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Addition to the List of Brackish Water Zygnemaceae of Sundarbans and its Adjoining Areas, India Genus S*pirogyra* Link

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Abstract
A total 12 species of *Spirogyra* Link was recorded from brackish water of Indian Sundarbans and its adjoining areas. *Spirogyra dubia* and *Spirogyra ternata* are found in the present study which was reported earlier. *Spirogyra setiformis* is uncommon to the present study which was also recorded earlier. This study represents 10 species of Spirogyra are being reported for the first time from this region.

***Key words*:** Algae, brackish water, *Spirogyra*, Sundarbans, India

Introduction

Brackish water of Sundarbans has long and traditional background of bheri fisheries in North and South 24 Parganas Districts of West Bengal, India. The Sundarbans cover an area about 9000 km^2 which is estimated about 34% in Indian Territory and 66% is in the Bangladesh. Sundarban is the largest continuous block of deltaic mangrove estuary in the world (Chaudhuri and Choudhuri, 1994). The average temperatures of Indian Sundarbans are 27^0C during summer and 17-20^0C during winter and average annual rainfall is 175-200 cm. The population of Sundarbans is 40 lakhs and population density with 694 persons / km^2.

Brackish water of Indian Sundarbans and its adjoining areas provide a unique habitat for algae and its enormous diversity and abundance have an impact on the faunal diversity of brackish water wetlands (Naskar, 2008).

The reports on brackish water algae from Indian Sundarbans are noticed in the works of Naskar and Santra (1985), Mandal and Naskar (1994), Sen *et al.* (1977), Sen and Naskar (2000), Sen (2003) and Naskar *et al.* (2006, 2007, 2008a, 2008b). The present study on algal biodiversity in brackish water of Sundarbans with the administrative blocks *viz.* Hingalganj, Sandeshkhali I and II, Haroa, Hasnabad and Minakhan and its adjoining areas with the blocks viz. Basirhat I and II, Baduria, Barasat II, Rajarhat and Deganga of North 24 Parganas, West Bengal, India reveals the Chlorophyceae second largest algal community as to compare with Cyanophyceae (largest community), Bacillariophyceae, Xanthophyceae, Chrysophyceae, Dinophyceae and Rhodophyceae. The Chlorophyceae

represents the orders Ulotrichales, Ulvales, Cladophorales, Oedogoniales, Zygnematales, Desmidiales and Chlorococcales. The 10 species of *Spirogyra* representing the family Zygnemaceae are not recorded earlier from brackish water of Sundarbans and its adjoining areas in India.

Materials and Methods

The study was carried out (2002-2005) in brackish water area of Sundarbans and its adjoining areas of North 24 Parganas district, West Bengal, India (Fig. 1). The location of the study sites cover an area about 34000.48 ha and lie at $22^0 26^/$-23^0N and $88^0 39^/$-$88^0 28^/$E.

The salinity spectrum divides the study area as Station 1 (Sandeshkhali I and II), Station 2 (Hingalganj, Haroa, Hasnabad, Minakhan, Basirhat I and II, Baduria) and Station 3 (Barasat II, Rajarhat and Deganga).

Algal samples were collected during 10-11 am covering the seasons summer, monsoon, post monsoon and winter by plankton net (mesh size 25µm), scalpel and forceps and preserved in 4% formalin. The samples were deposited at the CIFRI (ICAR) laboratory in Kolkata Centre. The camera lucida drawings and some microphotographs were also taken from preserved and fresh materials for identifying the specimens. Identification of algae based on the keys of Biswas (1949) and Randhawa (1959). The water parameters *viz*. p^H, temperature and salinity were also studied following APHA (1975).

Results and discussion

Taxonomic enumeration

Division Chlorophyta
Class Chlorophyceae
Order Zygnematales
Family Zygnemaceae
Genus *Spirogyra* Link

1. *Spirogyra maravillosa* Transeu (Pl. 1, Fig. 1)
Randhawa, 1959, P. 388, Fig. 443.
Filaments green; vegetative cells 52-56µm broad, 124-140µm long with plane end walls; 2-3 chloroplasts making 2-5 turns in the cell.
Locality: Station-3 (Deganga), free floating, winter.

