Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 1, No. 6, p. 165-173, 2011
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Taxonomic assessment of Zygnemataceae Bangladesh perspective

Md. Solaiman Ali*, Sabrina Naz

Department of Botany, University of Rajshahi, Rajshahi 6205, Bangladesh

Received: 04 November 2011
Revised: 14 November 2011
Accepted: 15 November 2011

Key words: Zygnemataceae, distribution, diversity, Bangladesh.

Abstract

Record from National and International literature from 1966 to 2006, six genera of Zygnemataceae recorded from different districts of Bangladesh. Among these, *Mougeotia* Agardh are represented 23 taxa, *Sirogonium* Kützing four taxa, *Spirogyra* Link 66 taxa, *Sirocladium* Randhawa, *Temnogametum* W. & G.S. West solitary taxa each and *Zygnema* Agardh 12 taxa. Maximum diversity of the taxa was observed in central part of Bangladesh. About 80% habitats were lentic type, while the others are of lotic type. In Bangladesh all the taxa of Zygnemataceae are reported to be found in freshwater habitats and found all the season specially in winter period. Distribution pattern and habitats of Zygnemataceae reveal that they are capable of growing in diversified habitat including varying degrees of alkalinity, acidity (pH = 6-7.5).

***Corresponding Author:** Md. Solaiman Ali ✉ ali_ru82@yahoo.com

Introduction

Zygnemataceae of Chlorophyta is unique among algal groups for its wide distribution and documentation as an integral part of global biodiversity. Biodiversity provides a useful measure of the quality of environment and of the probability of sustainability (Oksanen, 1997; Kunin and Lawton, 1996). Transeau (1951) divided order Zygnematales into 3 families viz., Zygnemataceae, Mesotaeniaceae and Desmidiaceae, again Transeau (1951) divided family Zygnemataceae in to 13 genera such as *Zygnema* Agardh, *Zygnemopsis* (Skuja) Transeau, *Hallasia* Rosenvinge, *Zygogonium* Kützing, *Pleurodiscus* Lagerheim, *Mougeotiopsis* Palla, *Debarya* (Wittrock) Transeau, *Mougeotia* Agardh, *Temnogametum* W. & G.S. West, *Sirocladium* Randhawa, *Entransia* Elwyn Hughes, *Spirogyra* Link and *Sirogonium* Kützing. Of these genera *Spirogyra* Link assumes larger with its 400 species in the world (Kim et al., 2006). Zygnemataceae are filamentous, mainly unbranched, fresh water algae but also some member like *Spirogyra* Link found in brackish water (e.g. *S. maravillosa* Transeau, *S. neglecta* (Hassall) Kützing, *S. hyalina* Cleve) where salinity range 5.9-6.7 gl-1, temperature 24.65°C-26.95°C, pH 8.15-8.25 (Naskar et al., 2009).

Actually they are free floating some attached by rhizoids in *Spirogyra* Link (*S. dubia* Kützing), *Mougeotia* Agardh, *Sirocladium* Randhawa (*S. kumaoense* Randhawa), *Zygogonium* (*Z. kumaoense* Randhawa), terrestrial forms are also found in *Zygogonium* Kützing, *Sirocladium* Randhawa, *Zygnema* Agardh (*Z. terrestre* Randhawa) (Randhawa, 1959). The members of the Zygnemataceae have a Worldwide distribution e.g. *Mougeotia* Agardh, *Spirogyra* Link and *Zygnema* Agardh, some have restricted distribution like *Debarya* (Wittrock) Transeau, *Zygnemopsis* (Skuja) Transeau, *Zygogonium* Kützing, *Mougeotiopsis* Palla, *Sirocladium* Randhawa, *Entransia* Elwyn Hughes, *Temnogametum* W. & G.S. West, *Pleurodiscus* Lagerheim and *Hallasia* Rosenvinge. *Debarya* (Wittrock) Transeau recorded from India, Australia, China, U.S.A.; *Zygnemopsis* (Skuja) Transeau from India, U.S.A., China, South Africa, England; *Zygogonium* Kützing form India, U.S.A., South Africa, Australia, China, England; *Mougeotiopsis* Palla from U.S.A., Czechoslovakia, Austria, Latvia; *Entransia* Elwyn Hughes from Canada, *Temnogametum* W. & G.S. West from Brazil, Ecuador, Trinidad, South Africa, India; *Pleurodiscus* Lagerheim and *Hallasia* Rosenvinge from Puertorico and Denmark respectively and *Sirocladium* Randhawa have been recorded only from India and Bangladesh (Randhawa, 1959).

