

# NEW ZYGNEMATACEAE COLLECTED IN CHINA<sup>1</sup>

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IN THE course of the writer's study of the freshwater algae collected for or by him in China, a great number of undescribed forms have been observed in the collections, of which the following belong to the Zygnemataceae. These new species were collected in various localities in China, mostly by his sisters, the Misses Chun Jao and Tu Jao, from the vicinities of Chungking and Kiangpei, Szechwan, West China, 1930 to 1933, and several species by Mr. C. Huang, from Poatin, Hopei, North China, 1928; by Messrs. Y. Y. Pei and T. C. Yu, from West Lake, Hangchow, Chekiang, East China, 1928; and by the writer, from Peiping, 1927.<sup>2</sup>

This study was made while the author was Fellow of the China Foundation for the Promotion of Education and Culture. He wishes to express his deep appreciation to Professors W. R. Taylor and H. H. Bartlett for their direction and assistance in the preparation of this paper. He also wishes to thank Professor E. N. Transeau for his valuable suggestions, and his friends and sisters for their help in collecting samples.

## *Spirogyra Transeuiana*, sp. nov. (fig. 1)

Filamenta caespites flavo-virides formata; cellulis vegetativis 42-58 (-61)  $\mu$  latis, 160-304  $\mu$  longis; dissepimentis replicatis; chromatophoris 2 vel 3, pyrenoideis magnis, anfractibus 2-5; conjugatione scalari; cellulis fructiferis cylindricis vel ad conjugationis tubi laterem paululum inflatis; zygosporis ellipsoideis, apice rotundatis, 41-58  $\mu$  latis, 96-183  $\mu$  longis, maturitate flavescens, membrana laevi circumdata.

Filaments forming yellowish-green masses; vegetative cells 42-58 (-61)  $\mu$  in diam., 160-304  $\mu$  long, with replicate end walls; chromatophores 2-3, with large pyrenoids, making 2-5 turns in the cell; conjugation scalariform; fertile cell cylindrical or slightly enlarged by the zygospore on the conjugating side; zygosporis ellipsoid, with rounded ends, 41-58  $\mu$  diam., 96-183  $\mu$  long, spore wall smooth, median layer yellow at maturity.

This species shows some characteristics of *Spirogyra proavita* Langer, *S. aequalis* Harvey, and *S. Hassalli* (Jenner) Petit. It differs from them chiefly in having all cells larger and in the scalariform conjugation.

This species was mixed with *Spirogyra Chuniae* Jao and a few other filamentous algae. Collected in a rice farm near Chungking, Jan., 1933. Types in C. C. Jao collections and Herb. Univ. Mich., No. S461: S1 and S2.

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<sup>2</sup> Figures 9, 12, 17, 21, 24, 26, 28, 31, 35, and 37 were made with the camera lucida at a magnification of 770 diameters, the others at 240 diameters. The markings of the zygosporis were generally drawn in detail for only one spore, or even only a small portion of one. Reduced by one-half in reproduction.

## *Spirogyra Chuniae*, sp. nov. (fig. 2, 3)

Cellulis vegetativis 28-39  $\mu$  latis, 67-130  $\mu$  longis, dissepimentis replicatis; chromatophoris singulis, interdum binis, margine undulatis, pyrenoideis grandibus; anfractibus 2-2.5; cellulis fructiferis inflatis, ad 80  $\mu$  latis; conjugatione scalari, tubo conjugationis summe brevi et interdum solum ex cellula mascula emissio; zygosporis ellipsoideis, apice acuminatis, 35-43  $\mu$  latis, (70-) 73-119  $\mu$  longis, membrana laevi, maturitate flavescens.

Vegetative cells 28-39  $\mu$  diam., 67-130  $\mu$  long, with replicate end walls; chromatophore one, sometimes two, with undulate margins and containing large pyrenoids, making 2-2.5 turns in the cell; fertile cells inflated, reaching a diameter of 80  $\mu$ ; conjugation scalariform, tube very short, sometimes formed only by the male gametangium; zygosporis ellipsoid, with pointed ends, 35-43  $\mu$  diam., (70-) 73-119  $\mu$  long, wall smooth, turning yellow at maturity.

In some respects this species resembles *Spirogyra Grevilleana* (Hassall) Kützing, but differs in the form of the zygosporis and in the larger dimensions of all cells, except the vegetative cells which are shorter.

This species, named in honor of Miss Chun Jao, the collector of this and many other new or interesting specimens, occurs scatteringly in the collection of *S. Transeuiana* Jao.

Collected in a rice farm near Chungking, Jan., 1933. Type in C. C. Jao collections and Herb. Univ. Mich., No. S461.

## *Spirogyra biformis*, sp. nov. (fig. 4, 5)

Caespites saturate virides formans; cellulis vegetativis 38-48  $\mu$  latis, 64-150 (-190)  $\mu$  longis; dissepimentis planis; chromatophoris 2-3, pyrenoideis grandibus; anfractibus 1.5-4.5 cellulis sterilibus interdum inflatis, latitudine usque ad 58  $\mu$ ; cellulis fructiferis cylindricis vel interdum paululum inflatis, aut abbreviatis, aut non abbreviatis; conjugatione plerumque laterali raro scalari; zygosporis, si in gametangiis longioribus formatis, ellipsoideis et apice rotundatis, si in gametangiis abbreviatis, subglobosis, 38-51  $\mu$  latis, 64-83  $\mu$  longis; membrana laevi, mesosporio maturitate flavescens.

Forming dark green masses; vegetative cells 38-48  $\mu$  diam., 64-150 (-190)  $\mu$  long, with plane end walls; chromatophores 2-3, containing large pyrenoids, making 1.5-4.5 turns in the cell; sterile cells sometimes swollen to 58  $\mu$  in diameter; fertile cells cylindrical or sometimes slightly enlarged, shortened or not; conjugation usually lateral, rarely scalariform; zygosporis ellipsoid and with rounded ends in longer gametangia or subglobose in the shorter ones, 38-51  $\mu$  diam., 64-83  $\mu$  long; spore wall smooth, median layer becoming yellow at maturity.

This species is nearest to *Spirogyra rivularis* (Hassall) Rabenh., but differs from it in the broader and shorter vegetative cells, the sterile cells sometimes swollen, and the zygosporis not oval-elliptical in form.

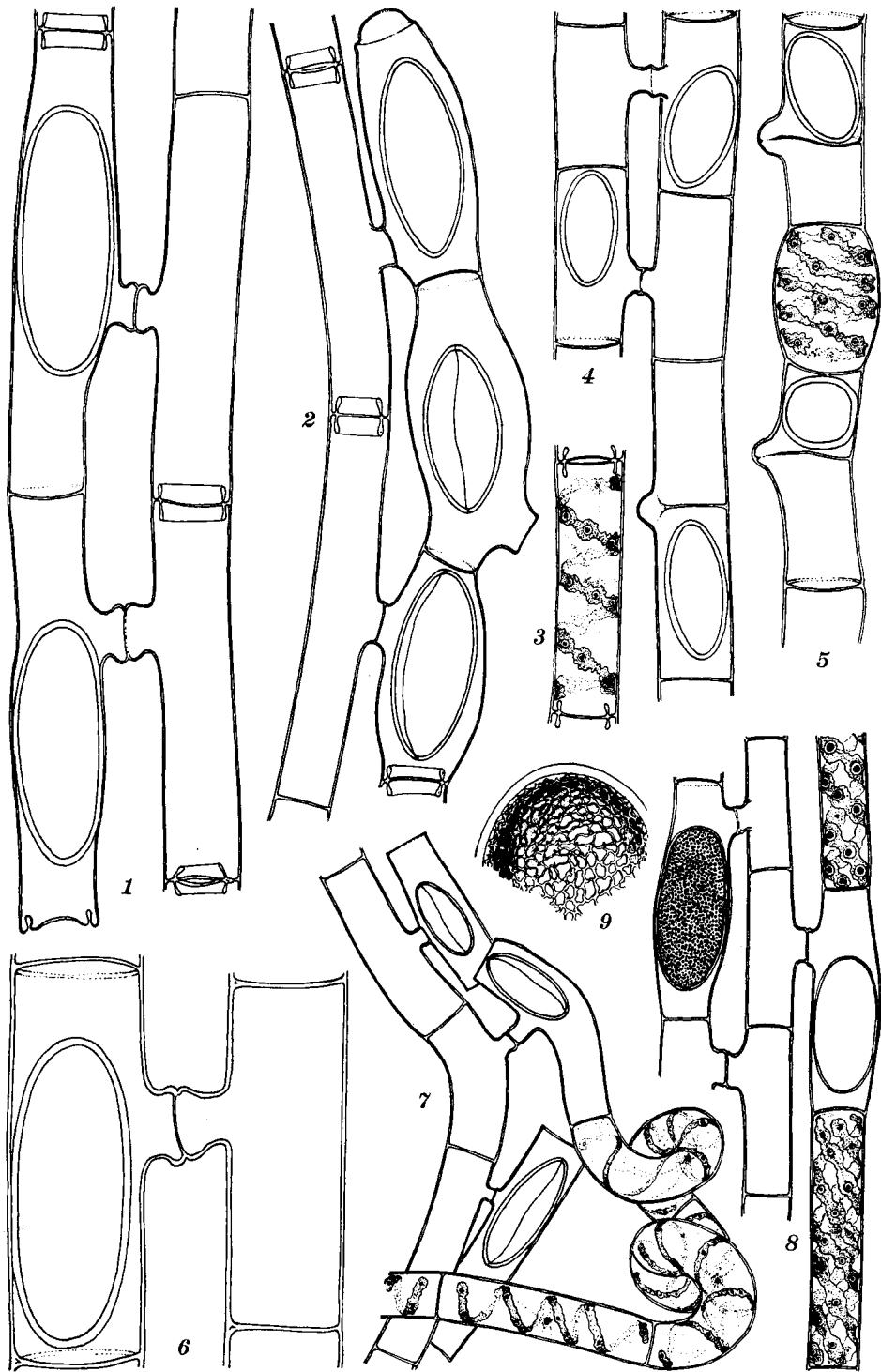


Fig. 1-9.—Fig. 1. *Spirogyra Transeauiana*, sp. nov.—Fig. 2, 3. *Spirogyra Chuniae*, sp. nov.—Fig. 4, 5. *Spirogyra bififormis*, sp. nov.—Fig. 6. *Spirogyra zechwanensis*, sp. nov.—Fig. 7. *Spirogyra intorta*, sp. nov.—Fig. 8, 9. *Spirogyra subcylindrospora*, sp. nov.

Collected in rice farms near Chungking, July, 1930. Materials abundant and pure. Types in C. C. Jao collections and Herb. Univ. Mich., No. S260, S262, and S272.

***Spirogyra szechwanensis*, sp. nov. (fig. 6)**

Cellulis vegetativis 75–90  $\mu$  latis, 125–240  $\mu$  longis, dissepimentis planis; chromatophoris 4, raro 2 vel 3, gracilibus, anfractibus 1–2; cellulis fructiferis cylindricis; conjugatione scalari; zygosporis cylindrico-ellipsoideis plus minusve rotundatis, rarissime subglobosis, 57–68  $\mu$  latis, 100–210  $\mu$  longis, membrana laevi, maturitate flavescens.

Vegetative cells 75–90  $\mu$  diam., 125–240  $\mu$  long, with plane end walls; chromatophores 4, rarely 2 or 3, slender, making 1–2 turns in the cell; fertile cells cylindrical; conjugation scalariform; zygosporis cylindrical-ellipsoid, very rarely subglobose, with more or less rounded ends, 57–68  $\mu$  diam., 100–210  $\mu$  long, spore wall smooth, yellowish at maturity.

This new form is characterized by its smaller vegetative cells not contracted at the ends and zygosporis having a smaller diameter, greater length, cylindrical-ellipsoid form, and yellow color, characteristics which distinguish it from the related species *S. jugalis* (Dillwyn) Kützing.

Collected in a rice farm near Chungking, 1930. Filaments scattered. Types in C. C. Jao collections and Herb. Mich. Univ., No. S270: B.

***Spirogyra intorta*, sp. nov. (fig. 7)**

Filamentis laete viridibus, saepe curvatis vel spiralibus; cellulis vegetativis 25–29  $\mu$  latis, 60–183  $\mu$  longis, dissepimentis planis; chromatophoris singulis, flexilibus et gracilibus, margine subtiliter dentatis, pyrenoideis minutis, anfractibus 3.5–6; conjugatione scalari vel laterali (?); cellulis fructiferis cylindricis, interdum paululum inflatis; zygosporis ellipsoideis, apice acuminatis, 22–29  $\mu$  latis, 41–68  $\mu$  longis, membrana laevi, mesoporio maturitate flavescens.

Filaments bright green, generally curved or spiral; vegetative cells 25–29  $\mu$  diam., 60–183  $\mu$  long, with plane end walls; chromatophore one, loose and slender, containing small pyrenoids, margins finely toothed, making 3.5–6 turns in the cell; conjugation scalariform or lateral (?); fertile cells cylindrical, sometimes slightly swollen; zygosporis ellipsoid, with pointed ends, 22–29  $\mu$  diam., 41–68  $\mu$  long, spore wall smooth, median layer yellow at maturity.

This species is nearest to *S. Juergensii* Kützing, but distinguished from it in having constantly curved to spiral filaments, fertile cells not enlarged toward the middle, and smaller zygosporis. It also bears some resemblance to *S. communis* (Hassall) Kützing, but is chiefly distinguished by its curved to spiral habit and larger dimensions.

Collected in rice farms at Shao-Chia-Wan, about seven miles to the westward from Chungking City. Filaments abundantly scattered among *Hydrodictyon reticulatum* (L.) Lagerheim, *Oedogonium Kurzii* Zeller, *Oe. crassum* (Hassall) Wittrock, *Oe. spiralidens* Jao, *Oe. brevicingulatum* Jao, and others. Types in C. C. Jao collections and Herb. Univ. Mich., No. S497 and S504.

***Spirogyra subcylindrospora*, sp. nov. (fig. 8, 9)**

Cellulis vegetativis 25–32  $\mu$  latis, 98–228  $\mu$  longis, dissepimentis planis; chromatophoris 2–3, raro 4, latis, margine irregulariter undulatis, pyrenoideis grandiusculis, anfractibus 1–5.5; conjugatione scalari; cellulis fructiferis cylindricis vel a zygospora paululum inflatis; zygosporis ellipsoideis vel cylindrico-ellipsoideis, apice rotundatis, 32–39  $\mu$  latis, 57–96  $\mu$  longis; mesoporio reticulato, maturitate fusciscenti.

Vegetative cells 25–32  $\mu$  diam., 98–228  $\mu$  long, with plane end walls; chromatophores 2–3, rarely 4, broad, with irregularly undulate margins and containing large pyrenoids, making 1–5.5 turns in the cell; conjugation scalariform; fertile cells cylindrical or slightly enlarged by the zygosporis; zygosporis ellipsoid or cylindrical-ellipsoid, with rounded ends, 32–39  $\mu$  diam., 57–96  $\mu$  long, median wall reticulate, yellowish brown at maturity.

Perhaps this new species is related to *S. Schmidtii* W. & G. S. West, but it is clearly distinguished by its smaller dimensions, by the fertile cells being sometimes only a little enlarged, and by the reticulate zygosporis.

Collected in rice farms near Chungking, Aug., 1930, in company with some other species of Zygnemataceae, *Oedogonium*, and blue-green algae. Types in C. C. Jao collections and Herb. Univ. Mich., No. S259 and S265.

***Spirogyra rhizopus*, sp. nov. (fig. 10–12)**

Cellulis vegetativis 25–32  $\mu$  latis, 80–250  $\mu$  longis, dissepimentis planis; chromatophoris 2, pyrenoideis grandibus, anfractibus 1.5–4; cellula basali retinaculo multum expanso et irregulariter lobato ad substratum affixa; conjugatione scalari; cellulis fructiferis quadrangulariter inflatis, interdum oblongis, latitudine usque ad 58  $\mu$ ; zygosporis ellipsoideis, apice rotundatis, 35–42  $\mu$  latis, 64–100  $\mu$  longis, membrana triplici: episporio crasso, evidenter lamelloso (lamellis 3–5), et hyalino, mesoporio irregulariter reticulato et maturitate bruno, endosporio tenui et subindistincto. Filamentorum partes fructiferae et basales saepe membranis crassiusculis lamellosisque praecipue ad cellularum extremitates praeditae.

Vegetative cells 25–32  $\mu$  diam., 80–250  $\mu$  long, with plane end walls; chromatophores 2, containing large pyrenoids, making 1.5–4 turns in the cell; basal cell with much expanded and irregularly lobed holdfast; conjugation scalariform; fertile cells quadrangularly inflated, sometimes oblong in form, reaching a diameter of 58  $\mu$ ; zygosporis ellipsoid, with well rounded ends, 35–42  $\mu$  diam., 64–100  $\mu$  long, spore wall of three layers: the outer layer thick, distinctly lamellose (from 3–5 layers), and colorless; the median layer irregularly reticulate, brown at maturity; the inner layer thin and not very distinct. The fruiting and basal portions of the filament are often characterized by thickened and lamellose cell walls, especially at both ends of the cells.

In some respects this species resembles *S. Schmidtii* W. & G. S. West, but differs in the smaller dimensions, especially in the size of the zygosporis and the length of the vegetative cells, in the number of chromatophores (two), in the quadrangularly inflated female gametangia, in the well developed holdfast, in

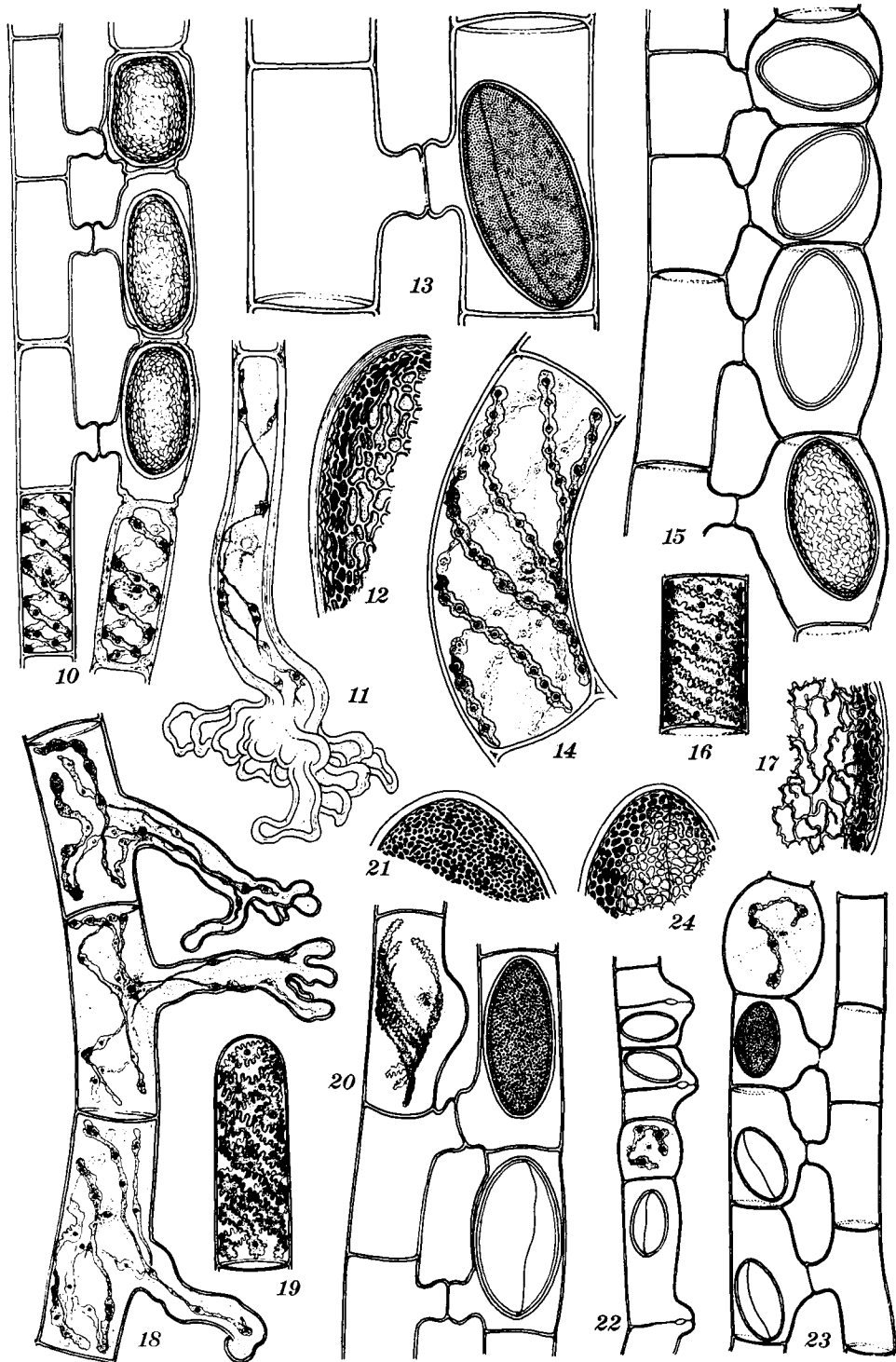


Fig. 10-24. — Fig. 10-12. *Spirogyra rhizopus*, sp. nov. Fig. 10. Quadrangularly inflated female gametangia containing irregularly reticulated zygospores, and one vegetative cell with the thick and lamellose wall.—Fig. 11. A basal cell, showing the thick and lamellose wall and its irregularly lobed holdfast.—Fig. 12. A part of the zygospore.— Fig. 13, 14. *Spirogyra punctulata*, sp. nov.— Fig. 15-17. *Spirogyra pulchrifigurata*, sp. nov.—Fig. 18-21. *Spirogyra rhizobrachiialis*, sp. nov.—Fig. 18. A part of the vegetative filament, showing the rhizoid-shaped attachment on each cell.—Fig. 19. An apical cell.—Fig. 22-24. *Spirogyra papulata*, sp. nov.

the unusual thickness and structure of cell walls, and in the irregularly reticulate zygospores. The expanded and lobed attachments are not commonly found in this genus, but do sometimes arise under abnormal conditions. In the writer's samples nearly all the filaments showed the presence of these structures and grew attached to submersed plants.

Collected in the southwest moat of Peiping, July, 1927, in company with *S. austriaca* Czurda, *S. pratensis* Transeau, *Oedogonium Pringsheimii* Cramer & Wittrock var. *abbreviatum* Hirn, and *Oe. peipingense* Jao. Types in C. C. Jao collections and Herb. Univ. Mich., No. H242: S1 and S2.

***Spirogyra punctulata*, sp. nov. (fig. 13. 14)**

Filamentis plerumque curvatis; cellulis vegetativis 70–84  $\mu$  latis, 105–315  $\mu$  longis, dissepimentis planis; chromatophoris 3–7, fere 4–5, pyrenoideis grandibus, anfractibus 0.5–1.5; conjugatione scalari vel (?) laterali; cellulis fructiferis cylindricis; zygosporis ellipsoideis, apice acuminatis, non lateraliter compressis, 64–74  $\mu$  latis, 83–179  $\mu$  longis, episporio laevi et hyalino, mesosporio subtiliter punctato et maturitate flavescente, endosporio distincto.

Filaments usually curved; vegetative cells 70–84  $\mu$  diam., 105–315  $\mu$  long, with plane end walls; chromatophores 3–7, usually 4–5, making 0.5–1.5 turns in the cell, containing large pyrenoids; conjugation scalariform or lateral (?); fertile cells cylindrical; zygospores ellipsoid, with pointed ends, not laterally compressed, 64–74  $\mu$  diam., 83–179  $\mu$  long, outer wall smooth and colorless, median wall finely punctate and yellow at maturity, inner wall distinct.

This species is near *S. Malmeana* Hirn, but differs chiefly in having punctate zygospores.

Pure sample, collected in a pond near Poatin, Aug., 1929. Types in C. C. Jao collections and Herb. Univ. Mich., No. H211.

***Spirogyra pulchrifigurata*, sp. nov. (fig. 15–17)**

Filamentis saturate viridibus; cellulis vegetativis 41–58  $\mu$  latis, 64–192  $\mu$  longis, dissepimentis planis; chromatophoris 4 vel 3, latis, margine dentatis, pyrenoideis grandibus, anfractibus 1.5–4; conjugatione scalari; cellulis fructiferis inflatis, latitudine usque ad 84  $\mu$ , interdum abbreviatis; zygosporis ellipsoideis, apice plus minus rotundatis, (51–) 54–64  $\mu$  latis, (61–) 70–109  $\mu$  longis, mesosporio irregulariter reticulato, maturitate bruno.

Filaments deep green; vegetative cells 41–58  $\mu$  diam., 64–192  $\mu$  long, with plane end walls; chromatophores 4 or 3, broad, with toothed margins and containing large pyrenoids, making 1.5–4 turns in the cell; conjugation scalariform; fertile cells inflated and sometimes shortened, reaching a diameter of 84  $\mu$ ; zygospores ellipsoid, with more or less rounded ends, (51–) 54–64  $\mu$  diam., (61–) 70–109  $\mu$  long, median wall irregularly reticulate, yellowish brown at maturity.

This species is characterized by its small vegetative cells, large zygospores and fertile cells, most strongly inflated on the conjugating side and less so on the outer side, in these points differing from the nearest species, *S. brunnea* Czurda.

Collected in a rice farm near Chungking, Feb., 1930. Material abundant, in company with *S. orientalis* W. & G. S. West. Types in C. C. Jao collections and Herb. Univ. Mich., No. S264: S1 and S2.

***Spirogyra rhizobrachialis*, sp. nov. (fig. 18–21)**

Caespites laete virides formans; cellulis vegetativis 40–45  $\mu$  latis, 144–240  $\mu$  longis, dissepimentis planis; chromatophoris 3–5, margine dense dentatis, pyrenoideis grandibus; anfractibus 1.5–2.5; cellulis sterilibus nonnunquam lateraliter appendicem rhizoideam cum haptero plus minusve lobato emittentibus; conjugatione scalari; cellulis fructiferis cylindricis, interdum brevibus et inflatis; zygosporis ellipsoideis, apice plus minus rotundatis, 38–55 (–61)  $\mu$  latis, (58–) 64–100  $\mu$  longis, mesosporio subtiliter et irregulariter reticulato, maturitate fusciscente.

Forming bright green masses; vegetative cells 40–45  $\mu$  diam., 144–240  $\mu$  long, with plane end walls; chromatophores 3–5, with densely toothed margins and containing large pyrenoids, making 1.5–2.5 turns in the cell; in some portions of the filaments each sterile cell laterally producing one rhizoid-shaped attachment with more or less lobed hapteron; conjugation scalariform; fertile cells cylindrical, sometimes shortened and enlarged by the zygospore; zygospores ellipsoid, with more or less rounded ends, 38–55 (–61)  $\mu$  diam., (58–) 64–100  $\mu$  long, median spore wall finely and irregularly reticulate, yellowish-brown at maturity.

This species bears some resemblances to *S. paraguayensis* Borge and *S. braziliensis* (Nordstedt) Transeau. It is recognized by the sterile cells often producing laterally rhizoid-shaped attachments, by the fertile cells sometimes becoming inflated, and by the chromatophores being 3–5 in number. It is especially distinguished, however, from the first species named in having larger zygospores and spiral chromatophores, and from the second in having smaller vegetative cells and reticulate zygospores.

Collected in rice farms near Chungking, Aug., 1930. Filaments abundantly scattered among other filamentous algae. Types in C. C. Jao collections and Herb. Univ. Mich., No. S256, S259, and S265.

***Spirogyra papulata*, sp. nov. (fig. 22–24)**

Filamentis flavo-viridibus; cellulis vegetativis 28–32  $\mu$  latis, 64–176  $\mu$  longis, dissepimentis planis; chromatophoro solitario, pyrenoideis grandibus, anfractibus 1–4.5; conjugatione scalari vel laterali; cellulis sterilibus interdum tumidis, latitudine usque ad 64  $\mu$ ; cellulis fructiferis fere abbreviatis et uno latere (in quo conjugatio sequitur) inflatis ad latitudinem 55  $\mu$ ; zygosporis ellipsoideis plus minus rotundatis, 22–32  $\mu$  latis, 35–55  $\mu$  longis, mesosporio irregulariter reticulato, maturitate aureo-flavescente.

Filaments yellowish green; vegetative cells 28–32  $\mu$  diam., 64–176  $\mu$  long, with plane end walls; chromatophore one, containing large pyrenoids, making 1–4.5 turns in the cell; conjugation scalariform or lateral; fertile cells usually shortened and inflated on the conjugating side, reaching 55  $\mu$  in diameter; sterile cells sometimes swollen to 64  $\mu$ ; zygospores ellipsoid, with more or less rounded ends, 22–32  $\mu$  diam., 35–55  $\mu$  long, median spore wall irregularly reticulate, golden-yellow at maturity.

This species perhaps is related to *S. scrobiculata* (Stockmayer) Czurda, but the new plant is quite clearly distinguished from it by the reticulate zygospores and the rather narrower vegetative cells.

Collected in a rice farm near Kiangpei City, Jan., 1933. The filaments are scattered in company with *Vaucheria polysperma* Hassall, *V. repens* Hassall, and *Spirogyra* spp. Type in C. C. Jao collections and Herb. Univ. Mich., No. S414: S1.

***Spirogyra quadrilaminata*, sp. nov. (fig. 25, 26)**

Filamentis laete viridibus; cellulis vegetativis 38–58  $\mu$  latis, 112–256  $\mu$  longis, dissepimentis planis; chromatophoris 3–4, margine irregulariter undulatis, anfractibus 1–3.5; cellulis fructiferis cylindricis; conjugatione scalari; zygosporis ellipsoideis vel cylindrico-ellipsoideis, apice plus minus rotundatis, 45–55  $\mu$  latis, 64–102  $\mu$  longis, membrana quadruplici, episporio hyalino, mesoporio exteriore laete bruneo, plus minus dense costato vel lineato, lineis longitudinalibus undulatisque, mesoporio interiore bruneo et subtiliter punctato, interdum subtiliter et irregulariter reticulato, endosporio tenui et laevi.

Filaments light green; vegetative cells 38–58  $\mu$  diam., 112–256  $\mu$  long, with plane end walls; chromatophores 3–4, margins irregularly wavy, making 1–3.5 turns in the cell; fertile cells cylindrical; conjugation scalariform; zygospores ellipsoid to cylindrical-ellipsoid, with more or less rounded ends, 45–55 diam., 64–102  $\mu$  long, spore wall of four layers, outer layer colorless, outer median layer brown, with more or less closely longitudinal, wavy lines, inner median layer brown, finely punctate, sometimes finely and irregularly reticulate, innermost layer thin and smooth.

This species is especially characterized by the four-layered spore wall, which distinguishes it from the related species *S. subreticulata* Fritsch.

Collected in a permanently flooded rice-farm, near Chungking, Aug., 1930. Filaments scattered among many other species of this genus and others, such as *Spirogyra chungkingensis* Jao, *S. pratensis* Transeau, *S. corrugata* Transeau ined., *Oedogonium spiralidens* Jao, *Oe. costatosporum* Jao, *Oe. excavatum* Jao, *Oe. Richterianum* Lemmermann, *Oe. crispum* (Hassall) Wittrock, *Oe. macrandrium* Wittrock var. *propinquum* (Wittrock) Hirn, *Mougeotia sphaerocarpa* Wolle, etc. Types in C. C. Jao collections and Herb. Univ. Mich., No. S270: 06 and A.

***Spirogyra chungkingensis*, sp. nov. (fig. 27, 28)**

Cellulis vegetativis 22–26  $\mu$  latis, 80–170  $\mu$  longis, dissepimentis planis; chromatophoris 3, anfractibus 1–3; conjugatione scalari; cellulis fructiferis inflatis; zygosporis ellipsoideis, apice plus minus rotundatis, 35–39  $\mu$  latis, 54–68  $\mu$  longis, membrana quadruplici episporio hyalino, mesoporio exteriore laete bruneo, plus minus dense costis praedito longitudinalibus et undulatis, mesoporio interiore bruneo et subtiliter et irregulariter reticulato, interdum subtiliter punctato, endosporio tenui et laevi.

Vegetative cells 22–26  $\mu$  diam., 80–170  $\mu$  long, with plane end walls; chromatophores 3, making 1–3 turns in the cell; conjugation scalariform; fertile cells inflated; zygospores ellipsoid, with more or less rounded ends, 35–39  $\mu$  diam., 54–68  $\mu$  long, spore wall of four

layers, outer layer colorless, outer median layer brownish, with more or less densely longitudinal and wavy lines, inner layer thin and smooth.

This species is near *S. orientalis* W. & G. S. West, from which it differs in the smaller diameter of the vegetative cells and zygospores and the four-layered spore wall. In zygospore characteristics it is like another new species, *S. quadrilaminata*, but *S. chungkingensis* is smaller in dimensions, the chromatophores are constantly 3, and the fertile cells are inflated.

Filaments scattered. Found in the samples collected from a permanently flooded rice farm near Chungking, Aug., 1930, in company with *S. quadrilaminata* Jao and many other filamentous algae. Types in C. C. Jao collections and Herb. Univ. Mich., No. S270: S1 and B1B.

***Spirogyra oblata*, sp. nov. (fig. 29–31)**

Cellulis vegetativis 96–119  $\mu$  latis, 80–256  $\mu$  longis, dissepimentis planis; chromatophoris 9–13, angustis, modo subrectis longitudinalibus, modo spiralibus, anfractibus 0.2–0.5; conjugatione scalari; cellulis fructiferis cylindricis et abbreviatis; zygosporis lentiformibus, diam. 92–106  $\mu$ , 64–71  $\mu$  crassis; episporio laevi et lamelloso, crassitie mesoporum aequante; mesoporio juventate irregulariter reticulato et luteo, demum maturitate verrucoso et aureo-bruneo.

Vegetative cells 96–119  $\mu$  diam., 80–256  $\mu$  long, with plane end walls; chromatophores 9–13, narrow, nearly straight and longitudinal, or spiral, making 0.2–0.5 turns in the cell; conjugation scalariform; fertile cells cylindrical and shortened; zygospores lenticular, 92–106  $\mu$  diam., 64–71  $\mu$  thick, outer spore wall smooth and lamellose, as thick as the middle layer, median wall irregularly reticulate and yellow at rather young stages, but verrucose and deep yellowish-brown at full maturity.

This species has a very thick spore wall, reaching a thickness of from 8 to 10  $\mu$ , and distinctly reticulate to verrucose zygospores. The change in the median wall of the zygospore is due to the breakdown of the reticulations. The intermediate types are easily found on the individual filament. *S. oblata* is distinguished from *S. maxima* (Hassall) Czurda by the smaller dimensions of all cells, the greater number of chromatophores, and the markings of zygospores.

Collected in West Lake, Hangchow, June, 1929. Filaments scattered. Type in C. C. Jao collections and Herb. Univ. Mich., No. C240.

***Spirogyra verruculosa*, sp. nov. (fig. 32, 33)**

Cellulis vegetativis 105–120  $\mu$  latis, 259–420  $\mu$  longis, dissepimentis planis; chromatophoris 5, pyrenoideis numerosis pergrandibus et confertim concatenatis, anfractibus 2–5; conjugatione scalari; cellulis fructiferis cylindricis, interdum paululum inflatis (in latere in quo conjugatio sequitur); zygosporis ellipsoideis vel oblongo-ellipsoideis, apice rotundatis, non lateraliter compressis, 105–120  $\mu$  latis, 168–220  $\mu$  longis, mesoporio evidenter verrucoso, maturitate fusco necque luteo.

Vegetative cells 105–120  $\mu$  diam., 259–420  $\mu$  long, with plane end walls; chromatophores 5, making 2–5 turns in the cell, containing numerous very large

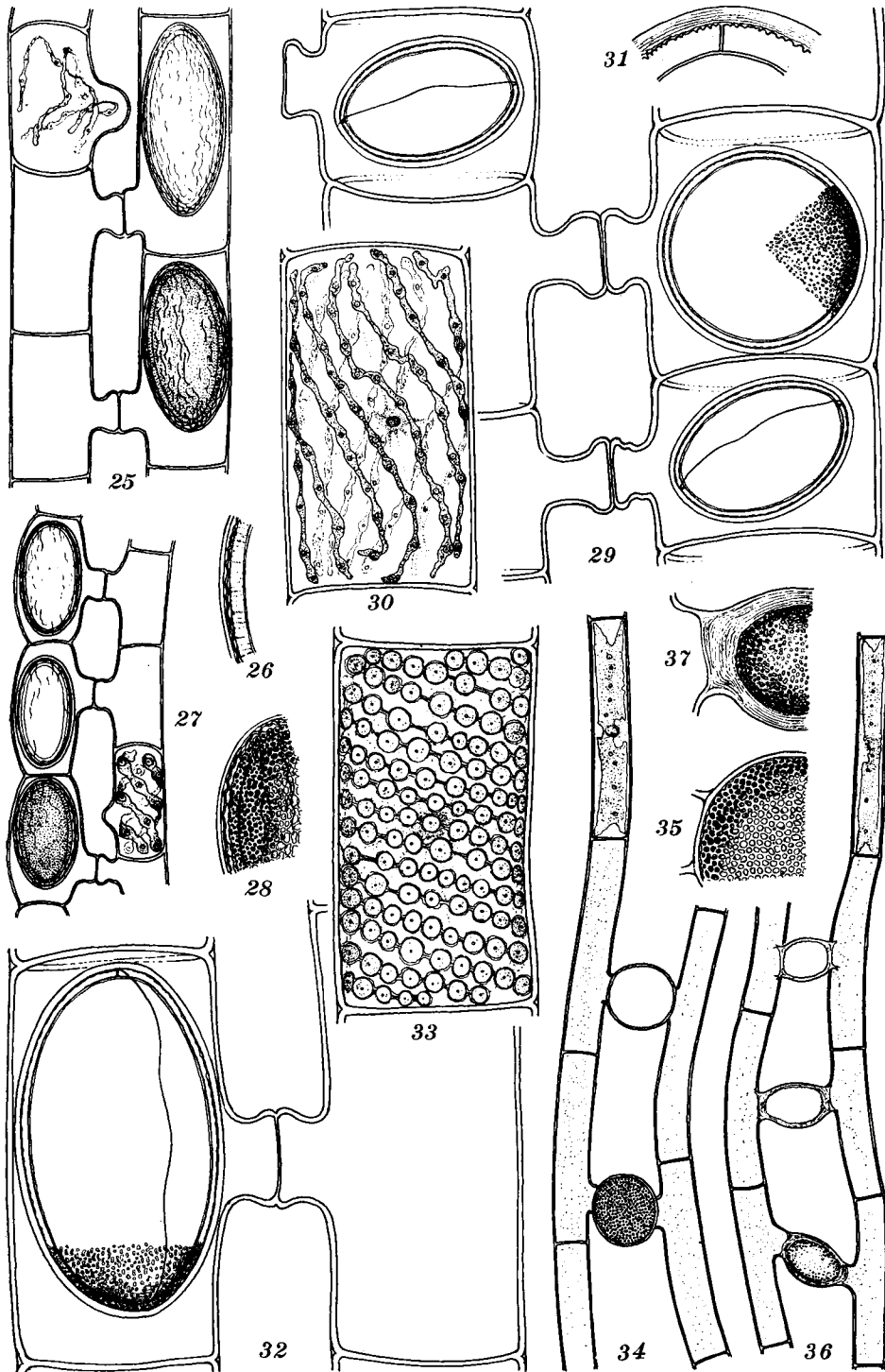


Fig. 25-37.—Fig. 25, 26. *Spirogyra quadrilaminata*, sp. nov.—Fig. 26. Section of the spore-wall, showing the 4-layered structure and punctate median wall.—Fig. 27, 28. *Spirogyra chungkingensis*, sp. nov.—Fig. 29-31. *Spirogyra oblata*, sp. nov.—Fig. 31. Section of the spore-wall, showing the thick and lamellose outer wall, the thick and verrucose median layer and its suture, and thin inner wall.—Fig. 32, 33. *Spirogyra verruculosa*, sp. nov.—Fig. 34, 35. *Mougeotia globulispora*, sp. nov.—Fig. 36, 37. *Mougeotia lamellosa*, sp. nov.

pyrenoids closely arranged as the pearls in a chain; conjugation scalariform; fertile cells cylindrical, sometimes slightly enlarged by the zygospores on the conjugating side; zygospores ellipsoid to oblong-ellipsoid, with rounded ends, not laterally compressed, 105–120  $\mu$  diam., 168–220  $\mu$  long, median wall distinctly verrucose, dark brown at maturity instead of yellow.

In some respects this species is near *S. Malmeana* Hirn and *S. Reinhardii* Chmielewski, but differs from them in the larger dimensions of all cells, in having 5 chromatophores, and in the verrucose zygospores. It is distinguished especially from the second by the non-inflated fertile cells.

Collected in the rice farm by West Lake, near Hangchow, June, 1929. Type in C. C. Jao collections and Herb. Univ. Mich., No. C252: 09.

***Mougeotia globulispora*, sp. nov. (fig. 34–35)**

Cellulis vegetativis 19–32  $\mu$  latis, 96–288  $\mu$  longis; pyrenoideis 6–12, monostichis; conjugatione scalariform; cellulis fructiferis erectis; zygosporangiis inter 2 cellulas sitis, in tubo conjugationis, globosis vel subglobosis, 32–39  $\mu$  latis, 32–35 (–38)  $\mu$  longis, mesosporio subtiliter et irregulariter scrobiculato vel reticulato, maturitate flavescenti vel bruno.

Vegetative cells 19–32  $\mu$  diam., 96–288  $\mu$  long; pyrenoids 6–12, in a single row; conjugation scalariform; fertile cells straight; zygosporangia adjoined by two cells, situated in the conjugating tube, globose or subglobose, 32–39  $\mu$  diam., 32–35 (–38)  $\mu$  long, median spore wall irregularly and finely scrobiculate to reticulate, yellow to brown at maturity.

This species in size of the vegetative cells and the markings of zygospores nearly resembles *M. robusta* (De Bary) Wittrock and its var. *biornata* Wittrock, but differs in having the pyrenoids not irregularly distributed and in having the smaller zygospores globose to subglobose.

Collected in rice farm near Chungking, Feb., 1932. Filaments scattered among many other filamentous algae, such as *Oedogonium orientale* Jao, *Oe. cymatosporum* Wittrock & Nordstedt, *Bulbochaete varians* Wittrock, *Vaucheria polysperma* Hassall, *Zygnema stellinum* (Müller) Agardh., *Spirogyra nitida* (Dillwyn) Link, etc. Type in C. C. Jao collections and Herb. Univ. Mich., No. S316: S6.

***Mougeotia lamellosa*, sp. nov. (fig. 36, 37)**

Cellulis vegetativis 19–30  $\mu$  latis, 60–185  $\mu$  longis; pyrenoideis 4–9, monostichis; conjugatione scalariform; gametangiis erectis; zygosporangiis inter 2 cellulas sitis, in tubo conjugationis, transverse-ellipsoideis, 28–45  $\mu$  latis, 24–32  $\mu$  longis; episporio laevi, lamellosa, et crasso, praecipue ad cellularum extremitates; mesosporio verrucoso, maturitate flavescenti.

Vegetative cells 19–30  $\mu$  diam., 60–185  $\mu$  long; chromatophores containing 4–9 pyrenoids in a single row; conjugation scalariform; gametangia straight; zygosporangium adjoined by two cells, situated in the conjugating tube, transversely ellipsoid in form, 28–45  $\mu$  diam., 24–32  $\mu$  long, outer spore wall smooth, lamellose, and thick, especially at the ends, median spore wall verrucose, yellowish at maturity.

This species is characterized by the thick and lamellose outer spore wall, verrucose median spore wall, and smaller size of the zygospores, features which distinguish it from the related *M. pulchella* Wittrock.

Collected in a rice farm near Kiangpei City, Jan., 1933, in company with *Spirogyra inflata* (Vauch.) Rabenh., *S. austriaca* Czurda, and *S. foveolata* (Transeau) Czurda. Type in C. C. Jao collections and Herb. Univ. Mich., No. S404: M1.

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## OCCURRENCE OF MARINE PLANKTON DIATOMS IN A TEN-YEAR SERIES OF DAILY CATCHES IN SOUTHERN CALIFORNIA<sup>1</sup>

Winfred Emory Allen

IN 1917 the activities of the Scripps Institution were directed into investigations of the fertility of the sea with particular attention to problems of development of food resources for war-time needs. At that time little attention had been given to marine microplankton, "the primary food supply of the sea" (Brooks, 1893), and the present writer was invited to make a preliminary survey of the field with a view to tracing relationships to food fishes and other marine products.

In 1919 the writer was induced to undertake a permanent program of investigations of marine phytoplankton, but it was soon found that financial resources were not sufficient to enable proper coordination of the work with that in commercial fisheries.

<sup>1</sup> Received for publication May 29, 1934.

However, it did appear that a general knowledge of geographic, bathymetric, and seasonal occurrences and distributions of phytoplankton (ocean pasturage) might be useful in itself (e.g., as an indicator of biological conditions) and that a well organized body of detailed evidence might be useful at any time as a basis for special studies of the relationships of other organisms to their food supply, or to other conditions of their existence.

Naturally, first attention in preparing a report from hundreds of thousands of recorded items has been given to formulating a few general statements concerning the trend of the evidence. Studies of particular features such as succession of species, distribution of particular species, and periodicities in occurrence are well advanced, but none of them are