2. *Spirogyra neglecta* (Hassall) Kützing (Pl. 1, Fig. 2)
Biswas, 1949, P. 82, Pl. 6, Figs. 60a-b; Randhawa, 1959, P. 324, Fig. 308.
Filaments green; vegetative cells 52-65µm broad, 165-169µm long, cells long 2 times or more than broad, septa plane; 3 chloroplasts making $2^1/_2$ turns.
Locality: Station-2 (Basirhat II), free-floating, winter.

3. *Spirogyra angolensis* Welwitsch (Pl. 1, Fig. 3)
Randhawa, 1959, P. 324, Fig. 324.
Filaments yellow-green; cells longer than broad, 52-61.75µm broad, 156-182µm long, plane end wall; 2 or 3 chloroplasts making 2 or 3 turns.
Locality: Station-3 (Barasat II), free-floating, monsoon.

4. *Spirogyra hyalina* Cleve (Pl. 1, Fig. 4)
Randhawa, 1959, P. 318, Fig. 294.
Filaments yellow-green; vegetative cells 45.5-52µm broad, 94-130µm long with plane end walls; chloroplasts 4, making 3 turns.
Locality: Station-3 (Barasat II), free-floating, monsoon.

5. *Spirogyra majuscula* Kützing (Pl. 1, Fig. 5)
Randhawa, 1959, P. 344, Fig. 348.
Filaments yellow green; vegetative cells 52-58.5µm broad, 224-247µm long, much longer than broad, end walls plane; chloroplasts 4, reticulate appearance.
Locality: Station-3 (Barasat II), free-floating, monsoon.

6. *Spirogyra irregularis* Nägeli (Pl. 2, Fig. 6)
Randhawa, 1959, P. 316, Fig. 290.
Filaments greenish, slender; vegetative cells 30-32µm broad, 160-192µm long; end walls plane; chloroplast 2 in number making single turn.
Locality: Station- 2 (Hasnabad), free-floating, monsoon and post monsoon.

7. *Spirogyra condensata* (Vaucher) Kützing (Pl. 2, Fig. 7)
Randhawa, 1959, P. 291, Fig. 245.
Filaments yellow-green; vegetative cells 52-65µm broad, 71.5-104µm long, septa of the cells plane; chloroplast single forming 1 to $2^1/_2$ spirals.
Locality: Station-3 (Barasat II), free-floating, winter.

8. *Spirogyra juergensii* Kützing (Pl. 2, Fig. 8)
Randhawa, 1959, P. 94, Fig. 250.
Filaments deep green; vegetative cells 25-44µm broad, 120-128µm long, up to 5 times long as broad, septa swollen; single chloroplast making more than two turns.
Locality: Station-2 (Hasnabad), free-floating, monsoon.

9. *Spirogyra sahnii* Randhawa (Pl. 2, Fig. 9)
Randhawa, 1959, P. 307, Fig. 274.
Vegetative cells 60-64µm broad, 68-76µm long, as long as broad, swollen and barrel shaped, septa plane; chloroplast single and arranged in an irregular fashion.
Locality: Station-2 (Basirhat II), free-floating, winter.

10. *Spirogyra silvicola* Britton (Pl. 2, Fig. 10)
Randhawa, 1959, P. 403, Fig. 478.
Vegetative cells longer than broad, 32-33µm broad, 84-104µm long; cells with single chloroplast making upto 3 turns in the cell.
Locality: Station-3 (Deganga), free-floating, monsoon.

The study area as a whole is an extraordinary in terms of algal species richness and diversity. Brackish waters are biologically more productive than fresh water or even sea water whether inshore or offshore (Sanjeevraj, 2003). The abundance and biodiversity of algae in the brackish water of Sundarbans and its adjoining areas influence the ecosystem function which in turn increases the fish production of the study area (Naskar, 2008). *Spirogyra* is the sign of polluted and turbulent water and indicator of high levels of organic pollution, high concentration of heavy metals, high levels of nutrients (Venkateswarlu and Reddy, 1997).