Study on member of Zynemataceae across North America such as *Zygnema* Agardh, *Spirogyra* Link, *Mougeotia* Agardh reported 95% of the collection made (Wehr and Sheath, 2003). Vegetative filaments of *Mougeotia* Agardh, *Spirogyra* Link and *Zygnema* Agardh forming green mats in arctic region are also found. Zygnemataceae are common in India, in fresh water ponds, puddles, paddy fields, Jhils and particularly are abundant in slowly flowing fresh water streams.

Exceptionally a small number of these algae are found in the major river when they are in flood during the monsoons. They also found in the Himalayas at the attitudes of 5500-10,000 feet but *Zygnema terrestre* Randhawa is also found in Kashmir at an altitude of 12,100 feet. Heavy and medium rainfall from 100-30 inches is favorable for its germination and growths but in the dry areas they are rare. Filaments of Zygnemataceae divided by cross walls, cell wall may be single or multilayered, without pores, contain different chloroplasts with pyrenoids and have a single nucleus in each cells. Reproduction of Zygnemataceae takes place vegetatively by fragmentation of filaments, asexual by akinetes, aplanospores, parthenospores and sexual known as conjugation that may be lateral or scalariform (Randhawa, 1959).

Bangladesh is agreat subtropical Delta in South Asia, between 20°34'-26°38' North latitude and 88°01'-

92°41' East longitude, containing area 147,570 sq km, a humid low-lying alluvial region abounding in innumerable natural and artificial bodies of water including the rivers, haors, baors, beels, flood plains, wetlands and multitude of ponds, Bangladesh is composed mainly of the great combined delta of the Ganges-Brahmaputra-Meghna Rivers. Climate of Bangladesh is subtropical monsoon. Average maximum and minimum winter temperatures are 29°C and 11°C respectively; average maximum and minimum summer temperatures are 34°C and 21°C respectively. Annual rainfalls are 1,194-3,454 mm; highest humidity is 80%-100% in August-September, lowest is 36% in February-March (http://www.banglapedia.org/httpdocs/HT/B_0141.HTM). In Bangladesh, furthermore, during monsoon, about 50% land is inundated and considered as wetland. These entire environments harbour a diverse number of Zygnematales member. Islam initiated the work of Zygnemataceae in 1965.

Geoclimatological position of Bangladesh indicates that the country might be rich in Zygnemataceae diversity, as anthropogenic activities are major causes which threaten the biodiversity most. An attempt has been undertaken in the present communication, to review the diversity, status and habitat of the Zygnemataceae in Bangladesh from existing data source (published and unpublished).

Materials and methods

The study was conducted mostly on the genera of Zygnemataceae of Bangladesh so far published with unpublished literatures viz. Sobhan, 1966; Islam, 1969 & 1972; Islam & Sobhan, 1976; Islam, 1977; Islam & Hossain, 1979; Islam, 1984; Zaman, 1991; Hasan, 2000; Salam, 2004; Fatima, 2005; Islam & Irfanullah, 2005 and Rashid, 2006. A detail taxonomic and ecological along with distribution study of the family Zygnemataceae was conducted by different researcher mostly from Dhaka district of Bangladesh.

