

SPIROGYRA LINK AND SIROGONIUM KÜTZING SPECIES: NEW TO ALGAL FLORA OF NEPAL

S.K. Rai and P.K. Misra*

Department of Botany

Post Graduate Campus, Tribhuvan University, Biratnagar, Nepal

Email: shivarai2003@yahoo.com

*Phycology Research Laboratory

Department of Botany, Lucknow University, Lucknow-226007, India

ABSTRACT

Eleven species of *Spirogyra* Link and two species of *Sirogonium* Kützing have been described in this communication as new records for Nepal. These are *Spirogyra communis* (Hassal) Kützing, *S. daedaleoides* Czurda, *S. decimina* (Müller) Kützing, *S. esthonica* (Skuja) Czurda, *S. juergensii* Kützing, *S. paradoxa* Rao, *S. pratensis* Transeau, *S. rhizopus* Jao, *S. rugulosa* Iwanoff, *S. spreeiana* Rabenhorst's, *S. verrucosa* (Rao) Krieger, *Sirogonium illinoiense* (Transeau) G.M. Smith and *S. sticticum* (Engl. Bot.) Kützing. All these taxa were collected from the lotic and lentic habitats of eastern Nepal. The genus, *Sirogonium*, is being described for the first time from this country.

Key words: Algae, chlorophyceae, zygnemataceae, *Spirogyra*, *Sirogonium*.

INTRODUCTION

Our knowledge of zygnemataceae specially of the genera *Spirogyra* Link and *Sirogonium* Kützing in Nepal is inadequate. So far, only one species of *Spirogyra* i.e., *S. nepalensis* nov. sp. is found to be reported from Lobuche by Müller (1965). The information regarding *Sirogonium* and its distribution in Nepal is completely lacking. Therefore, it was felt desirable to study the zygnematacean flora of Nepal.

The present paper describes the morphology and distribution of *Spirogyra* and *Sirogonium* species belonging to the family zygnemataceae under the class chlorophyceae, which are unreported from Nepal hitherto. All these taxa were observed by the authors in the course of studies on freshwater algal diversity of eastern Nepal.

MATERIAL AND METHODS

Between 2002-2004, samples were collected using a plankton-net of mesh size 80 µm and preserved in 4% unbuffered formalin. Detailed morpho-taxonomic study and photomicrography were done under Nikon Labophot microscope with camera attachment. Identification of species was by consulting various literatures and monographs and the classification followed Smith (1933). Species under each genus are enumerated alphabetically.

SYSTEMATIC DESCRIPTIONS

Class: Chlorophyceae

Order: Zygnematales

Family: Zygnemataceae

Genus: *Spirogyra* Link 1820

Filaments free floating, rarely attached, simple, long, unbranched, covered with mucilaginous sheath, without basal-distal differentiation; vegetative cells cylindrical, 1/2-30 times as long as broad; cross walls plane, colligate, semi-replicate, replicate or unduliseptate; chloroplasts 1-16, spirally arranged, parietal band or ribbon shaped, 1/2-3 (rarely more than 8) turns, often straight, each with numerous prominent pyrenoids; nucleus centrally placed, supported by several cytoplasmic strands.

Reproduction by zygospores, aplanospores, parthenospores, akinetes and fragmentation; conjugation usually scalariform, sometimes lateral; zygospores usually ellipsoid, rarely ovoid or lenticular; median spore wall chitinous, smooth or variously ornamented, pale yellow to chestnut brown.

Spirogyra is more or less universal in distribution and more than 289 species have been described in the world (Randhawa, 1959).