The genus *Spirogyra* is found during monsoon, post monsoon and winter only. Temparature and light have important role in regulating algal growth but the water temperature is not a significant factor for algal growth as it was always within the biokinetic range and never fall below 12^0C (Knopp, 1960). But it definitely played an important role in regulating the seasonal spectrum of algae. Brackish water was

Figure 1. Study area

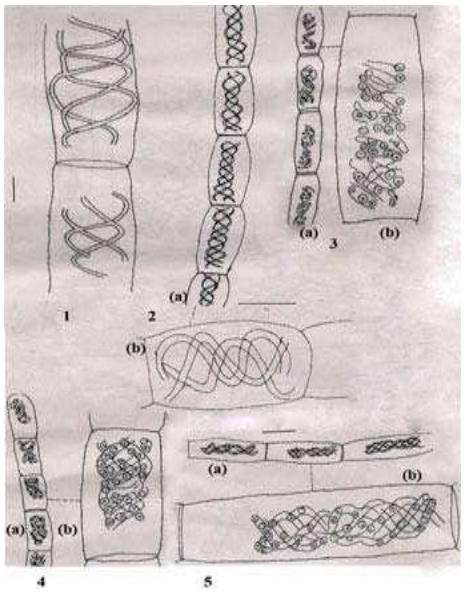

Plate 2: Figure 1. *Spirogyra maravillosa* Transeu, 2. *Spirogyra neglecta* (Hassall) Kütz., 3. *Spirogyra angolensis* Welwitsch, 4. *Spirogyra hyalina* Cl., 5. *Spirogyra majuscula* Kütz.. Scale bar: Figs 1, 2(b), 3(b), 4(b), 5(b)= 20µm; Figs 2(a), 3(a), 4(a), 5(a)= 100µm.

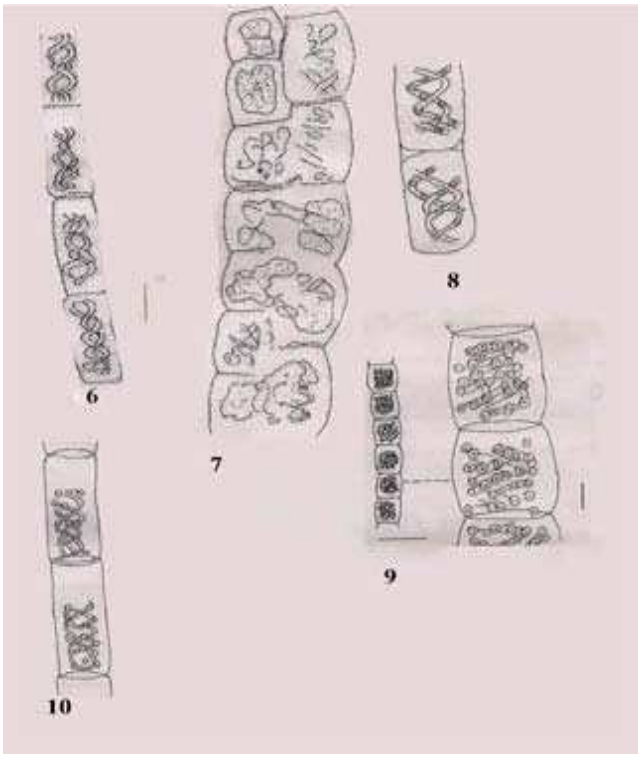

Plate 3: Figure 6. *Spirogyra irregularis* Näg., 7. *Spirogyra condensata* (Vaucher) Kütz., 8. *Spirogyra juergensii* Kütz., 9. *Spirogyra sahnii* Randhawa, 10. *Spirogyra silvicola* Britton. Scale bar: Figs 7, 8, 9(b), 10= 20µm; Figs 6, 9(a)= 100µm.

Table 1. Occurrence and distribution of *Spirogyra* spp. in brackish water of Sundarbans and its adjoining areas, India.

Locality	Average salinity (gl^{-1})	No. of species	Average Temperature (^0C)	Average p^H
Station 1 (Sandeshkhali I and II)	15.1	Nil	26.05	8
Station 2 (Hingalganj, Haroa, Hasnabad, Minakhan, Basirhat I and II, Baduria)	6.7	6	24.65	8.15
Station 3 (Barasat II, Rajarhat and Deganga)	5.9	6	26.95	8.25

alkaline as the p^H values are always above 7 (Table 1) supports high algal number than acid waters (Woodson, 1960).

The salinity values also played an important role affecting the distribution and growth of algae in the brackish water. The Station 1 with average salinity value 15.1 gl^{-1} is not favourable for the growth of *Spirogyra* spp. which showed total absence from this zone (Table 1). The average salinity values with 5.9 gl^{-1} of station 3 and 6.7 gl^{-1} of station 2 (Table 1) appear to be favourable for the growth of *Spirogyra* spp. Hence, the certain salinity values favour the occurrence of this group of algae. So, the distribution and occurrence of *Spirogyra* spp. may be used for bio-monitoring study.

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