Results and Discussion

The study was conducted mostly on the genera of Zygnemataceae of Bangladesh so far published with unpublished literatures viz. Sobhan, 1966; Islam, 1969 & 1972; Islam & Sobhan, 1976; Islam, 1977; Islam & Hossain, 1979; Islam, 1984; Zaman, 1991; Hasan, 2000; Salam, 2004; Fatima, 2005; Islam & Irfanullah, 2005 and Rashid, 2006. Existing literatures on Zygnemataceae (1966 – 2006) show (Table – 1) that till now 107 taxa of Zygnemataceae has so far been reported from different districts of Bangladesh. Inside Bangladesh, Zygnemataceae are found which represent 6 genera. Between these genera *Spirogyra* Link (66 taxa) found to be maximum followed by *Mougeotia* Agardh (23 taxa), *Zygnema* Agardh (12 taxa), *Sirogonium* Kützing (4 taxa), while *Sirocladium* Randhawa, *Temnogametum* (W. & G.S. West) with solitary taxa each. Maximum diversity of Zygnemataceae (*Mougeotia* 15, *Sirocladium* 1, *Sirogonium* 1, *Spirogyra* 27, *Temnogametum* 1, *Zygnema* 2 = 47 taxa) has been reported from Dhaka district followed by Sirajganj (*Mougeotia* 1, *Sirogonium* 1, *Spirogyra* 18, *Zygnema* 4 = 24 taxa), Narayanganj (*Sirogonium* 3, *Spirogyra* 17, *Zygnema* 3 = 23 taxa), Rajshahi (*Mougeotia* 6, *Sirogonium* 1, *Spirogyra* 6, *Zygnema* 3 = 16 taxa), Bandarban (*Spirogyra* 11 taxa), Naogaon (*Mougeotia* 2, *Spirogyra* 5, *Zygnema* 2 = 09 taxa), Chittagong (*Spirogyra* 04 taxa), Gazipur (*Spirogyra* 4 taxa), Mymensingh (*Sirocladium* 1, *Zygnema* 3 = 4 taxa), Bagerhat, Meherpur, Not mentioned (solitary *Spirogyra* each), Moulovi Bazar (solitary *Mougeotia*) Map: 1. Number of locations reveal a bit different scenario as it can be seen that maximum taxa were reported from Dhaka division (4 districts) followed by Rajshahi (3 districts), Chittagong, Khulna (2 districts each), and Sylhet (1 district). In both ways the interpretation of accumulated data reveals Dhaka district exhibited maximum diversity (47 taxa). This figure does not confirm that members of Zygnemataceae flourished well in and around Dhaka.

Table 1. List of *Mougeotia* Agardh, *Spirogyra* Link, *Sirocladium* Randhawa, *Sirogonium* Kützing, *Temnogametum* W. & G.S. West and *Zygnema* Agardh made from Islam, 1965; Sobhan, 1966; Islam, 1969 & 1972; Islam & Sobhan, 1976; Islam, 1977; Islam & Hossain, 1979; Islam, 1984; Zaman, 1991; Hasan, 2000; Salam, 2004; Fatima, 2005; Islam & Irfanullah, 2005 and Rashid, 2006.