Key to the species:

- 1. Cross wall plane ----- 2
- 1. Cross wall replicate, gametangia fusiform, zygospore ellipsoid, vegetative cells 18-24 µm broad ----- *S. spreeiana* (10)
- 2. Conjugation tube formed wholly or largely by male gametangia, chloroplast 1 ----- 3
- 2. Conjugation tube formed by both gametangia, chloroplast 1 to many ----- 4
- 3. Zygospore laterally compressed, median spore wall irregularly reticulate, vegetative cells 26-39 µm broad ----- *S. esthonica* (4)
- 3. Zygospore ellipsoid, median spore wall punctate, vegetative cells 48-52 µm broad ----- *S. rugulosa* (9)
- 4. Chloroplast 1 ----- 5
- 4. Chloroplast many ----- 8

- 5. Median spore wall smooth ----- 6
- 5. Median spore wall irregularly reticulate, zygospore ellipsoid or pear shaped, vegetative cells 34-45 µm broad ----- *S. daedaleoides* (2)
- 6. Gametangia cylindrical ----- 7
- 6. Gametangia swollen, vegetative cells 18-20 µm broad ----- *S. pratensis* (7)
- 7. Vegetative cells 17-20 µm broad ----- *S. communis* (1)
- 7. Vegetative cells 24-34 µm broad ----- *S. juerjensii* (5)
- 8. Median spore wall smooth ----- 9
- 8. Median spore wall variously ornamented --- 10
- 9. Gametangia nearly cylindric, zygospore ovoid to globose, chloroplasts 2-3, vegetative cells 37-42 µm broad ----- *S. decimina* (3)
- 9. Gametangia swollen, zygospore broadly ellipsoid to almost spherical, chloroplasts 3-4, vegetative cells 80-90 µm broad ----- *S. paradoxa* (6)
- 10. Median spore wall irregularly reticulate, zygospore ovoid, chloroplasts 2, vegetative cells 40 µm broad ----- *S. rhizopus* (8)
- 10. Median spore wall verrucose, zygospore ellipsoid, chloroplasts 4-8, vegetative cells 110-130 µm broad ----- *S. verrucosa* (11)

Spirogyra communis (Hassal) Kützing 1849 (Pl. 1, Fig. 8)

Prescott, G.W. 1951, P. 312; Tiffany, L.H. and M.E. Britton 1952, P. 146, Pl. 43, Fig. 455; Randhawa, M.S. 1959, P. 293, Fig. 247

Vegetative cells 40-69 µm long, 17-20 µm broad, with plane end walls; chloroplast 1, 1/2-4 turns; conjugation scalariform, tubes formed by both gametangia; empty cells 40-60 µm long, 17 µm broad; fruiting cells cylindrical, 62-65 µm long, 17.5 µm broad; zygospores ellipsoid, 37-40 µm long, 17-19 µm broad; median spore wall smooth, yellow.

Locality: Free floating in a reservoir near Koshi Barrage, 162 m, Bhantabari, Sunsari district.

Collection number and date: EN 128, 29-03-2003.

Distribution: India (Gorakhpur, Assam), U.S.A. (New Caledonia).

Spirogyra daedaleoides Czurda 1932 (Pl. 1, Fig. 5)

Prescott, G.W. 1951, P. 313, Pl. 72, Figs. 9-11; Tiffany, L.H. and M.E. Britton 1952, P. 148, Pl. 45, Figs. 473-474; Randhawa, M.S. 1959, P. 377, Fig. 416

Vegetative cells 60-85 μm long, 34-45 μm broad, with plane end walls; chloroplast 1, 2-8 turns; conjugation scalariform and lateral; empty cells 60-65 μm long, 47 μm broad; fruiting cells slightly inflated, 70 μm long, 55 μm broad; zygospores ellipsoid or pear shaped, 65-70 μm long, 42-49 μm broad; median spore wall with irregularly reticulate ridges, brown.

Locality: Free floating in the roadside pool at Itahari, 120 m, Sunsari district.

Collection number and date: EN 303, 10-09-2004.

Distribution: Latvia, U.S.A.

Spirogyra decimina (Müller) Kützing 1843 (Pl. 1, Fig. 9)

Prescott, G.W. 1951, P. 313; Tiffany, L.H. and M.E. Britton 1952, P. 153, Pl. 46, Fig. 489; Randhawa, M.S. 1959, P. 325, Figs. 309a-b; Prasad, B.N. and P.K. Misra 1992, P. 80, Pl. 13, Figs. 4-5

Vegetative cells 55.5-105 μm long, 37-42 μm broad, with plane end walls; chloroplasts 2-3, 1-2 turns; conjugation scalariform, tubes formed by both gametangia; empty cells 55-70 μm long, 37.5 μm broad; fruiting cells slightly inflated, 98-102 μm long, 48-53 μm broad; zygospores ovoid to globose, 58-60 μm long, 35-38 μm broad; median spore wall smooth, yellow.

Locality: Floating on the edge of Muga river on the way from Hile to Pakhribas, 1850 m, Dhankuta district.

Collection number and date: EN 78, 20-10-2002.

Distribution: Africa, Asia (India: Banaras, Bareilly, Gorakhpur, Hosangabad, Kerala, Port

Blair, Srinagar; Java; Myanmar: *S. decimina* var. *plena* West and West from Kyauktaga of Pegu district and Singaing of Kyaukse district), Europe, South America, U.S.A., West Indies.

Spirogyra esthonica (Skuja) Czurda 1932 (Pl. 1, Figs. 3-4)

Randhawa, M.S. 1959, P. 396, Fig. 460

Vegetative cells 140-168 μm long, 26-39 μm broad, with plane end walls; chloroplast 1, 7.5 -8 turns; conjugation scalariform, tubes formed largely by male gametangia, sterile cells present between gametangia; empty cells 138-140 μm long, 27-30 μm broad; fruiting cells inflated, 186-190 μm long, 43-50 μm broad; zygospores ellipsoid, laterally compresses, 80-85 μm long, 42-49 μm broad; median spore wall irregularly corrugate with minute punctations between the ridges.

Locality: Free-floating in Mechi pond, 80 m, Maheshpur, Bhadrapur, Jhapa district.

Collection number and date: EN 269, 17-06-2004.

Distribution: Estonia.

Spirogyra juergensii Kützing 1845 (Pl. 1, Fig. 10)

Prescott, G.W. 1951, P. 316, Pl. 73, Figs. 7-8; Tiffany, L.H. and M.E. Britton 1952, P. 146, Pl. 44, Fig. 463; Randhawa, M.S. 1959, P. 294, Fig. 250

Vegetative cells 90-115 μm long, 24-34 μm broad, with plane and occasionally swollen end walls; chloroplast 1, 2-4 turns; conjugation scalariform, tubes formed by both gametangia; empty cells 92-105 μm long, 28-29 μm broad; fruiting cells cylindrical, 90-95 μm long, 35-36 μm broad; zygospores ellipsoid, 60-68 μm long, 30-32 μm broad; median spore wall smooth, yellow.

Locality: Free-floating in a reservoir near Koshi Barrage, 162 m, Bhantabari, Sunsari district.

Collection number and date: EN 128, 29-03-2003.

Distribution: Australia, Europe, India (Gorakhpur), Pakistan (Lahore), South America, U.S.A.

Spirogyra paradoxa Rao 1937 (Pl. 2, Fig. 3)

Randhawa, M.S. 1959, P. 326, Fig. 313; Rattan, R.S. 1967, P. 98, Figs. 15-16; Prasad, B.N. and P.K. Misra 1992, P. 85, Pl. 13, Figs. 8 and 10.

Vegetative cells short, 50-70 µm long, 80-90 µm broad, with plane end walls; chloroplasts 3-4; conjugation scalariform; empty cells 50-56 µm long, 82-90 µm broad; fruiting cells slightly inflated, 80-90 µm long, 96 µm broad; zygospore broadly ellipsoidal to almost spherical, 80-85 µm long, 68-72 µm broad; median spore wall smooth, brown.

Locality: Floating with other algae in Pitchhra pond, 72 m, Biratnagar, Morang district.

Collection number and date: EN 84, 16-12-2002.

Distribution: India (Dehradun, Meerut, Port Blair, Punjab, Sarnath).

Spirogyra pratensis Transeau 1914 (Pl. 1, Fig. 11)

Prescott, G.W. 1951, P. 319, Pl. 75, Figs. 4-6; Tiffany, L.H. and M.E. Britton 1952, P. 144, Pl. 43, Fig. 457; Randhawa, M.S. 1959, P. 297, Fig. 257; Prasad, B.N. and P.K. Misra 1992, P. 87, Pl. 14, Figs. 5 and 7.

Vegetative cells 100-135 µm long, 18-20 µm broad, with plane end walls; chloroplast 1 (rarely 2), 1-8 turns; conjugation scalariform and lateral, tubes formed by both gametangia; empty cells 105-120 µm long, 20 µm broad; fruiting cells fusiform-inflated, 95 µm long, 38-42 µm broad; sterile cells cylindrical; zygospores usually ellipsoid, sometimes ovoid or cylindrical ovoid, 56 µm long, 29 µm broad; median spore wall smooth, yellow.

Remarks: Bullate-shaped inflations of sterile cells are not observed in the present specimen but in other respects resemble to the type.

Locality: Free-floating in Raja Rani lake, 700 m, Bhogateni, Morang district.

Collection number and date: EN 113, 11-01-2003.

Distribution: China (Nanking, Peiping), India (Banaras, Port Blair, Punjab), U.S.A.

Spirogyra rhizopus Jao 1936 (Pl. 1, Figs. 6-7)

Randhawa, M.S. 1959, P. 331, Figs. 321a-c

Vegetative cells 160-175 µm long, 40 µm broad, with plane end walls; basal cell expanded with irregularly lobed holdfast; chloroplasts 2, ½-4 turns; conjugation scalariform, tubes formed by both gametangia; empty cells 70-80 µm long, 40 µm broad; fruiting cells quadrangularly inflated,

90-95 µm long, 40-50 µm broad; zygospores ellipsoid, 58-60 µm long, 38-40 µm broad; outer spore wall thick, lamellose, hyaline; median spore wall irregularly reticulate, brown.

Locality: Attached on moist stones around the tap, 520 m, Bhandare Ghat, Sun Koshi, Udayapur district.

Collection number and date: EN 191, 24-05-2003.

Distribution: China (Peiping).

Spirogyra rugulosa Iwanoff 1902 (Pl. 1, Figs. 1-2)

Tiffany, L.H. and M.E. Britton 1952, P. 156, Pl. 47, Fig. 498; Randhawa, M.S. 1959, P. 352, Fig. 365.

Vegetative cells 90-160 µm long, 48-52 µm broad, with plane end walls; chloroplast 1, 5-6 turns; conjugation scalariform, tubes formed by male gametangia; empty cells 80-95 µm long, 52-55 µm broad; fruiting cells both short and long, inflated on conjugating side, 50-118 µm long, 55-70 µm broad; zygospore ellipsoid, 70 µm long, 38-45 µm broad; median spore wall finely punctate, yellow-brown.

Remarks: In the present algae, zygospores are small in size mainly on length and their shapes are not ovoid with broadly rounded ends as described in type specimen. Also, not all zygospore bearing cells are shortened otherwise in other respects resemble the type.

Locality: Planktonic in the roadside pool near P.G. Campus, 72 m, Biratnagar, Morang district.

Collection number and date: EN 224, 24-07-2003.

Distribution: China, Rumania, Russia, U.S.A.

Spirogyra spreeiana Rabenhorst's 1863 (Pl. 2, Fig. 2)

Prescott, G.W. 1951, P. 321, Pl. 77, Fig. 9; Tiffany, L.H. and M.E. Britton 1952, P. 158, Pl. 48, Fig. 513; Randhawa, M.S. 1959, P. 355, Fig. 370

Vegetative cells 100-142 µm long, 18-24 µm broad, with replicate end walls; chloroplast 1, ½-4 turns; conjugation scalariform and lateral; empty cells 19 µm broad; fruiting cells inflated, 112 µm long, 35 µm broad; zygospores ellipsoid, 75 µm long, 30-32 µm broad; median spore wall smooth, yellow.

Remarks: The vegetative cells of this algae are shorter than the type.

Locality: Free-floating in Phooli Khola stream near Damku Village, 1690 m, Khotang district.

Collection number and date: EN 175, 18-05-2003.

Distribution: Finland, Germany, India, Rumania, South Africa, U.S.A.

Spirogyra verrucosa (Rao) Krieger 1944 (Pl. 2, Fig. 1)

Randhawa, M.S. 1959, P. 339, Fig. 336

Vegetative cells 150-190 μm long, 110-130 μm broad, with plane end walls; chloroplasts 4-8, conjugation scalariform, tubes formed by both gametangia; empty cells 140-200 μm long, 110-140 μm broad; fruiting cells cylindrical, 180-240 μm long, 135-140 μm broad; zygospores ellipsoid, 150-170 μm long, 75-125 μm broad; median spore wall thick, minutely verrucose, with coarsely meshed reticulate ridges, brown.

Locality: Planktonic in Baghjoda Jhill, 137 m, Khorsane, Morang district.

Collection number and date: EN 309, 17-11-2004.

Distribution: India.

Genus: *Sirogonium* Kützing 1843

Filaments simple, unbranched; vegetative cells cylindrical, 2-6 times as long as broad, with plane end walls and without external pectic layer; chloroplasts 2-9, straight or slightly spiral, rarely more than $\frac{1}{2}$ a turn; otherwise vegetatively similar to *Spirogyra*.

Reproduction by zygospore; conjugation direct between gametangia, without conjugation tubes; progametangia divide into unequal gametangia—small as male and large as female, rarely progametangia conjugate without division, flexing of filaments during conjugation; zygospores ellipsoid or ovoid; median spore wall thick, smooth or variously ornamented, yellow, brown or black.

Key to the species:

1. Median spore wall reticulate with scattered protuberances, zygospores 90-94 μm broad,

chloroplasts 6-9, vegetative cells 76-80 μm broad ----- *S. illinoiense* (1)

1. Median spore wall smooth, zygospores 60 μm broad, chloroplasts 3-6, vegetative cells 45-48 μm broad ----- *S. sticticum* (2)

Sirogonium illinoiense (Transeau) G.M. Smith 1933 (Pl. 2, Fig. 4)

Tiffany, L.H. and M.E. Britton 1952, P. 164, Pl. 50, Figs. 529-530; Randhawa, M.S. 1959, P. 426, Fig. 511

Vegetative cells 230 μm long, 76-80 μm broad; chloroplasts 6-9, nearly straight or upto 1 turn; conjugation direct; both gametangia more or less reflexed; fruiting cells inflated to 130 μm ; zygospores ellipsoid, 155-160 μm long, 90-94 μm broad; median spore wall with scattered protuberances connected by a more or less prominent reticulum, yellow.

Locality: Planktonic in the stagnant water of Rawa river at Katahare Bensi, 720 m, Khotang district.

Collection number and date: EN 180, 19-05-2003.

Distribution: U.S.A.

Sirogonium sticticum (Engl. Bot.) Kützing 1843 (Pl. 2, Fig. 5)

Prescott, G.W. 1951, P. 321, Pl. 76, Figs. 5-7; Tiffany, L.H. and M.E. Britton 1952, P. 162, Pl. 50, Fig. 531; Randhawa, M.S. 1959, P. 424, Fig. 508

Vegetative cells 150 μm long, 45-48 μm broad; chloroplasts 3-6, nearly straight or $\frac{1}{2}$ a turn; conjugation direct; gametangia usually shortened, more or less reflexed; fruiting cells inflated to 75 μm ; zygospores ellipsoid, sometimes more or less ovoid, 89 μm long, 60 μm broad; median spore wall smooth, yellow.

Locality: Free-floating in the Pitchhra canal, 72 m, Biratnagar, Morang district.

Collection number and date: EN 126, 26-03-2003.

Distribution: Africa, Australia, India (Banaras, Fyzabad), Italy (Pavia), South America, U.S.A.

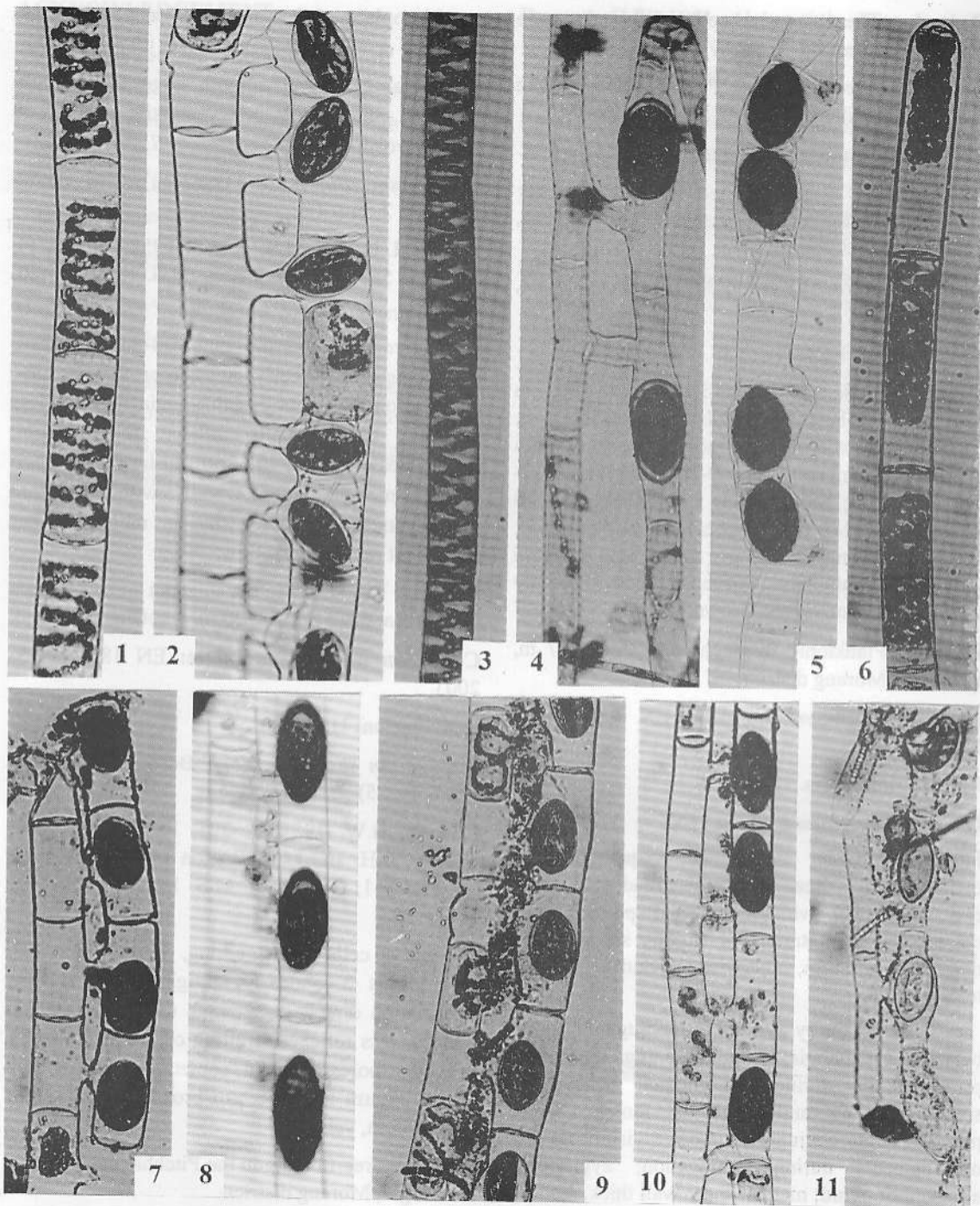


Plate I. (Figs. 1-2. *Spirogyra rugulosa* Iwanoff, Figs. 3-4. *S. esthonica* (Skuja) Czurda, Fig. 5. *S. daedaleoides* Czurda, Figs. 6-7. *S. rhizopus* Jao, Fig. 8. *S. communis* (Hassal) Kützing, Fig. 9. *S. decimina* (Müller) Kützing, Fig. 10. *S. juergensii* Kützing, Fig. 11. *S. pratensis* Transeau). (All figures $\times 200$ magnification)

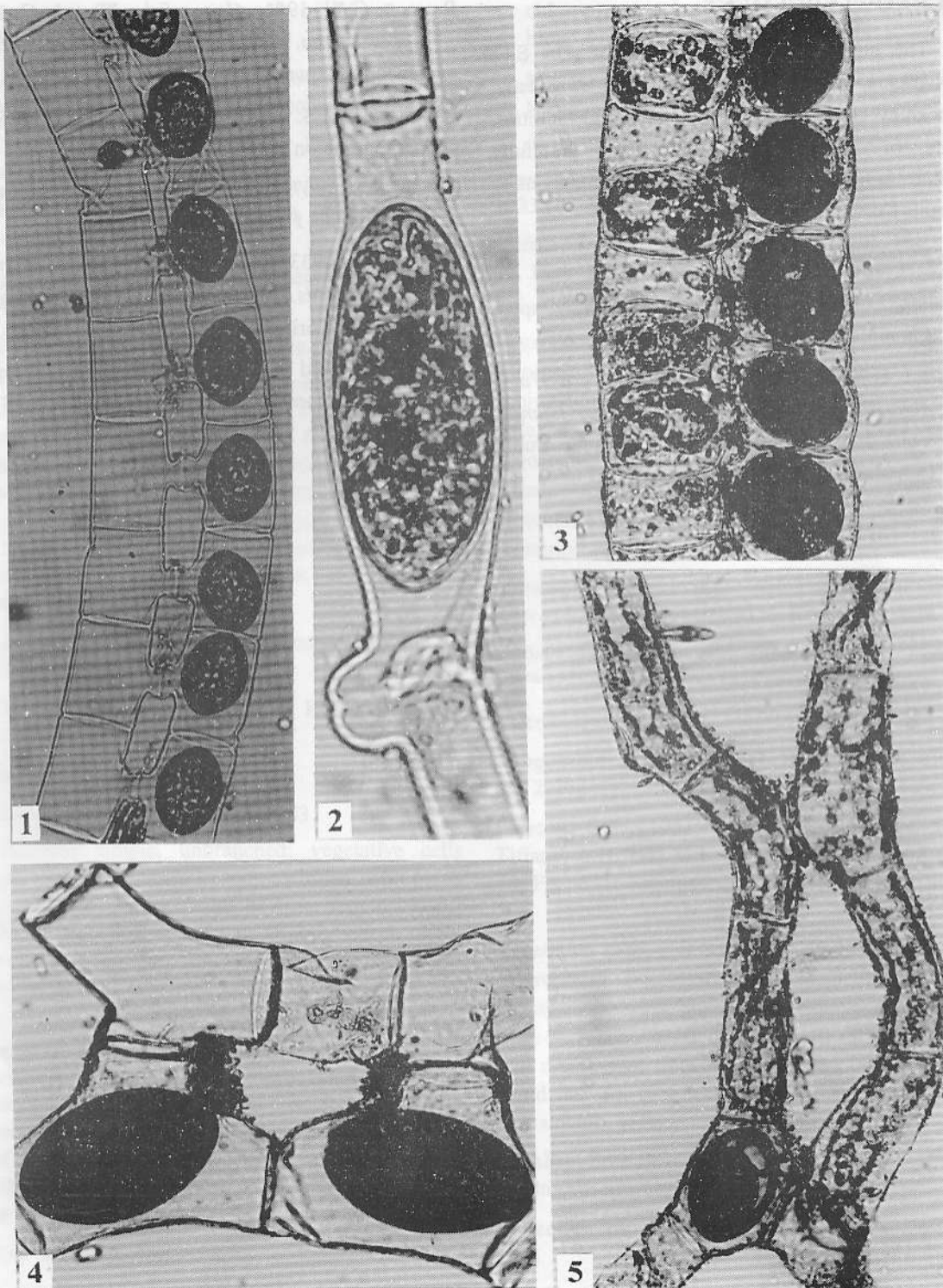


Plate 2. (Fig. 1. *Spirogyra verrucosa* (Rao) Krieger $\times 75$, Fig. 2. *S. spreeiana* Rabenhorst's $\times 750$, Fig. 3. *S. paradoxa* Rao $\times 200$, Fig. 4. *Sirogonium illinoiense* (Transeau) G.M. Smith $\times 200$, Fig. 5. *S. sticticum* (Engl. Bot.) Kützing $\times 200$).

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