Centritractus africanus* n. sp. *A* and *B*, cells of the usual type; *C*, abnormal (?) cell; *D* and *E*, cells with enlarged apices. (*E* × 2000; the remainder × 1200.)

longam solidam interdum curvatam productis; spinis a basi ad apicem attenuatis, non semper ejusdem longitudinis; chromatophoris ca. 4. Long. cell., 80–94 μ; long. corp. cell., 24–37 μ; lat. cell., 5–6 μ; long. spin., 25–36 μ.

Samples 825 and 844 (rather rare).

The reference of this species to the genus *Centritractus* is based on the general shape of the cell. No indications of the wall being composed of two overlapping pieces could be discovered, and the material was too scanty to admit of the use of macerating agents. The general shape of the cell is shown in Fig. 23, *A* and *B*; the body is of about the same length as the spines into which each acute apex is produced, the sides of the body either being straight or, more commonly, a little invaginated so as to form a slight waist. Quite frequently one apex is somewhat dilated (Fig. 23, *D* and *E*), never both, and such individuals rather resemble an *Ophiocytium* with long spines. The latter are solid and taper gradually from the base to the apex; generally the two spines of an individual are not of quite the same length, and they are often not quite straight. There are several chloroplasts (about four), and usually a number of oil-drops are recognisable in the cell-contents. The cell shown in Fig. 23, *C* is probably abnormal. This species requires further study.

Group 3. HETEROTRICHALES.

Genus Tribonema, Derbès and Solier.

1. *Tribonema bombycinum*, Derb. and Sol.; Heering, Suesswasseralg. Schleswig-Holsteins, etc., i, 1906, p. 120, fig. 25.

Forma *minor*, Wille (diam. fil., 56 μ).

Samples 680 and 682 (rather common in the former).

VI. DINOPHYCEAE (PERIDINIEAE).

Genus Glenodinium, Stein.

1. * *Glenodinium neglectum*, Schilling, Süsswasserfl., iii, 1913, p. 23, fig. 25.

Sample 844 (rare).

Long. cell., 37–49 μ; lat., 32–37 μ.

Genus Peridinium, Ehrenberg.

1. * *Peridinium inconspicuum*, Lemmermann; Schilling, *op. cit.*, p. 42, fig. 48.

Sample 635 (rather common).

The individuals were rather larger than usual; long. cell., 26–27 μ; lat., 20–24 μ. Some of the individuals contained cysts and a large proportion were empty, all of these having set free their cysts by rupture of the antapical half.

2. * *Peridinium minimum*, Schilling, *op. cit.*, p. 43, fig. 49.

Sample 868 (rare).

Long. cell., 19–20 μ; lat., 14 μ.

3. * *Peridinium tabulatum* (Ehrenb.), Clap. and Lachm.; Schilling, *op. cit.*, p. 34, fig. 38.

Sample 833 (rare).

Long. cell., 58 μ; lat., 54 μ.

VIII. EUGLENINEAE.

(1) EUGLENACEAE.

Genus EUGLENA, Ehrenberg.

1. *Euglena intermedia* (Klebs), Schmitz; Lemmermann, Suesswasserfl., ii, 1913, p. 128, fig. 214.

Var. * *brevis* nov. var. (Fig. 25, *G*).

Var. cellulis parvis elongatis angustis (long., 44–54 μ; lat., 6–7 μ), distincte metabolicis, periplasto subtenui, striis spiralibus non manifestis, fine posteriore spina bene evoluta praedito, fine anteriore paullo attenuato rostriformi; granulis "paramylon" 2, elongatis, varie dispositis; chromatophoris multis discoideis.

Sample 825 (rather common).

This is really a small form of the type, with a more marked posterior spine and apparently an unstriated periplast. The two rod-shaped paramylon-grains are sometimes placed one near the front and the other near the back end; in other individuals, however, both are near together in the back half of the body, and occasionally they lie side by side.

2. *Euglena oxyuris*, Schmarda; Lemmermann, *op. cit.*, p. 130, fig. 207.

Forma minor, Deflandre, Bull. Soc. Bot. d. France, xxiv, 4 sér., 1924, p. 1117, fig. 9. (Fig. nostr. 24, *A–C*.)

Samples 642, 643, and 844 (rather rare).

Long. sine spin., 128–148 μ; c. spin., 148–170 μ; lat., 20–27 μ.

These specimens are very much smaller than those described and figured by Lemmermann (*cf.* also Kryptogamenfl. d. Mark Brandenburg, iii, 1910, p. 483, fig. 16), and never show the very emphatic spiral twist that he depicts (see Fig. 24, *A–C*). Some of the individuals, in fact, give no indication of twisting at all (Fig. 24, *C*), thus agreeing with Deflandre's figure (*loc. cit.*). Others, however, exhibit more or less marked spiral ridges at certain points, but these can never be traced all round the body (Fig. 24, *A*, *B*). They give much more the impression of being folds or crests on the periplast, that extend for a certain distance and then die out. In some individuals such ridges are visible in certain positions, and not in others.

The body of the cell is slightly flattened, being broader in one position than in another. It is straight or sometimes slightly curved (Fig. 24, *C*). The two paramylon-grains, situated anterior and posterior to the large oval nucleus (Fig. 24, *C*), are always very conspicuous and have the form of elliptical rings with a narrow slit-shaped opening in the middle. When seen from the edge, they appear as broader or narrower rods. The periplast shows well-marked spiral striation. The posterior spine is hollow, and either straight or curved to one side ; its thick wall is continuous with the periplast over the rest of the body. In the few cases in which it was seen the flagellum appeared short, about one-quarter the length of the body (Fig. 24, *A*, *C*).

The form recorded by Fritsch from the Cape (Ann. S. Afr. Mus., ix, 1918, p. 600, fig. 42, *A*) is, no doubt, the same as this. It is much to be desired that this *Euglena* should be carefully studied in fresh material, in order to determine the nature of the spiral ridges. It is of course possible that the form here described is specifically distinct from *E. oxyuris,* although there is much agreement except in dimensions and the twisting of the body.

(NOTE.—Indeterminable material of *Euglena* was also observed in the following samples: 600, 624, 627, 630, and 805 (here very common). *Palmella*-stages were found in samples 713, 714, and 832 (see p. 24), in all cases very common.)

Genus LEPOCINCLIS, Perty.

1. * *Lepocinclis Buetschlii*, Lemmermann, *op. cit.*, p. 135, fig. 224.

Sample 844 (rare).

Very large specimens (long., 61 μ ; lat., 45 μ), but otherwise quite typical.

2. *Lepocinclis fusiformis* (Carter), Lemmermann, *op. cit.*, p. 135, fig. 219.

Var. * *major* nov. var. (Fig. 24, *D–G*).

Var. cellulis majoribus (long. sine spin., 39–51 μ ; lat., 24–39 μ), fine anteriore labiis 2, interdum inaequalibus, fine posteriore aut obtuso aut spina plus minus elongata recta vel leviter curvata praedito, striis spiralibus periplasti exiguis saepe non manifestis, granulis " paramylon " vel 2 magnis lateralibus deplanatis annuliformibus quam in typo, vel multis parvis annuliformibus, vel multis formae irregularis.

Sample 844 (rare).

This variety is distinguished by its larger dimensions, the very faint spiral striation of the periplast, the variability of its paramylon-grains, and the frequent termination of the body at the posterior end in a short straight or curved spine. The paramylon-grains are sometimes as in the type (Fig. 24, *E–G*); other individuals have numerous small, ring-shaped grains (Fig. 24, *D*) or numerous grains of indefinite shape. The striation of the periplast is unrecognisable in the majority of the individuals. The two lips at the front end are very characteristic.

Zacharias (Forschungsber. Biol. Stat. Plön, x, 1903, Tab. II, fig. 17) has already figured individuals of this species with a posterior spine, but one that is much broader and blunter than that seen in our material. Deflandre (Bull. Soc. Bot. France, 4 sér., xxiv, 1924, p. 1122, fig. 24) shows an individual lacking striation, but which otherwise resembles the type.

3. * *Lepocinclis Steinii*, Lemmermann, *op. cit.*, p. 134, fig. 220.

Sample 617 (?, rare).

4. * *Lepocinclis texta* (Duj.), Lemmermann, *op. cit.*, p. 135, fig. 238.

Forma cellulis ovatis, fine posteriore late rotundato, fine anteriore acutato; foramine flagelli oblique disposito. Long. cell., 48–60 μ; lat., 32–45 μ (Fig. 25, *A*).

Samples 642, 643 (rather common).

Genus Phacus, Dujardin.

1. * *Phacus anomala* n. sp. (Fig. 24, *H–N*).

Cellulis e partibus duabus (corpore et ala) constantibus; corpore non torquato, saepe crassiore quam lato, plus minus oblongo, saepe cuneiformi in aspectu frontali (qua cellula plerumque quiescat), polis latis deplanatis, posteriore paullo latiore cum spina brevi manifeste curvata (vel pro parte e ala evoluta ?), superficie e qua ala oritur deplanata vel etiam concava, altera convexa; ala latiore quam crassa, cum corpore aspectu propria cellulae efficienti, plerumque pro corpore inclinata, raro parallela, non corpus in tota longitudine affixa; granulis "paramylon" plerumque 2, interdum cum foramine minuto, raro aequalibus, altero in corpore magno a latere viso crasso constricto clepsydraeformi, altero in ala parvo interdum minimo vel absenti; periplasto cum striis sublongitudinalibus. Long. cell. sine spin., 24–27 μ; lat. (in aspectu frontali), 26–27 μ; crass. corp., 17–22 μ; lat. corp. (in aspectu frontali), 16–18 μ; crass. alae, 11–12 μ.

Sample 844 (common).

It is only after prolonged investigation that we have arrived at what we believe to be the correct interpretation of this peculiar form. The

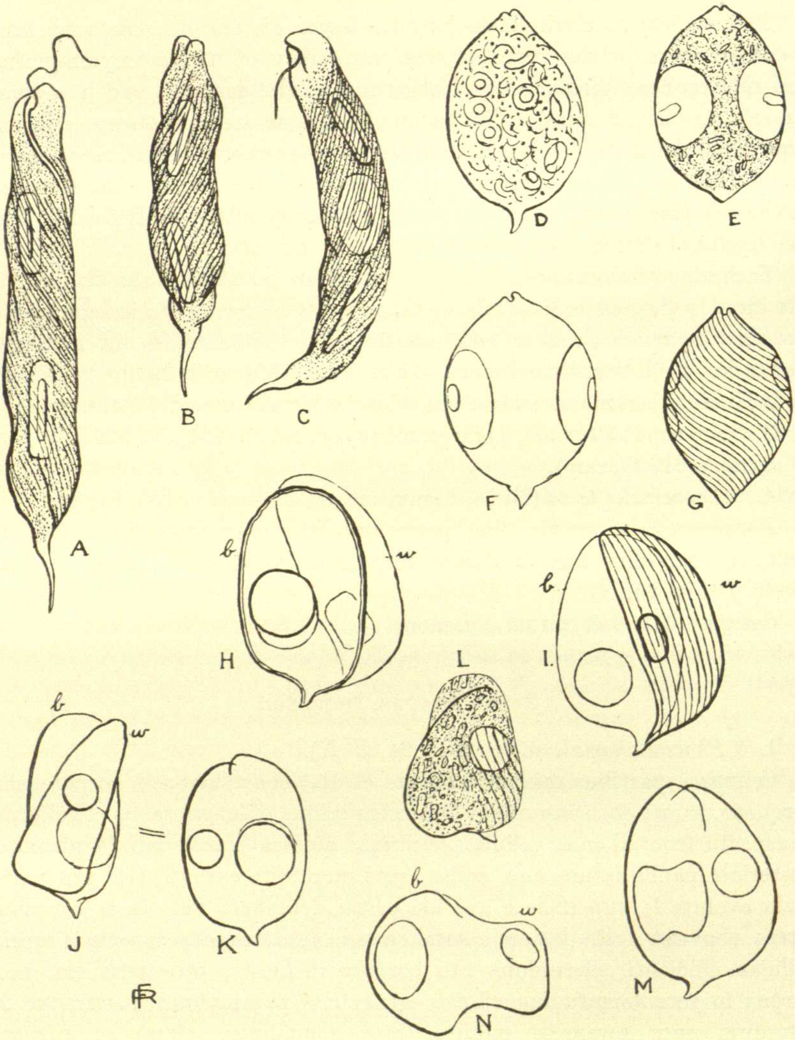


FIG. 24.—*A–C, Euglena oxyuris,* Schmarda f. *minor,* Deflandre (× 400). *D–G, Lepocinclis fusiformis* (Carter), Lemm. var. *major* nov. var. (× 700) ; *D,* an individual with many small ring-shaped paramylon-grains and a curved posterior spine ; *G,* showing the striation of the periplast, which is often indistinguishable. *H–N, Phacus anomala* n. sp. (× 1100) ; *H,* individual with the " body " uppermost ; *I,* the same, with the wing (shaded) uppermost ; *J* and *K,* the same individual in two different positions (*J* a side-view) ; *L,* somewhat oblique view showing the wing ; *M,* another view showing the large paramylon-grain from the side ; *N,* end-view, probably slightly oblique. *b,* body ; *w,* wing.

individuals, which possess an almost longitudinally striated periplast, are composed of two parts which may be called the " body " and the " wing " respectively. The former is more or less oblong (Fig. 24, *H*), frequently appearing somewhat wedge-shaped in the " front-view " (*i.e.* the position in which the individual naturally rests) ; the extremities are more or less flattened, the posterior one being generally somewhat broader than the anterior. In cross-section the body (Fig. 24, *N*, *b*) would probably appear more or less elliptical or subhemispherical, a little thicker than it is broad, its outer face rounded, and the inner face from which the wing arises more flattened or even concave. The body appears to be quite straight and not twisted in any way.

The wing arises from the flattened or concave surface of the body and is distinctly broader than thick. In the " front-view " it forms, together with the body, the characteristic outline of the whole individual. On closer inspection, it appears as a definite outgrowth arising from the upper (Fig. 24, *I*) or under (Fig. 24, *H*) surface of the body, according to the position in which the individual is lying ; in the latter case the edge of the body is clearly seen running over the wing. In the majority of cases the wing is a little inclined (Fig. 24, *H–J*) ; it forms an acute angle with the body (about 75°), as seen in " end-view " (Fig. 24, *N*, *w*), whilst both in " front " and " side " (Fig. 24, *J*) views it usually appears oblique, and often very markedly so, to the long axis of the body. Only in rare cases are wing and body practically parallel (*cf.* Fig. 24, *L*). This obliquity of insertion of the wing, when pronounced, leads to the whole individual in front-view being much broader at the posterior than at the anterior end (*cf.* Fig. 24, *H*, *I*). When seen in side-view, the wing commonly appears a little curved, and its anterior extremity is pointed with a rounded apex, while the posterior one is broad, the whole outline being roughly that of a triangle with a short base (Fig. 24, *J*, *w*). Owing to the wing running obliquely and being attached near one margin of the body at the anterior end, an end-view at this extremity shows a protrusion of the body to one side (Fig. 24, *N*, but only partly shown here). The wing is not joined along its whole length to the body, its insertion commencing a little way behind the anterior and probably also a little way in front of the posterior end (*cf.* Fig. 24, *J* and *L*). As a result there is a notch between the two parts of the individual, scarcely visible in front-view and not seen in side-view, but often very pronounced when the individual lies a little askew (Fig. 24, *K*, *M*). At the posterior end of the cell there is a short, sharply curved spine. This appears to belong to the body, although in some cases it seems as though both body and wing enter into its formation (Fig. 24, *I*).

As a general rule the individuals, when seen in front-view, show two more or less rounded paramylon-grains, a larger one occupying the body and a smaller one the wing (Fig. 24); in a few cases both are of the same size. Not uncommonly the smaller paramylon-grain appears elongated in the front-view, with a very slight constriction in the middle. The larger grain occupying the body is, when seen in side-view, always observed to be thicker than its breadth, and very commonly it is markedly constricted in the middle, so that it is shaped like an hour-glass or cottage loaf (*cf.* Fig. 24, *M*). In certain oblique "front-views" this grain may appear double (Fig. 24, *H*, *K*), but we have not been able to satisfy ourselves that this appearance is ever due to anything else than the constriction of the single grain. In some cases the paramylon-grain in the wing is very small or even absent (Fig. 24, *L*); or it may be replaced by a number of small grains. Both grains frequently show a minute central hole.

Since the individuals are so constructed that it is impossible to get them to rest on end, it has not been possible to arrive at an exact estimate of the shape in optical section, but it is believed that the above description is fairly accurate. This curious form bears some general resemblance to species such as *P. caudata*, Hübner and *P. triqueter* (Ehrenb.), Duj., but their description is so inadequate that it is hardly possible to institute comparisons. In fact it may be doubted whether *P. anomala* will fit into the present diagnoses of the genus *Phacus*; the individuals are certainly not flat. We have preferred, however, in view of having only formalin material at our disposal, to refrain from establishing a new genus until further investigations have been carried out.

2. *Phacus longicauda* (Ehrenb.), Duj.; Lemmermann, *op. cit.*, p. 138, fig. 235.

Var. * *torta*, Lemmermann, Kryptogamenfl. d. Mark Brandenburg, Algen, i, 1910, p. 511.

Forma corpore solum supra spinam posteriorem leviter spiraliter torto, sed parte anteriore plus minus retroflexa aut torta. Long. cell. c. spin., 60–75 μ; lat., 31–41 μ (Fig. 25, *B–F*).

Samples 642, 643 (rare).

These specimens in no way show the pronounced twisting illustrated by Deflandre (Bull. Soc. Bot. d. France, 4 sér., xxiv, 1924, p. 1118, fig. 6) and others. As a general rule there is a slight twist at the top of the spine, where the flat body commences (Fig. 25, *B*, *D*, *F*). The latter is slightly concave and very thin in the majority of the individuals. This flat body is usually more or less folded upon itself (Fig. 25, *D*, *F*), or the right and left halves are curved to different sides (Fig. 25, *E*). The curvature or line of folding is, however, mostly not strictly longitudinal but somewhat oblique, so that there is a semblance of a twist. Occasional individuals were scarcely twisted or folded at all (*cf.* Fig. 25, *C*). Lemmermann's variety is based on a figure given by Stein (Organ. d. Infusionsthiere, iii, 1, t. xx, fig. 3), who states that the twisted cells are able slowly to straighten out again; this is denied by Lemmermann (*loc. cit.*). The specimens here recorded, however, lend support to Stein's statements.

The large central paramylon-grain was evident in most specimens. The

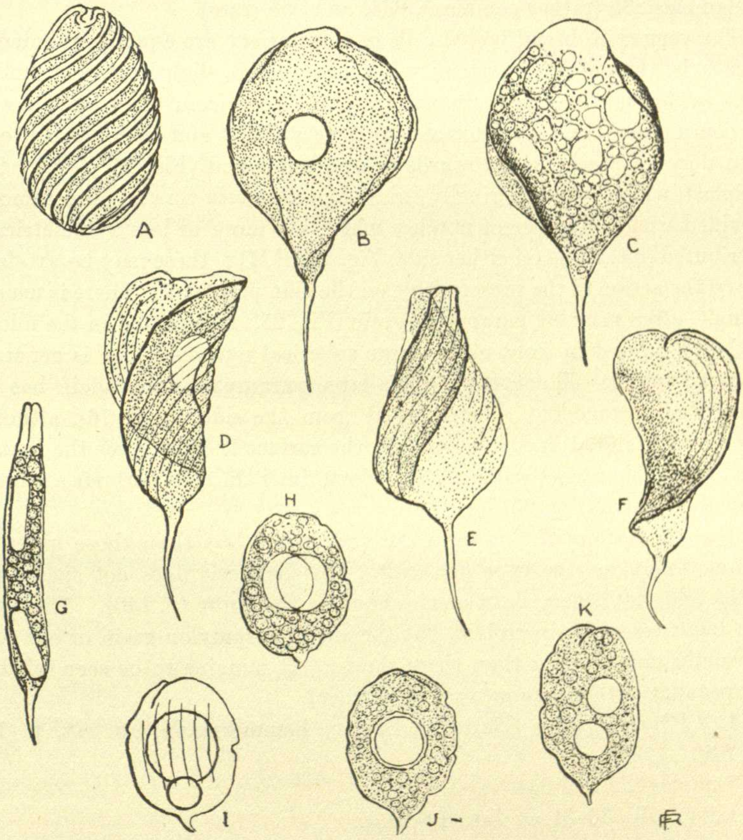


FIG. 25.—*A*, *Lepocinclis texta* (Duj.), Lemm., forma (× 750). *B–F*, *Phacus longicauda* (Ehrenb.), Duj. var. *torta*, Lemm., forma (× 750). *G*, *Euglena intermedia* (Klebs), Schmitz var. *brevis* nov. var. (× 960). *H–K*, *Phacus orbicularis*, Hübner var. *minor* nov. var. (× 750).

spine is quite straight or sometimes a little undulate or curved to one side (Fig. 25, *D*, *F*).

3. *Phacus orbicularis*, Hübner; Lemmermann, *op. cit.*, p. 138, fig. 256.

Var. * *minor* nov. var. (Fig. 25, *H–K*).

Cellulis late ovalibus, tenuissimis, e margine visis concavo-convexis, polis aequaliter rotundatis, fine posteriore cum spina parva cava leviter curvata vel interdum subrecta, plica dorsali exigua, periplasto tenui longitudinaliter striato, saepe incisuris paucis (artefactis ?) plus minus regulariter dispositis praedito, granulo "paramylon" plerumque singulo magno in medio corpore, interdum granulis numerosis parvis. Long. c. spin., 34–37 μ; lat., 22–26 μ.

Samples 833 (rather common), 844, and 853 (rare).

The very thin, broadly oval cells of this variety are equally rounded at both ends, the posterior extremity bearing a small, slightly curved, hollow spine, which is sometimes almost straight. Seen from the edge the cells are concavo-convex. The dorsal fold is very slight and is continued only for a very short distance towards the posterior end (Fig. 25, *I–K*). The periplast, which is longitudinally striated, is relatively thin and is commonly provided with a number of notches which are more or less symmetrically distributed (often one on either side, Fig. 25, *H*, *I*); these may be artefacts due to the action of the preservative on the thin periplast. There is usually a single, often very big paramylon-grain (Fig. 25, *H*) situated in the middle of the body, just in front of the large spherical nucleus which is generally obscured by the cell-contents. This large paramylon-grain again has the form of a cottage-loaf, when viewed from the side (*cf.* p. 76), although here very much flattened. Seen from the surface it often gives the impression of a double ring (Fig. 25, *H*, *J*). Sometimes the cells harbour a number of smaller grains (Fig. 25, *K*).

The dimensions of this form are very much less than those given by Lemmermann for the type (*loc. cit.*). His diagnosis does not speak of a dorsal fold, but a very short one is shown in the figure (p. 140). The latter also indicates a thin periplast, but the single paramylon-grain of our form is usually much bigger than there shown. It remains to be seen whether the peculiar notches are natural or artificial.

4. * *Phacus pyrum* (Ehrenb.), Stein; Lemmermann, *op. cit.*, p. 139, fig. 245.

Samples 825 and 844 (rare).

Long. cell., 30–31 μ; lat., 14–18 μ.

Genus Trachelomonas, Ehrenberg.

1. *Trachelomonas volvocina*, Ehrenb.; Lemmermann, *op. cit.*, p. 145, fig. 246.

Samples 642, 643, and 822 (in the latter rather common).

XI. MYXOPHYCEAE (CYANOPHYCEAE).

Group 1. CHROOCOCCALES.

(1) CHROOCOCCACEAE.

Genus Dactylococcopsis, Hansgirg.

1. * *Dactylococcopsis fascicularis*, Lemmermann, Kryptogamenfl. d. Mark Brandenburg, Algen, i, p. 50, and p. 44, fig. 4.

Sample 833 (very common).

2. * *Dactylococcopsis rhaphidioides*, Hansgirg, Prodr. d. Algenfl. v. Boehmen, ii, 1892, p. 139, fig. 49, *a*.

Samples 642 and 643 (rare).

Some of the cells were rather elongated and much contorted.

Genus Merismopedia, Meyen.

1. *Merismopedia glauca* (Ehrenb.), Naegeli, Einzell. Alg., 1849, p. 55, Tab. I, *D*, fig. 1; Lemmermann, Alg. Brandenburg, 1910, p. 85.

Samples 601, 603, 604, 717, 733, 737, 743, and 822 (mostly rare, but commoner in 717).

2. *Merismopedia tenuissima*, Lemmermann, *op. cit.*, p. 85.

Samples 614, 635, 734, 738, 844, and 868 (very common in the last, elsewhere rare).

Genus Gomphosphaeria, Kützing.

1. *Gomphosphaeria lacustris*, Chodat, Bull. Herb. Boissier, vi, 1898, p. 180.

Samples 603, 604, 726, 733–735, 736, and 740 (often not uncommon).

Genus Microcystis, Kützing.

1. * *Microcystis flos-aquae* (Wittr.), Kirchn.; Lemmermann, *op. cit.*, p. 75; Geitler, Suesswasserfl., xii, 1925, p. 60, figs. 41, 42.

Samples 668, 811, 813, 814, and 822 (except in last very common).

Diam. cell., 4–6 μ. Recorded from plankton of Lake Nyassa (Schmidle).

Genus Gloeocapsa, Kützing, emend. Naegeli.

1. * *Gloeocapsa aeruginosa* (Carm.), Kütz.; Lemmermann, *op. cit.*, p. 64; Geitler, *op. cit.*, p. 89, fig. 87.

Samples 607, 612, 752, and 754 (common in all).

The figure published by Bernard (Sur q. Alg. unicell. d'eau douce récoltées dans le domaine Malais, Depart. de l'Agric. aux Indes-Néerlandaises, 1909, Pl. I, fig. 5) does not belong to this species.

Genus Aphanocapsa, Naegeli.

Material of this species, that was inadequate for determination, was observed in samples 612, 635, and 872.

Genus Chroococcus, Naegeli.

1. *Chroococcus minutus* (Kütz.), Naegeli; Lemmermann, *op. cit.*, p. 54.

Sample 872 (abundant).

2. *Chroococcus turgidus* (Kütz.), Naegeli; Lemmermann, p. 53.

Samples 614, 618, 619, 622, 635, 682, 687, 822, and 868 (common only in 687).

Diam. cell., 13–18 μ.

Group 2. CHAMAESIPHONALES.

(1) PLEUROCAPSACEAE.

Genus Xenococcus, Thuret.

1. * *Xenococcus Kerneri,* Hansgirg, Prodr. d. Algenfl. v. Böhmen, ii, 1892, p. 128, fig. 41; Geitler, *op. cit.*, p. 135, fig. 170. (Fig. nostr. 26.)

Sample 705 (forming a dense stratum on *Spirogyra* sp., especially on the rhizoids).

The stratum was usually one-layered, although here and there several-layered, and was bounded towards the outside by a thin layer of ill-defined mucilage (Fig. 26, *A*), mainly rendered obvious by adhering foreign particles. The cells were a vivid blue-green with granular contents. In side-view they were always longer than broad, very commonly pyriform and narrowing towards the basal attachment, but sometimes oblong (Fig. 26, *B*). In surface-view they were of very diverse size and shape, circular, oblong or irregular. Small cells, originating by repeated division of the larger ones, were frequent, but no sporangia were present. The cell-walls were thin and no sheaths were apparent on the cells, nor were any filaments seen. The cells measured 6–12·5 μ long and 4–9 μ broad, being from $1\frac{1}{4}$ to $1\frac{1}{2}$ times as long as broad.

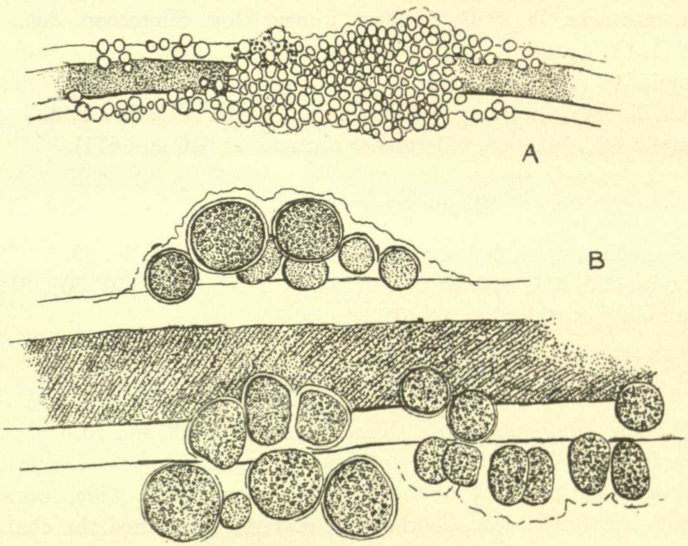


FIG. 26.—*Xenococcus Kerneri*, Hansg. *A*, general aspect; *B*, a small part enlarged. (*A* × 340; *B* × 800.)

Group 3. HORMOGONEALES.

(1) OSCILLATORIACEAE.*

Genus OSCILLATORIA, Vaucher.

1. *Oscillatoria amphibia*, Agardh; Gomont, Monogr. d. Oscillariées, Ann. Sci. nat., sér. 7, xvi, 1893, p. 221, Pl. VII, figs. 2, 3.

Sample 815 (rather common).

2. * *Oscillatoria chalybea*, Mertens; Geitler, *op. cit.*, p. 364, fig. 430; Gomont, p. 232, Pl. VII, fig. 19.

Sample 871 (common).

3. *Oscillatoria formosa*, Bory; Gomont, p. 230, Pl. VII, fig. 16.

Samples 671, 825, 828, and 860 (common).

4. *Oscillatoria princeps*, Vaucher; Gomont, p. 306, Pl. VI, fig. 9.

Samples 671 (very common) and 710.

5. *Oscillatoria sancta*, Kütz.; Gomont, p. 209, Pl. VI, fig. 12.

Samples 673 (very common), 671, and 733 (rare).

6. *Oscillatoria splendida*, Greville; Gomont, p. 224, Pl. VII, figs. 7, 8.

Sample 732 (common).

* An indeterminate member of this family was present in sample 862.

Var. *attenuata*, W. & G. S. West, Journ. Roy. Microscop. Soc., 1896, p. 165, Pl. IV, fig. 58.

Sample 706 (very common).

7. *Oscillatoria tenuis*, Ag. ; Gomont, p. 220, Pl. VII, figs. 2, 3.

Samples 631, 642–646, 671 (rather common in 646 and 671).

Genus Spirulina, Turpin.

1. *Spirulina major*, Kütz. ; Gomont, p. 251, Pl. VII, fig. 29.

Samples 600, 617, 624, 626, 627, 734, 737, 743, 748, 750, 807, 812, 815 (common only in 600, 617, and 812).

Genus Phormidium, Kütz.

1. * *Phormidium ambiguum*, Gomont, p. 178, Pl. V, fig. 10.

Sample 635 (only small pieces of stratum available).

Although the majority of the trichomes were 5–6 μ wide, occasional ones were up to 9 μ wide, so that the material combined the characters of the type and of Lemmermann's var. *major*. The septa were not granulated.

2. *Phormidium autumnale* (Ag.), Gomont, p. 187, Pl. V, figs. 23, 24. (Syn. : *P. uncinatum*, Gom.)

Samples 625, 652, 661, 672 (on surface of stratum of *P. corium*), 703 (on surface of stratum of *P. inundatum*), 806–808, 810, 812 (on surface of stratum of *P. molle*), 815, 818, 823, 825, 826, 828, 844, 854, 860, 872 (mostly common).

3. *Phormidium Corium* (Ag.), Gomont, p. 172, Pl. V, figs. 1, 2.

Samples 672 and 1355 (very common).

4. * *Phormidium incrustatum* (Naeg.), Gomont, p. 170, Pl. IV, fig. 27.

Sample 857 (common).

Since the material was fragmentary, the determination is a little doubtful.

5. *Phormidium inundatum*, Kütz. ; Gomont, p. 172, Pl. IV, figs. 31, 32.

Samples 703 (common, overgrown by *P. autumnale* or forming a stratum jointly with it) and 812 (rather common, with *P. autumnale*, on surface of stratum of *P. molle*).

6. *Phormidium molle* (Kütz.), Gomont, p. 163, Pl. IV, fig. 12.

Samples 607, 665, and 812 (common).

7. * *Phormidium papyraceum* (Ag.), Gomont, p. 173, Pl. V, figs. 3, 4.

Sample 666 (rather common, fragments only).

8. *Phormidium Retzii*, Gomont, p. 175, Pl. V, figs. 6–9.

Samples 662–664 (a tangled mass on rotten tree in Vaal River).

9. * *Phormidium subincrustatum* n. sp. (Fig. 27, *I–L*).

Stratum tomentosum, 2–3 mm. crassum, glaucum, calce induratum, filis subparallelis, non erectis; vaginae filorum tenues, mucosae, non lamellatae, saepe persistentes; trichomatibus 5–6, 5 μ latis, apicibus rotundatis vel subconicis, haud attenuatis vel capitatis, inter cellulas breves non constrictis, septis saepe indistinctis non granulatis, calyptra nulla.

Sample 623 (very common).

This differs from *P. incrustatum* (Naeg.), Gom. in the colour of the stratum, the more regular arrangement of the component filaments, and in the non-attenuation of the ends of the trichomes which have wider and shorter cells. The apices of the trichomes are blunter than those of *P. incrustatum* (Fig. 27, *I*, *L*).

10. *Phormidium tenue* (Menegh.), Gomont, p. 169, Pl. IV, figs. 23–25.

Samples 686, 815, and 1356 (very common).

11. *Phormidium valderianum*, Gomont, p. 167, Pl. IV, fig. 20.

Samples 807, 809, 810, 812, 872, and 1356 (very common).

Genus Lyngbya, C. Agardh.

1. *Lyngbya aerugineo-coerulea*, Gomont, p. 146, Pl. IV, figs. 1–3.

Samples 642, 643 (rare).

In some of the filaments the sheaths were more or less mucilaginous.

2. * *Lyngbya constricta* n. sp. (Fig. 27, *A–C*).

L. trichomatibus rectis vel leviter curvatis, interdum apicem versus paullo curvatis, inter cellulas non constrictis, cellulis longitudine ca. 4 plo latioribus, contentu coerulea vel aeruginea, granulata, septis haud granulatis, apicibus leviter attenuatis capitatis, cellula apicali obtuse rotundata, membrana externa interdum paullo incrassata; vaginibus hyalinis, non lamellatis, primo tenuissimis, demum incrassatis et constrictionibus angustis numerosis praeditis, ita ut vagina vacua filamentum mortuum *Oscillatoriae* similis est.

Diam. fil., 27–30 μ; diam. trich., 23–25, 5 μ; long. cell., 4–7 μ.

Samples 822 and 824 (commoner in the last).

This form is most markedly characterised by its sheaths. At first the latter are quite thin and structureless, but subsequently they become thickened in such a way that a number of narrow constrictions appear at more or less regular intervals, apparently corresponding to some or all of the septa of the contained trichome (Fig. 27, *B*); when such sheaths are found empty, they resemble a dead *Oscillatoria*-trichome. This structure appears to result from the deposition of somewhat irregular thickening on the outer surface of the original sheath, the thickening being absent at the points of constriction (Fig. 27, *C*), which consequently appear as double lines in surface-view (Fig. 27, *B*), but in optical section of the sheath are seen as narrow canals bounded by the thickening on either side. The sheaths are colourless and are not stained by chlor-zinc-iodide. Many of the trichomes were found free from their sheaths.

The trichomes show many points of resemblance to those of *L. aestuarii* (Mert.), Liebm., but here the older sheaths take on a yellow-brown colour

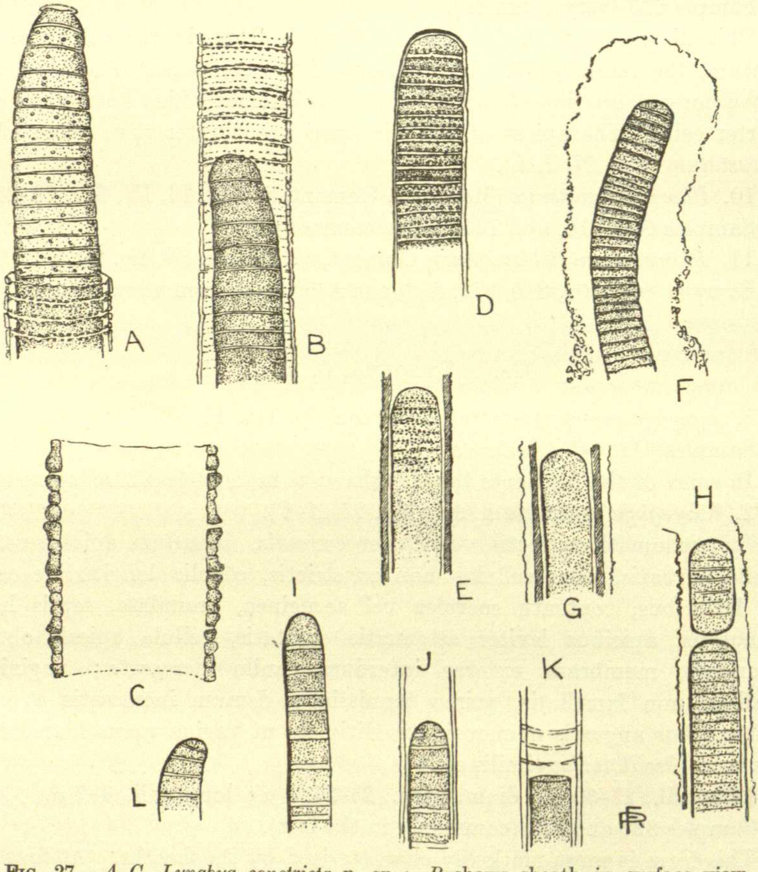


FIG. 27.—*A–C*, *Lyngbya constricta* n. sp.; *B* shows sheath in surface view, *C* shows it in optical section slightly magnified. *D–H*, *L. subaestuarii* n. sp.; *E*, *G*, *F* show progressive stages in the development of the sheath. *I–L*, *Phormidium subincrustatum* n. sp. (*A*, *B* × 480; *D–H* × 400; *I–L* × 1200.)

and do not show the distinctive structure above described. The species may also be compared with *L. Lindavii*, Lemmermann (Forschungsber. Plön, xii, 1905, p. 147, Tab. IV, figs. 10, 11).

3. * *Lyngbya nigra*, Ag.; Gomont, p. 145, Pl. III, fig. 16.

Sample 635 (rather rare, among *Phormidium autumnale*).

4. * *Lyngbya subaestuarii* n. sp. (Fig. 27, *D–H*).

L. filamentis saepe longissimis, rectis vel plus minus curvatis; trichomatibus inter cellulas levissime constrictis, cellulis brevissimis, contentu non granulata, sed septis plerumque lineis geminis granulorum praeditis, apicibus obtuse rotundatis, non attenuatis vel capitatis, membrana externa cellulae apicalis paullo incrassata; vaginis hyalinis, non lamellatis, saepe cum particulis calcis, primo firmis compactis, postea diffluentibus et mucosis; ad ultimum in parte interiore vaginae novum stratum firmum evolvit (?).

Lat. trich., 11–27 μ; lat. fil. c. vag. firm., 15–30 μ; lat. fil. c. vag. mucos., 34–51 μ.

Sample 682 (rather common).

It is not possible to say whether this species forms a stratum or is free-floating. The most distinctive feature is again the sheath, which is always colourless and non-stratified. It would seem that the trichomes are at first provided with a firm compact sheath (Fig. 27, *E*), whose outer margin gradually becomes diffluent (Fig. 27, *G*) until the whole sheath consists of a wide mass of mucilage with an irregular edge (Fig. 27, *F*). Within the latter it appears that another firm sheath can develop. The sheaths are often densely encrusted with particles of carbonate of lime. The trichomes commonly contain highly refractive biconvex cells, some of which are almost flat.

This species differs from *L. aestuarii* (Mert.), Liebm. in the possession of colourless and non-stratified sheaths, and in the absence of any attenuation of the apices of the trichomes.

Genus Microcoleus, Desmazières.

1. *Microcoleus chthonoplastes*, Thuret; Gomont, *op. cit.*, xv, 1893, p. 353, Pl. XIV, figs. 5–8.

Sample 601 (very rare).

This species is usually found in salt-water. W. & G. S. West have recorded from marshy ground near Huilla in Africa a species named *M. sociatus* (*cf.* Journ. of Bot., 1897, p. 272) which stands very close to *M. chthonoplastes*, Thur. (*cf.* Borge, Algenfl. d. Tåkernsees, Stockholm, 1921, p. 10). Our material, which was very scanty, differed from West's form in dimensions and in containing a rather large number of trichomes within the sheath. Diam. fil., 18–27 μ; diam. trich., 3 μ.

Genus Schizothrix, Kütz.

1. * *Schizothrix lardacea*, Gomont, p. 311, Pl. VIII, figs. 8, 9.

Sample 752.

2. * *Schizothrix lateritia* (Kütz.), Gomont, p. 308, Pl. VIII, figs. 4, 5.

Sample 868.

3. * *Schizothrix Lenormandiana*, Gomont, p. 312, Pl. VIII, fig. 10.

Sample 612 (very common, forming a dense stratum, overgrown by *Gloeocapsa aeruginosa*).

The trichomes (1, 5–2 μ broad) had more or less quadrate cells (sometimes shorter than long) and were often prominently constricted between the cells. The filaments were practically unbranched.

4. * *Schizothrix penicillata* (Kütz.), Gomont, p. 305, Pl. VII, figs. 8–10.

Sample 673 (very common, overgrown in part by *Oscillatoria sancta*).

The habitat is unusual, but the material was probably exposed to the drip from the watering-pipe. A small amount of carbonate of lime was deposited in and about the mucilage. The broad sheaths were in places very distinctly transversely plicated.

(2) NOSTOCACEAE.

Genus Nostoc, Vaucher.

1. *Nostoc commune*, Vaucher ; Geitler, *op. cit.*, p. 301, fig. 350.

Samples 667 and 803 (very common).

Diam. cell. veg., 3, 2–4 μ (six in 20 μ) ; diam. heterocyst., 6–7 μ ; diam. spor. (?), 4–4, 2 μ (five in 20 μ).

The label of sample 667 states with reference to the occurrence of this species : " On bare open veldt at Alexandersfontein, Kimberley ; found best after light rains, near small scrub bushes, unattached to any object ; dark green, gelatinous when wet, a thin crisp brittle skin when dry." Hodgetts records it from a similar habitat near Stellenbosch (*loc. cit.*, p. 96).

The material in sample 803 was exceptional in the fact that the foliaceous masses were not provided with a very firm integument. At the same time the bulk of the trichomes were in a peculiar condition, possibly the result of drought. The cells occurred in long chains and were in general slightly smaller than the heterocysts. They possessed well-defined, firm, colourless walls, and the contents included a well-marked circular vacuole, generally confined to one end of the cell (Fig. 28, *C–E*). The cells were nearly always quite spherical. Apart from their contents, they show much resemblance to the spores described by Geitler (Österr. Bot. Zeitschr., 1921, p. 165) for this species. These differ considerably from those described and figured by Bristol (Ann. Bot., xxxiv, 1920, p. 52), and it seems possible that the species observed by her was not *N. commune*. The structures here described as doubtful spores were never larger than the heterocysts (Fig. 28, *E*).

2. * *Nostoc piscinale*, Kütz. ; Geitler, *op. cit.*, p. 298.

Sample 659.

(NOTE.—Indeterminate material of *Nostoc* was also observed in samples 600 and 682.)

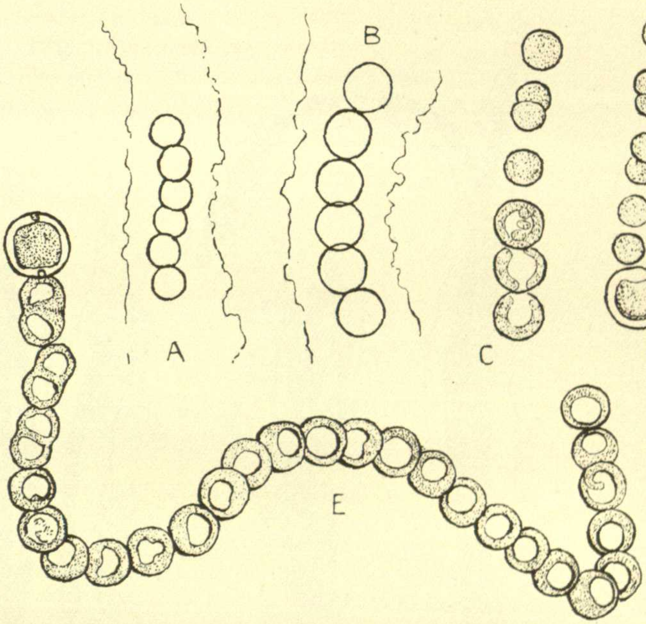


FIG. 28.—*Nostoc commune*, Vauch., forma. *C* and *E* show the doubtful spores. (× 1400.)

Genus ANABAENA, Bory.

1. * *Anabaena vaginicola* n. sp. (Fig. 29, *A–D*).

A. fragmenta vegetabilia affixa, trichomatibus pluribus, raro singulis, intra vaginam communem, subparallelis ; cellulis elongato-cylindricis vel subquadratis, raro deplanatis et longitudine latioribus, cellula apicali conica acuminata ; heterocystis cylindricis, vix latioribus quam cellulis vegetativis ; sporis oblongis vel breviter cylindricis, heterocystis semper contiguis, saepe 4–5 in series irregulares et interdum plus minus oblique etiam fere transverse dispositis, membrana hyalina.

Diam. cell. veg., 4–4, 5 μ ; diam. heterocyst., 4–5 μ, long., 6–10 μ ; diam. vag. cum trichom. singula, 11, 5 μ ; diam. vag. cum trichom. plur., 17–21 μ ; diam. spor., 6, 5–10 μ ; long. spor., 12–17, 5 μ.

Sample 601 (not uncommon).

This species comes nearest to *A. cylindrica*, Lemm., but it is essentially distinguished from it by the usual occurrence of a number of trichomes within a common sheath (Fig. 29), and by the oblong shape of the spores which are produced often, in irregular chains, adjacent to the heterocysts. The spores are often not placed in the long axis of the trichome, lying

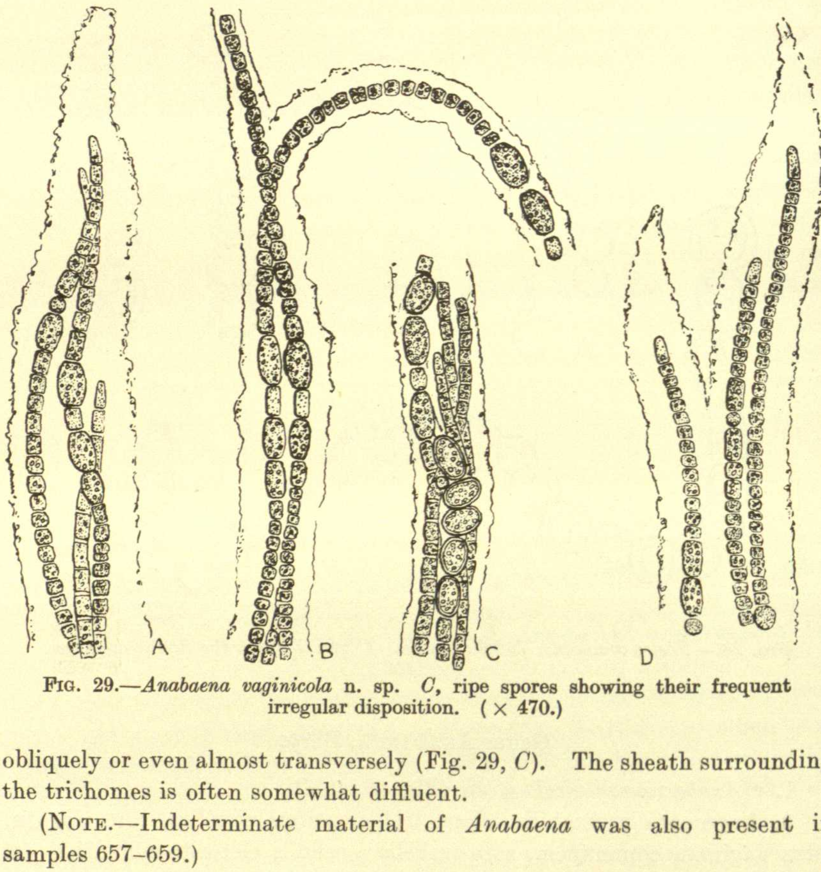


FIG. 29.—*Anabaena vaginicola* n. sp. *C*, ripe spores showing their frequent irregular disposition. (× 470.)

obliquely or even almost transversely (Fig. 29, *C*). The sheath surrounding the trichomes is often somewhat diffluent.

(NOTE.—Indeterminate material of *Anabaena* was also present in samples 657–659.)

Genus NODULARIA, Mertens.

1. * *Nodularia spumigena*, Mertens ; Geitler, *op. cit.*, p. 289.

Samples 600, 617, 624–628, 630, 818, 833 (in most cases abundant).

Var. * *vacuolata* n. var. (Fig. 30, *H*, *I*).

Differt a typo vagina nulla, cellulis cum pseudo-vacuolis, heterocystis vix latioribus quam cellulis vegetativis ; sporis quam in typo. Diam. trich., 9–11 μ ; diam. heterocyst., 11–12 μ ; diam. spor., 13 μ, long., 8, 5–10 μ.

Samples 807, 811, 813–816, 818 (often common).

The most striking feature of this variety is the occurrence of pseudo-vacuoles in the vegetative cells. They are also to be found in the young heterocysts, but are absent from the spores. The latter were always produced singly (Fig. 30, *H*, *I*).

2. * *Nodularia tenuis*, G. S. West, Journ. Linn. Soc., Bot., xxxviii, 1907, p. 171. (Fig. nostr. 30, *A–G*.)

Samples 601 and 737 (common in the last).

This species would perhaps be better regarded as an *Anabaena* ; it does, in fact, stand very close to *A. oscillarioides*, Bory var. *tenuis*, Lemm. In

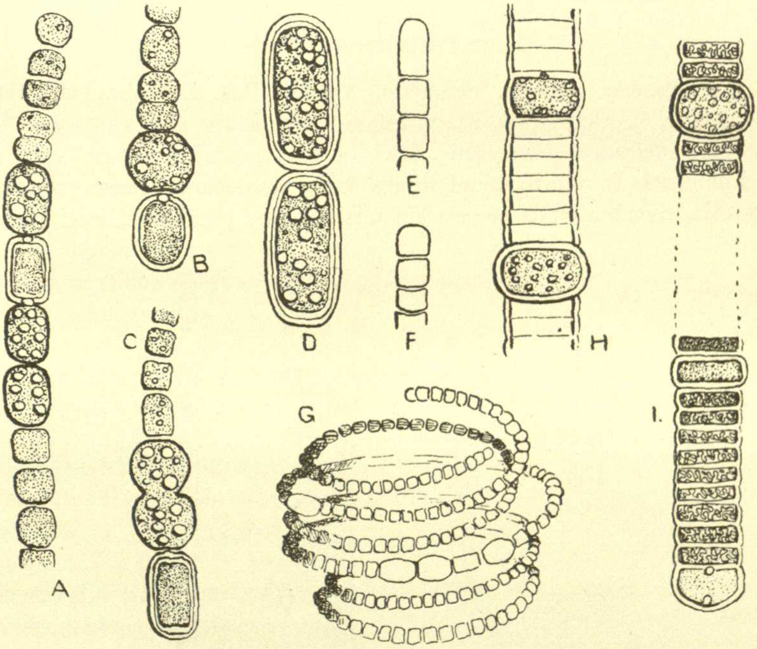


FIG. 30.—*A–G*, *Nodularia tenuis*, G. S. West. *A* and *B*, filaments with young spores ; *D*, mature spores ; *E* and *F*, apices of two trichomes ; *G*, spirally coiled trichome. *H*, *I*, *N. spumigena*, Mertens var. *vacuolata* n. var. (*A–F* × 1400 ; *G* × 550 ; *H*, *I* × 1000.)

our material the threads were by no means always straight, many were somewhat curved and a few even spirally coiled (Fig. 30, *G*). They usually formed a stratum in which the sheaths of the individual filaments were more or less confluent and consequently indistinct. In other respects the specimens agreed with those described by G. S. West from Lake Tanganyika, except that occasional cells were barrel-shaped and quite twice as long as broad. The heterocysts were often almost exactly cylindrical (Fig. 30, *A*). The mature spores are 12–18 μ long and 8–10 μ wide ; they have a firm membrane and abundant granular contents (Fig. 30, *D*). Those described by G. S. West from Columbia (Mem. Soc. neuchâteloise d. Sci. nat., v, 1914, p. 1017, Pl. XXI, figs. 4, 5) were probably not quite mature. Some of the threads in sample 601 had almost rounded heterocysts like those of typical *Anabaena oscillarioides*. It may be noted that of var. *tenuis* of this species, Playfair has described a forma *circinalis*. Further observations must show whether *Nodularia tenuis* can be retained as a separate species.

(3) SCYTONEMATACEAE.

Genus Plectonema, Thuret.

1. *Plectonema notatum*, Schmidle, Allgem. Bot. Zeitschr., vii, 1901, p. 4, figs. 8, 9; Geitler, *op. cit.*, p. 249.

Var. * *africanum* n. var. (Fig. 31).

Filamentis in strato tenui dilute viridi aggregatis, dense intricatis, flexuosis, pseudoramulis sparsis singulis vel raro geminatis, vaginis plus

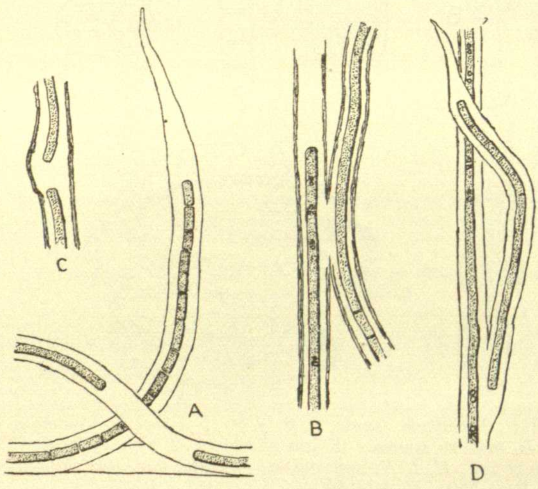


Fig. 31.—*Plectonema notatum*, Schmidle var. *africanum* n. var. (× 1000.)

minus mucosis; cellula apicali trichomatis obtuse rotundata; vaginis saepe ultra trichomata productis, apice acuminato. Diam. fil., 4–5 μ; diam. trich., 1, 5–2 μ.

Sample 822 (very common).

This differs from Schmidle's form in the production of a dense stratum, in the rather wide mucous sheaths, and in their frequent protrusion beyond the trichomes (Fig. 31, *A* and *D*). The cells were usually twice as long as broad, but shorter ones were also encountered. One or two granules were evident adjacent to the septa in some trichomes, but by no means in all.

Compare also with a form described by Borge (Bot. Notiser, 1913, p. 102, Tab. III, fig. 46).

(4) RIVULARIACEAE.

Genus CALOTHRIX, Agardh.

1. * *Calothrix parietina* (Naeg.), Thur.; Geitler, *op. cit.*, p. 226, fig. 272.
Sample 668 (rather common, fragments of strata only).
A variety of this species has been recorded from Natal.

Raphidiopsis nov. gen.

Trichomatibus brevibus, plus minus curvatis, vagina nulla; trichomatibus apices versus acuminatis vel altero apice acuminato altero rotundato, apicibus acuminatis in setam brevem productis; cellulis cum pseudovacuolis; sporis singulis vel binis in media parte filamenti, doliformibus.

1. * *Raphidiopsis curvata* n. sp. (Fig. 32).

Trichomatibus libere natantibus, singulis vel rarius in fasciculis parvis, curvatis vel sigmoideis vel circularibus, raro fere rectis, inter cellulas haud constrictis; cellulis $1\frac{1}{2}$–2 plo longioribus quam latis, saepe cum pseudovacuolis multis; sporis doliformibus, lateribus leviter convexis, polis obtusis, cum granulis magnis sparsis. Diam. cell., 4, 5 μ; diam. spor., 5 μ, long., 10–13, 5 μ.

Samples 825 and 844 (common).

In habit the threads of this striking free-floating form recall Lagerheim's *Raphidonema*. The majority of the threads are quite short and composed of about a dozen cells, but occasional longer ones are found (Fig. 32, *B*). As a general rule they occur isolated, although now and again met with in small bundles, looking like those of an *Ankistrodesmus*. Typically both ends of the trichome terminate in a point (Fig. 32, *A–C*). The frequent occurrence of threads with one end rounded and the other acuminate (Fig. 32, *D–F*) is probably due to the threads of the usual type breaking across their middle in the course of vegetative reproduction. The trichomes generally commence to taper only a little way before the end, sometimes not until the last cell is reached, sometimes already in the third cell from the end. The apex terminates in a sharp point which is solid and seems to be mucilaginous (Fig. 32, *A*, *B*, *C*), and is sometimes curved a little to one side; there are never any hair-cells. Occasionally the apex is prolonged for a little way as a solid gelatinous bristle (Fig. 32, *D–F*). The threads are rarely straight; they are often curved into a semicircle (Fig. 32, *C*, *E*, *F*), are sometimes sigmoid (Fig. 32, *B*), and occasionally wound into a circular form (Fig. 32, *A*, *D*).

The cells are usually densely filled with pseudovacuoles of irregular shape, although occasional threads are altogether without them. They are often wanting in some of the cells of threads, which contain them (Fig. 32, *E*, *G*). The septa are difficult to decipher when the pseudovacuoles are present.

The spores are formed in the middle of the trichomes, and occur singly

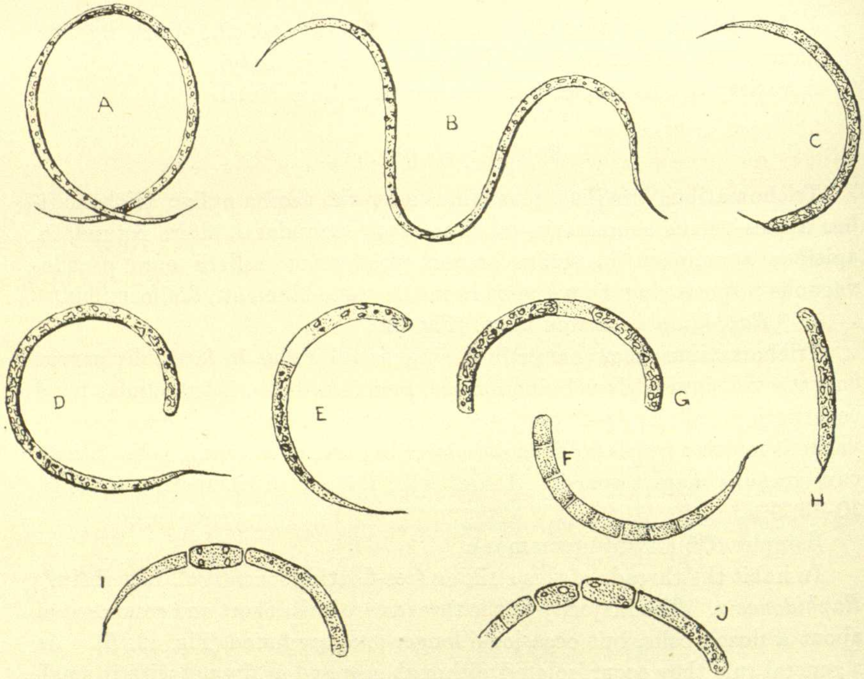


FIG. 32.—*Raphidiopsis curvata* nov. gen. et spec. *I* and *J* show spores. ($\times$ 600.)

or in pairs (Fig. 32, *I*, *J*). They contain a few very conspicuous granules of a large size.

It is not altogether easy to determine the systematic position of this form, but owing to the tapering of the ends of the trichomes and the presence of spores the Rivulariaceae seem to constitute the nearest affinity. The trichomes are, however, altogether devoid of a sheath, and the acuminate apex is solid, not composed of a series of hair-cells. There is some resemblance to Sauvageau's *Tapinothrix,* which lacks heterocysts and is unbranched, but appears to have a sheath.

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