Genus: *Mougeotia* Agardh			
No	**Name of Taxa**	**No**	**Name of Taxa**
01	*M. americana* Transeau (R)	02	*M. banneergattense* Iyengar (D)
03	*M. capucina* (Bory) Agardh (R)	04	*M. gelatinosa* (R)
05	*M. gotlandica* Cleve (Ng)	06	*M. laetevirens* (Br.) Wittr. fa. *dacchense* Islam (D)
07	*M. longiarticulata* Islam (D, Ng)	08	*M. longiarticulata* fa. *brevis* Islam (D)
09	*M. longiarticulata* fa. *nayarhatense* Islam (D)	10	*M. nummuloides* (Hassall) de Toni (R)
11	*M. oedogonoides* Czurda var. *dacchense* Islam (D)	12	*M. operculatam* Transeau (R)
13	*M. parvula* Hassall (D)	14	*M. pawhuskae* Taft. (D)
15	*M. scalaris* Hassall (D, S)	16	*M. seminoleana* Tiffany (R)
17	*M. subellipsoidea* Islam (D)	18	*M. subpaludosa* (D)
19	*M. thylespora* Skuja (D)	20	*M. transeaui* Collins (D)
21	*M. varians* (Wittr.) Czurda(D)	22	*M. virescens* (Hassall) Borge (D)
23	*M. viridis* (MB)	-	-
Genus: *Spirogyra* Link			
01	*S. amphimorpha* Islam (Nm)	02	*S. australensis* Möbius (G)
03	*S. bellis* (Hassall) Croun frat.(N)	04	*S. biformis* Jao (N)
05	*S. braziliensis* (Nordst.) Transeau (N)	06	*S. chakiense* Kolk. & Krie. (S)
07	*S. chittagongensis* Islam (C)	08	*S. communis* (Hassall) Kützing (S)
09	*S. collinsii* (Lewis) Printz (D)	10	*S. crassa* Kützing (S)
11	*S. crassoidea* (Transeau) Tiffany (D, S)	12	*S. crenulata* Singh (S)
13	*S. decimina* (Mull.) Kütz. (S)	14	*S. dubia* Kützing (D)
15	*S. ellipsospora* Transeau (D, S)	16	*S. elliptica* Jao (Mp)
17	*S. fluviatilis* Hilse (D, N)	18	*S. fragilis* Jao var. *dacchense* Islam (D)
19	*S. ghosei* Singh (S)	20	*S. gracilis* Kützing (Bb)
21	*S. hatillensis* Transeau (N, Ng, S)	22	*S. hoehnei* Borge (D, C)
23	*S. hopeiensis* Jao (C, Bb)	24	*S. hyalina* Cleve (D, N, Ng, S, R)
25	*S. hymerae* Britton and Smith(D, S, N)	26	*S. inflata* (Vaucher) Kützing (Bb)
27	*S. intorta* Jao (D, R)	28	*S. irregularis* Nägeli ex Kützing (D)
29	*S. jatobae* Transeau (D)	30	*S. juergensii* Kützing (Bb, S)
31	*S. lagerheimii* Wittrock & Nordstedt (Bb)	32	*S. lenticularis* Transeau (D)
33	*S. liana* Transeau (D, R)	34	*S. luteospora* Czurda (Bb)
35	*S. lutetiana* Petit (Ng, S)	36	*S. macrospora* (Rao) Krieger (N)
37	*S. marvillosa* Transeau(R)	38	*S. manoramae* Randhawa (Ng, S)
39	*S. mienningensis* Li. (N)	40	*S. nitida* (Dillwyn) Link (D, N)
41	*S. obovata* Jao (D)	42	*S. parvispora* Wood (N)
43	*S. porangabae* Transeau (D)	44	*S. pratensis* Transeau (D, Bb, R)
45	*S. pulchifigurata* Jao (D)	46	*S. quadrilaminata* Jao (N)
47	*S. randhawae* Kolkwitz & Krieger (D, N)	48	*S. rectangularis* Transeau (C)
49	*S. rhizobrachialis* Jao (D, G)	50	*S. rhizoides* Randhawa (D)

51	*S. robusta* (Nyg.) Czurda (Bb)	52	*S. scrobiculata* (Stockmayer) Czurda (S)
53	*S. setiformis* (Roth) Mart. (D)	54	*S. singularis* Wittrock & Nordstedt (D, G)
55	*S. subfragilis* Islam (Bb)	56	*S. sublamellata* Islam (N)
57	*S. submaxima* Transeau (D, S)	58	*S. subpapulata* Jao (Bb)
59	*S. subvermiculata* Islam (D)	60	*S. ternata* Ripart (G)
61	*S. undulisepta* Randhawa (R)	62	*S. varians* (Hassall) Kütz. (Bb, B, S)
63	*S. velata* Nordstedt (N)	64	*S. verrucosa* (Rao) Krieger (N, Ng, S)
65	*S. verrucosa* (Rao) Krieger var. *minor* Islam (D)	66	*S. verruculosa* Jao (N)

	Genus: *Sirocladium* Randhawa		
01	*Sirocladium kumaoense* Randhawa (D, M)	-	-
	Genus: *Sirogonium* Kützing		
01	*S. hui* (Li) Transeau (N)	02	*S. illinoiense* (Trans.) Smith (N)
03	*S. sticticum* (Engl. Bot.) Kütz. (D, S, R)	04	*S. ventersicum* Transeau (N)
	Genus: *Temnogametum* W. & G.S. West		
01	*T. subtropicum* Islam (D)	--	-
	Genus: *Zygnema* Agardh		
01	*Z. conspicuum* (Hassall) Transeau (D)	02	*Z. cylindrospermum* (West & West) Krieger (S)
03	*Z. globosum* Czurda (N)	04	*Z. globosum* var. *tropica* Islam (N, R)
05	*Z. haroonii* Islam (M, R)	06	*Z. insigne* (Hassall) Kützing (Ng, S)
07	*Z. kashmirense* Misra (S)	08	*Z. pectinatum* (Vaucher) Ag. (D)
09	*Z. reticulospora* Islam (M)	10	*Z. spontaneum* Nordstedt (Ng, S)
11	*Z. stellinum* (Vaucher) Ag. (M)	12	*Z. synadelphum* Skuja (N,R)

Elaboration of the Letter (Members of Zygnemataceae presented in this area)

B = Bagerhat, Bb = Bandarban, C = Chittagong, D = Dhaka, G = Gazipur, M = Mymensingh, MB = Maulvi Bazar, Mp = Meherpur, N = Narayanganj, Ng = Naogaon, Nm = Not mentioned, R = Rajshahi, S = Sirajganj.

Rather, it can be assumed that in early sixties to early eighties most of the algal research initiatives were concentrated within and surrounding areas of Dhaka as the first university of Bangladesh is situated in Dhaka and most of the researchers of Dhaka University were not interested to go out of Dhaka in present and past due to lack of fund, time and difficult travels. A detailed study in the country may reveal different pictures. Specimens were collected from different types of fresh water habitats. Habitats were of both lentic and lotic type. During present study 80% habitats were lentic type which included deep water rice field, ponds, road side ditch, and fresh water tanks. Among the lotic habitat Zygnemataceae were reported from lakes, large wetlands, beel (local name for wetland) and stranded river courses. Distribution pattern and habitats of Zygnemataceae reveal that they are capable of growing in diversified habitat including varying degrees of alkalinity, acidity (pH = 6-7.5). So far in Bangladesh all the taxa of Zygnemataceae are reported from freshwater habitats, not single taxa reported from brackish water habitats but some taxa of *Spirogyra* Link reported from brackish water of Sundarbans and its adjoining areas of India (Naskar et al., 2009). All the taxa found to grow in aquatic habitats without *Sirocladium kumaoense* Randhawa collected from moist soil at Mymensingh and Dhaka (Islam, 1965), sterile filament was also collected from similar habitat at Bagerhat (Islam and Hossain, 1979). However *Spirogyra setiformis* (Roth) Kg. was found from muddy soil in Bandarban districts (Islam 1984). Species of *Zygnema* Agardh, *Mougeotia* Agardh, *Temnogametum* (W. & G.S.

West), and *Sirogonium* Kützing were recorded mostly from Dhaka and other part of Bangladesh (Islam 1972, 1977).

On the other hand (Islam and Sobhan, 1976) the attached forms of *Spirogyra* Link, *Zygnema* Agardh, *Mougeotia* on *Enhydra fluctuans*, *Oryza sativa*, *Nymphaea* spp., etc were observed. The free-floating members of Zygnemataceae were found to be associated with various desmids such as *Cosmarium*, *Micrasterias*, *Desmidium*, *Netrium* and *Staurastrum*. Among these other phytoplankton, Diatoms, *Euglena*, *Tetraspora*, *Pandorina* and *Pediastrum* were common. Besides these the species of *Oedogonium*, *Pithophora*, *Cladophora*, *Stigeoclonium*, *Hydrodictyon, Bulbochaete*, *Chaetophora*, etc. were also found associated with Zygnemataceae members (Islam and Sobhan, 1976). To a lesser extent the blue-green algal species of *Microcystis*, *Oscillatoria*, *Lyngbya*, *Gloeotrichia*, *Nostoc*, *Anabaena, Scytonema* could be found to form an association with Zygnemataceous filaments. Generally when blue-green algae found in abundance, producing water-blooms the members of Zygnemataceae are not flourished well. Beautiful growth of the members of Zygnemataceae was observed in undisturbed aquatic habitat exposed to bright sun light. But the abundance of *Eichornea crassipes*, *Pistia stratoies* and *Azolla pinnata* usually checked their growth (Islam and Sobhan, 1976).

In Bangladesh reported genera of Zygnemataceae were found all the season, in winter period (November - February) species of *Temnogametum* (W. & G.S. West), *Spirogyra* Link and *Sirogonium* Kützing was collected in mature forms. In vegetative condition *Temnogametum subtropicum* Islam collected along with *Spirogyra* Link and *Zygnema* Agardh in December, matured stages found in January. Matured zygospore stages of the following *Spirogyra* species were found namely, *Spirogyra quadrilaminata* Jao, *S. irregularis* Naeg., *S. hymerae* Brit. and Smith, *S. ellipsospora* Trans., *S. fluviatilis* Hilse, *S. pulchifigurata* Jao, *S. singularis* Nordst., *S. randhawae* Kolkw. & Krieger, *S. rhizoides* Randhawa, *S. oblata* Jao, *S. jatobae* Trans., *S. lenticularis* Trans., *S. braziliensis* (Nordst.) Trans., *S. bellis* (Hassall) Cleve., *Sirogonium sticticum* (Engl. Bot.) Kg. was found in vegetative condition from the second week of December up to the end of this period. In spring and summer periods (March - May), zygospore of *Sirogonium sticticum* (Engl. Bot.) Kg. and *Spirogyra bellis* Hassall was found matured stage. *Mougeotia laetevirens* (Braun) Wittrock was found in vegetative and in early conjugating stage but not matured. The terrestrial *Sirocladium kumaoense* Randhawa was obtained with matured zygospores in May (Islam, 1965).

In Monsoon period (June - August) matured zygospores found on the following species *Mougeotia laetevirens* (Braun) Wittrock, *Temnogametum subtropicum* Islam, *Zygnema pectinatum* (Vauch.) Ag., *Z. synadelphum* Skuja, *Z. conspicuum* (Hass.) Trans., *Spirogyra bullata* Jao, *S. porangabae* Trans., *S. velata* Nordst., *S. macrospora* (Rao) Krieger, *S. hoehnei* Borge, *S. verrucosa* (Rao) Krieger, *S. verruculosa* Jao, *S. nitida* (Dillw.) Link, *S. quadrilaminata* Jao, *S. biformis* Jao, *S. randhawae* Kolkw. & Krieger and *S. lenticularis* Trans., *S. hui* (Li) Trans., *S. illinoiensis* (Trans.) Smith and *S. ventersicum* Trans., but in autumn period (September - November) matured zygospores are found on the following species *Spirogyra australensis* Moebius, *S. fluviatilis* Hilse, *S. hyalina* Cleve, *S. rhizobrachialis* Jao, *S. jatobae* Trans. and *S. bellis* (Hass.) Cleve. Immature stages of *Spirogyra elliptica* Jao and *S. hatillensis* Transeau have also been recorded in the ponds and ditches.

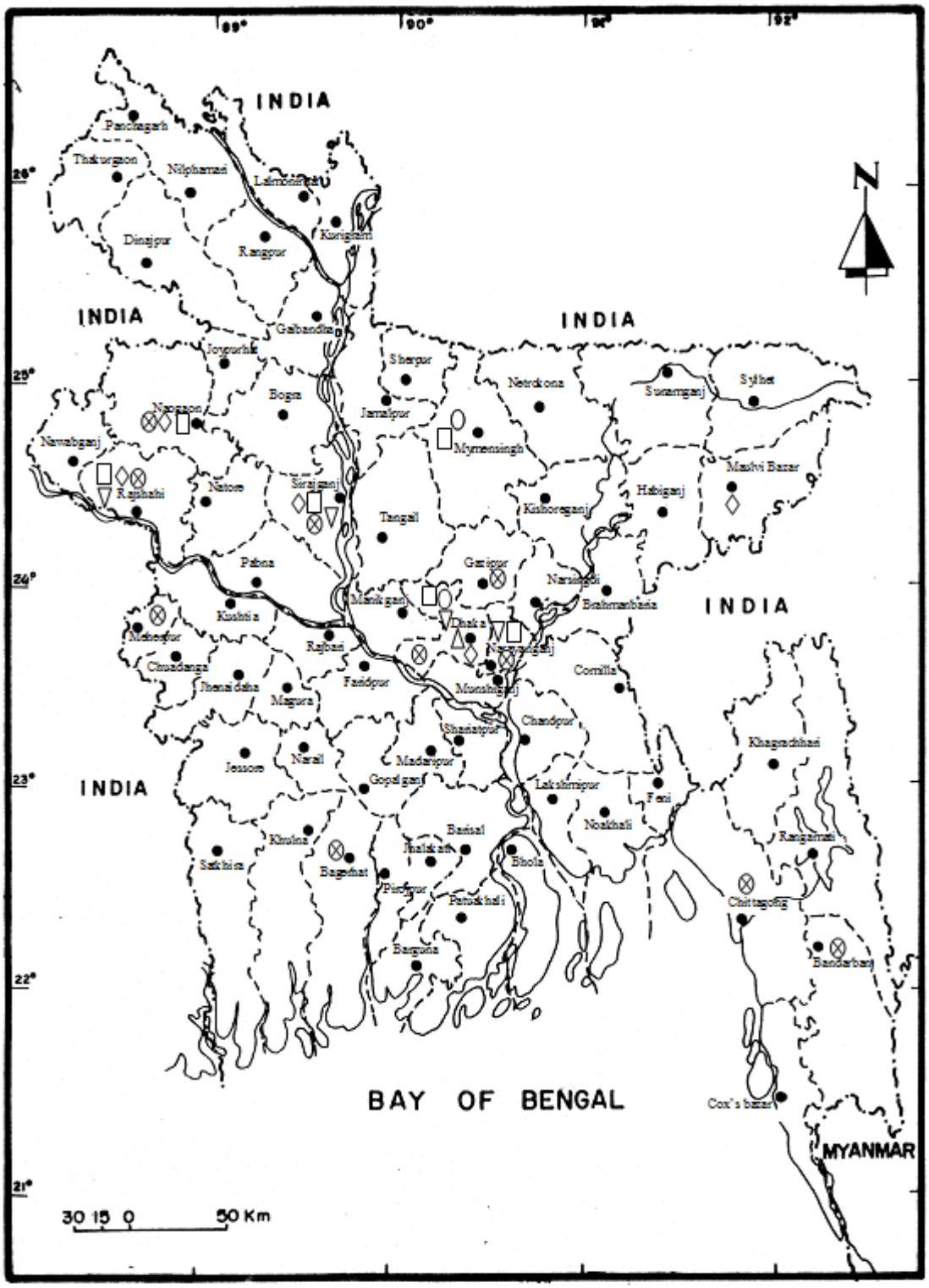

Fig. 1. Distribution of the reported Genera.

◊ = ***Mougeotia*** O = ***Sirocladium*** ∇ = ***Sirogonium***

⊗ = ***Spirogyra*** ∆ = ***Temnogametum*** □ = ***Zygnema***

Conclusion

The present review (1966 – 2006) on Zygnemataceae distribution (Map 1) reveals that till now they have been so far reported from 12 districts of Bangladesh. