Morpho-Taxonomic Studies on the Genus Spirogyra Link (Chlorophyta) Occuring in Fresh Water Bodies of Jammu, Jammu And Kashmir

Priyanka Chalotra¹, Madhvi Gaind² and V.K.Anand³

¹²³Department of Botany, University of Jammu, Jammu

Abstract: Sixteen species of Spirogyra Link 1820 (Zygnemophyceae, Chlorophyceae) were collected during 2008 to 2010 from different freshwater habitats of three districts of Jammu province viz., Samba district, Jammu district and Udhampur district. They were taxonomically determined on the basis of vegetative structure and reproductive structure. Their reproduction was mostly studied during winters and spring seasons. Both lateral conjugation and scalar form conjugation were observed. The scalariform conjugation was most common type of conjugation method among species. S. calcarea, S rectispire, S submarina, S hollandiae and S buchetii were taxonomically determined and have been described for first time in India and Jammu. Their reproduction was observed to occur mostly in winter and spring season. All sixteen species were found abundantly in both lentic and lotic water habitats.

Key words: Spirogyra, Vegetative Structure, Reproductive structure, Lateral conjugation, Scalariform conjugation, morpho-taxonomic, lentic and lotic water bodies.

I. Introduction

The occurrence of Zygnematales in India was reported by Martens (1869). Lateron, Danforth (1910)and Carter (1926) studied the periodicity and occurrence of Spirogyra in winter season from high altitude of Missouri, Assam and Sikkim. Randhawa (1940) recorded various filamentous green algae occurring in India and complied a monograph of Zygnema in 1959. Lateron, Kumar & Singh (1984) reported new species of Spirogyra from Uttar Pardesh.

In Jammu, prior work on Zygnematales was done by Misra (1937), he worked on four new taxa and recorded the distributed of seventeen more taxa belonging to genus Spirogyra and Zygnema growing in waters of Jammu & Kashmir. He also recorded the occurrence of five species of Spirogyra from fresh water of Jammu.

The study on distribution and morphology of Zygnematales was further proceeded by Kant (1974) he studied that Spirogyra formed 80% of its population in Lakes of Srinagar. Goyal et al, (1984) and Anand (1988) reported the occurrence of Spirogyra species in fresh water of Jammu.

Since then no much work had been done in the field of taxonomic studies of Spirogyra growing in Jammu waters. Keeping in view the paucity of the work done on morphology and taxonomic studies on Spirogyra, an extensive survey had been conducted in three districts of Jammu (Jammu,Samba and Udhampur) from 2008 to 2010. While surveying various local water bodies like pond, puddles, road side ditches,lakes, slow moving streams, rivers etc. sixteen species of Spirogyra were studied , of which five species i.e, S calcarea, S rectispire, S submarina, S hollandiae and S buchetii were new to Indian taxonomy.

II. Materials And Methods

Collections were made from Samba, Udhampur and Jammu districts of Jammu province during the period of January 2008 to March 2010. The specimens were obtained by hand-picking from various freshwater habitats like fountain water, running water channels, stagnant ponds and road-side puddles. They were preserved in glass bottles containing 5 % formalin and brought to the laboratory, where they were stained in iodine solution and examined in 10 % glycerin mounts under light microscope. Their drawings were made with the help of camera lucida and was micro photographed. The material was taxonomically determined with the help of authentic literature (Randhawa, 1959; Transeau,1951; Chin-Chin,1982; Vidyavati, 1995; Kargupta and Jha,2004; Taft,2009).

III. Results

Sixteen species of pond scum genus Spirogyra ( phylum Chlorophyta, class Chlorophyceae, order Zygnematales, family Zygnemataceae) have been identified. Their taxonomic enumeration is as follows:
The genus *Spirogyra* was founded by Link in 1820 and is represented by a large number of species, filaments are free floating and rarely attached.

**Vegetative features:** Cells are cylindrical, 0.5-30 µ times as long as broad; chloroplast 1-16 µ spirally arranged; parietal ribbon-like bodies with numerous prominent pyrenoids; nucleus centrally situated in a protoplasmic strand.

**Reproductive features:** Reproduction by zygospores, parthenosore, aplanospores, akinetes or by fragmentation; conjugation scalariform or lateral; zygospores usually ellipsoid, rarely ovoid or lenticula; median wall pale yellow to chestnut brown in colour; either smooth or variously ornamented.

The following sixteen species were collected which may be distinguished as follows:

**Key to the local species of genus *Spirogyra***

1. Reproduction by Zygospores .......................................................... 2
2. Cross walls plane ........................................................................... 3
3 (a) Gamentangia one in each cell ................................................... 4
3 (b) Gamentangia many in each cell ................................................ 5
4 (a) Gametangia cylindrical or enlarged .......................................... 6
4 (b) Gametangia swollen on both sides .......................................... 7
5 (a) Vegetative cells 30-35 µ broad ................................................. S. borgeana
5 (b) Vegetative cells 37-42 µ broad ............................................... S. calcarea
6 (a) Zygospores laterally compressed ............................................. 8
6 (b) Zygospores ellipsoid ................................................................. S. crossoidea
7 (a) Gametangia swollen on outer sides ........................................ 9
7 (b) Zygospores ellipsoid ................................................................. S. rectispera
8 (a) Gametangia cylindrical ............................................................. 10
9 (a) Gametangia cylindrical ............................................................. 11
9 (b) Gametangia swollen ................................................................. 12
10 (a) Zygospores ellipsoid ............................................................... S. submarina
10 (b) Zygospores not laterally compressed ..................................... 13
11 (a) Chloroplasts 3-4 in each cell ................................................. S. paradoxa
11 (b) Chloroplasts 2-3 in each cell ................................................ S. dubia
12 (c) Chloroplast 2 in each cell ....................................................... S. bucteii

1. **Spirogyra communis** (Hassal) Kutzing.

**Habitat and Habit:** Lentic water conditions; Free floating.

**Vegetative feature:** Vegetative cells 18-25 µ x 40-75 µ; end wall plain; chloroplast 1, making 1.5-4 turns (Plate-I; Fig.1).

**Reproductive features:** Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cell cylindrical, rarely enlarged; Zygospores ellipsoid to ovoid, 19-25 µ x 42-78 µ; medium spore wall yellow and smooth (Plate-I; Fig.2&3).

**Geographical distribution:**
World: New Caledonia (U.S.A), North-east Pakistan, Poland
India: Gorakhpur (U.P), Assam.
Jammu: Paddy fields of Seri, Bandhu Rakh stream (12-1-2008), Pond of Bagh-e-Bahu (8-2-2009), Seasonal pond of Sagoon (19-10-2008).
Variations recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, number of spiral turns of chloroplast, conjugation types differed from scalariform to lateral. Zygospore variations also differed.

2. *Spirogyra singularis* Nordstedt.


**Habitat and Habit:** Lentic water condition; Free floating.

**Vegetative feature:** vegetative cells 25 x 35μ x 80-105μ; end wall plain; chloroplast 1, making 2-3.5 turns (Plate-I; Fig.4).

**Reproductive features:** Conjugation Scalariform; conjugation canal is formed by both gametangia; fertile cell centric, rarely enlarged; Zygospores ellipsoid to oval, 23-32 x 45-65 μ; medium spore wall yellowish brown and smooth (Plate-I; Fig5&6).

**Geographical Distribution:**
World: China, South Africa, Brazil, Finland, New Zealand and U.S.A.
Jammu: Paddy fields of Raipur (13-8-2009), River Tawi (3-1-2009), Pond of Bagh- e- Bahu (8-2-2009), ditches along the main stream, Jhajjar Kotli (27-11-2008).

**Variation recorded:** This species was collected in winter seasons from the ditches, fields, ponds and puddles and is rice field after monsoons. This species is highly variable in cell dimensions, number of spiral turns of chloroplast, turns varied from 3-7. Zygospore variations also differed.


**Habitat and Habit:** Lotic water condition; Free floating.

**Vegetative feature:** Vegetative cells 20 x 30μ x 42-80μ; chloroplast 1, making 1-2 turns (Plate-I; Fig-7).

**Reproductive features:** Conjugation Scalariform; conjugation canal is formed by both gametangia; fertile cell slightly swollen on conjugation side; Zygospores oval, 28-32 x 58-74 μ; medium spore wall yellowish brown and smooth (Plate-I; Fig-8).

**Geographical distribution:**
World: Nanking, Peiping, China, Humania, U.S.A, Arizona, Pakistan
India: Not reported earlier.
Jammu: Slow moving stream Pragwal (2-3-2008), River Tawi tributary (14-12-2008), Lake Mansar (10-2-2009), ditches along the main stream at Jhajjar Kotli (4-1-2009).

**Variation recorded:** This species was collected in winter seasons from the ditches, fields, ponds and puddles.
This species is highly variable in cell dimensions, number of spiral turns of chloroplast, turns varied from 1-6.
Zygospore variations also differed from 50-78 μ to 52-80μ.


**Habitat and Habit:** Lotic water condition; Free floating / Epiphytic on *Potamegeton* sp.

**Vegetative feature:** vegetative cells 35-48μ x 58-120μ; chloroplast 1, making 1-2 turns.

**Reproductive features:** Conjugation Scalariform; conjugation canal is formed by both gametangia; fertile cell inflated on the outer side; Zygospores ovoid to ellipsoid, 38-50 x 60-125 μ; medium spore wall brown; mesospore 2 layered and smooth (Plate-I; Fig-9).
Geographical distribution:
World: Tibet, China, U.S.A, Pakistan
India: Not reported earlier.
Jammu: Pond in Botanical Garden, JU (7-01-2009), Lake Surinsar (4-1-2008), ditches along the road side at Bishnah (15-3-2008).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, number of spiral turns of chloroplast, turns varied from 1.5-5. Zygospore varied in shape, oval to ellipsoid and yellow to brown, respectively.

5. **Spirogyra calearea** Transeau.
(Transeau ,1951. p.226; Randhawa, 1959, The Zygnemataceae, p 413, fig. 499).

Habitat and Habit: Letic water condition; Free floating / Epiphytic on *Potamegeton* sp.

Vegetative feature: Vegetative cells 38-40µ x 60-75µ; chloroplast 1, making 2-2.5 turns (Plate-I; Fig-10).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; receptive gamentangia inflated only on the outer side; Zygospores ellipsoid, 40-45 × 65-78 µ; medium spore wall yellowish brown; smooth (Plate-I; Fig-11).

Geographical distribution:
World: U.S.A, Brazil, India, Pakistan.
India: Punjab, Dehradun, U.P.
Jammu: Seasonal pond at village Gho Manasha (15-11-2008), Slow moving stream at Samba (5-2-2008), Jhajjar Nallah (7-10-2008), Lake Mansar (12-1-2009), Seasonal pond at Sagoon (3-3-2008), Paddy Field at R.S.Pura (27-11-2009).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, number of spiral turns of chloroplast, turns varied from 2-3. Nature of reproductive cells show difference viz., fertile cells inflated on conjugating scale or inflated completely. Zygospores varied in dimension, shape, colour and nature showed variability.

6. **Spirogyra crassoidea** Transeau.

Habitat and Habit: Letic water condition; Free floating.

Vegetative feature: Vegetative cells 140-145µ x 180-320µ; chloroplast 3, making 2-2.5 turns in each cell (Plate-I; Fig-12).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells cylindric and slightly swollen on the inner side; Zygospores ellipsoid, 125-140µ × 150-220µ; medium spore wall brown; smooth (Plate-I; Fig-13).

Geographical distribution:
World: U.S.A, Brazil, India, Pakistan.
India: Punjab, Dehradun, U.P.
Jammu: Seasonal pond at village Gho Manasha (15-11-2008), Slow moving stream at Samba (5-2-2008), Jhajjar Nallah (7-10-2008), Lake Mansar (12-1-2009), Seasonal pond at Sagoon (3-3-2008), Paddy Field at R.S.Pura (27-11-2009).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, number of spiral turns of chloroplast, turns varied from 1-6. Nature of reproductive cells show difference viz., fertile cells inflated on conjugating scale or inflated completely. Zygospores varied in dimension, shape, colour and nature showed variability.

7. **Spirogyra rectispira** Merriman.
Habitat and Habit: Letic water condition; Free floating.

Vegetative feature: Vegetative cells 130-170 µ x 80-280 µ; plain end walls; chloroplast 12-14, making 1-1.5 turns in each cell (Plate-I; Fig-14).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells cylindric and slightly enlarged on the inner side; Zygospores ellipsoid to ovoid, 155-145 µ x 100-120 µ; brown (Plate-I; Fig-15).

Geographical distribution:
World: U.S.A.
India: Not reported earlier.
Jammu: Man made pond at Bagh-e-Bahu (5-2-2008), Athum pond at Jammu-Surinsar road (19-8-2008), Seasonal pond at Sagoon (18-1-2009), Paddy Field at Raipur (27-8-2008).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, chloroplast number varied from 2-3, turns varied in number. Zygospores varied in dimension, shape, colour and nature shown variability.


Habitat and Habit: Letic water condition; Free floating.

Vegetative feature: Vegetative cells 20-35 µ x 68-155 µ; plain end walls; chloroplast 3, making 2-3 turns in each cell (Plate-I; Fig-16).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells cylindric and slightly enlarged on the inner side; Zygospores ellipsoid to ovoid, 25-37 µ x 55-125 µ; brown (Plate-I; Fig-17).

Geographical distribution:
World: U.S.A, China, Brazil, Pakistan, Bermuda
India: Not reported earlier.
Jammu: Agriculture field Bishnah (12-8-2008), Paddy Field at R S Pura (07-8-2009).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, chloroplast number varied from 2-3, turns varied in number. Zygospores varied in dimension, shape, colour and nature showed variability.


Habitat and Habit: Lotic water condition; Free floating.

Vegetative feature: Vegetative cells 35-38 µ x 80-210 µ; plain end walls; chloroplast 3-4, making 0.5-1 turns in each cell (Plate-II; Fig-18).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells cylindric and slightly enlarged on the inner side; Zygospores ellipsoid to ovoid, 32-35 µ x 45-85 µ; yellowish brown (Plate-II; Fig-19).

Geographical distribution:
India: Sunderbands.
Jammu: Ditches along the road side Bishnah (15-3-2008), Lake Surisar (6-12-2008), Permanent pond in Botanical Gardern JU (17-1-2008).
Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, chloroplast number varied, turns varied in number from 1.5-5. Zygospores varied in dimension, shape, colour and nature showed variability.

10. **Spirogyra hollandiae** Taft.

Habitat and Habit: Lotic water condition; Free floating.
Vegetative feature: Vegetative cells 32-35µ x 68-120µ; plain end walls; chloroplast 2, making 2-3 turns in each cell (Plate-II; Fig-20).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells cylindric or slightly enlarged on the inner side; Zygospores ellipsoid, 34-36µ x 70-75µ; yellow to brown at maturity (Plate-II; Fig-21).

Geographical distribution:
World: Dutch New Guinea.
India: Not reported earlier
Jammu: Lake Mansar (15-08-2009), Permanent pond in Bagh-e-Bahu (7-1-2008).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, chloroplast number varied from 2-4, turns varied in number from 1-2.5. Zygospores varied in dimension, shape, colour and nature showed variability.

11. **Spirogyra hyaline** Cleve.

Habitat and Habit: Lotic water condition; Free floating.
Vegetative feature: Vegetative cells 45-50µ x 150-200µ; plain end walls; chloroplast 4, making 2-2.5 turns in each cell (Plate-II; Fig-22).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells cylindric; Zygospores ellipsoid, 48-52µ x 155-175µ; brown (Plate-II; Fig-23).

Geographical distribution:
World: China, Sweden, U.S.A.
India: Widely distributed
Jammu: Slow-moving stream at Bandhu Rakh (15-08-2009), Permanent pond in Bagh-e-Bahu (7-1-2008), Agricultural field at Tikri (3-4-2008).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, chloroplast number varied from 2-4, turns varied. Zygospores varied in dimension, shape, colour and nature showed variability.

12. **Spirogyra pseudoneglecta** Czurda.

Habitat and Habit: Lotic water condition; Free floating.
Vegetative feature: Vegetative cells 50-60µ x 132-150µ; plain end walls; chloroplast 3, making 1.5-2 turns in each cell (Plate-II; Fig-24).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells cylindrical or swollen slightly; Zygospores ellipsoid, 60-65µ x 98-120µ; median spore wall reddish brown, mesospore 3 layered, smooth (Plate-II; Fig-25).
Geographical distribution:
World: Moravia.
India: M.P
Jammu: Slow-moving stream at Bandhu Rakh (15-08-2009), Permanent pond in Sagoon (7-1-2008), Agricultural field at Tikri (3-4-2008), Ditches of Pragwal (17-10-2008).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, chloroplast number varied, turns varied from 1-2. Nature of reproductive cell show difference viz., fertile cells inflated on conjugating scale or inflated completely. Zygospores varied in dimension, shape, colour and nature showed variability.


Habitat and Habit: Letic/lotic water condition; Free floating.

Vegetative feature: Vegetative cells 52-60µ x 162-185µ; plain end walls; chloroplast 4, making 2-2.5 turns in each cell (Plate-II; Fig-26).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gametangia; fertile cells swollen slightly on the conjugating side; Zygospores oval, 54-62µ x 162-187µ brown, mesospore, smooth (Plate-II; Fig-27).

Geographical distribution:
World: Brazil, China, Germany, Finland, U.S.A, Siam,South Africa, Macedonia, Java.
India: M.P. U.P.Calcutta, Punjab.
Jammu: Slow-moving stream near Surinsar (12-10-2009), ditches along the main stream Jhajjar Kolti (17-10-2008), Agricultural field at Tikri (6-11-2008), Ditches along the road side at Samba (4-1-2008).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, number of chloroplast turns varied from 3-4. Zygospores varied in dimension, shape, colour and nature showed variability.


Habitat and Habit: Letic water condition; Free floating.

Vegetative feature: Vegetative cells 80-92µ x 70-85µ; plain end walls; chloroplast 3-4, making 1-2 turns in each cell (Plate-II; Fig-28).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gametangia; fertile cells swollen slightly on the conjugating side; Zygospores oval, 82-95µ x 72-89µ; yellowish brown at maturity; median spore wall 2 layerd, smooth (Plate-II; Fig-29).

Geographical distribution:
India: U.P.Bihar.
Jammu: Slow-moving stream near Surinsar (12-10-2009), ditches along the main stream Jhajjar Kolti (17-10-2008), Agricultural field at Tikri (6-11-2008), Ditches along the road side at Samba (4-1-2008).

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions, number of chloroplast turns varied from 1-3.5. Shape of zygospores showed variation i.e, spherical to oval. Zygospores varied in dimension, shape, colour and nature showed variability. Layers of zygospores ranged from 2-3.
15. Spirogyra dubia (Kutzing) Czurda.

Habitat and Habit: Letic water condition ; Free floating.

Vegetative feature: Vegetative cells 52-58µ x 90-110µ ; plain end walls; chloroplast 2, making 2-3 turns in each cell (Plate-II; Fig-30).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells swollen slightly on the conjugating side ; Zygospores oval , 50-55µ x 88-100µ;mesospores thick, smooth brown (Plate-II; Fig-31).

Geographical distribution: World: Africa, Bulgaria, Egypt, North America

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions , number of chloroplast varied from 2-4, number of chloroplast turns varied from 2-4. Reproductive cell show slight variation in nature. Zygospores wall ranges from 2-3 and also showed variation in colour and ornamentation.


Habitat and Habit: Letic water condition ; Free floating.

Vegetative feature: Vegetative cells 45-48µ x 120-140µ ; plain end walls; chloroplast 2, making 2-3 turns in each cell (Plate-II; Fig-32).

Reproductive features: Conjugation Scalariform; conjugation canal is formed by both gamentangia; fertile cells inflated from outer side ; Zygospores ellipsoid to oval, 47-50µ x 125-150µ;median spore wall yellow, mesopores 2 layered, smooth (Plate-II; Fig-133).

Geographical distribution: World: China, Moracco, U.S.A.

Variation recorded: This species was collected in winter seasons from the ditches, fields, ponds and puddles. This species is highly variable in cell dimensions , number of chloroplast varied, number of chloroplast turns varied. Reproductive cell varies viz, shortened oval inflated to 50-52µ. Zygospores dimension and colour also showed difference.

References:
[15]. Kutzin.1849. Species Algarum, p.441
[17]. Nagelli.1849. In Kutzin Species Algarum, p. 440
[20]. Raandhawa, M.S.1940. Some peculiarities in conjugation in new Himalayan species of Zygnum .129.

Plate I

Fig.1- S communis vegetative filament; Fig.2- S communis Lateral conjugation; Fig.3-Alpanospore of S communis; Fig.4- S singularis Vegetative filament; Fig.5- S singularis Scalariform conjugation; Fig.6-Zygospore of S singularis; Fig.7-S teodoresei Vegetative filament; Fig.8-Zygospore of S teodoresei; Fig.9- S borgeana Scalariform conjugation; Fig.10- S calcarea Vegetative filament; Fig.11- S calcarea Zygospore; Fig.12-S crassoidea Vegetative filament; Fig.13-S crassoidea Receptive gametangia; Fig.14- S rectispira vegetative filament; Fig.15- S rectispira scalariform conjugation; Fig.16- S submarina vegetative filament; Fig.17- S submarina Scalariform conjugation.
Fig. 18 - *S irregularis* vegetative filament; Fig. 19 - *S irregularis* scalariform conjugation and Zygospore formation; Fig. 20 - *S hollandiae* Vegetative filament; Fig. 21 - *S hollandiae* Scalariform conjugation; Fig. 22 - *S hyalina* Vegetative filament; Fig. 23 - *S hyaline* Scalariform conjugation; Fig. 24 - *S pseudoneglecta* vegetative filament; Fig. 25 - *S pseudoneglecta* Mature zygospore; Fig. 26 - *S neglecta* vegetative filament; Fig. 27 - *S neglecta* Scalariform conjugation; Fig. 28 - *S paradoxa* vegetative filament; Fig. 29 - *S paradoxa* Mature zygospore; Fig. 30 - *S dubia* vegetative filament; Fig. 31 - *S dubia* Scalariform conjugation; Fig. 32 - *S buchetii* vegetative filament; Fig. 33 - *S buchetii* Zygospores.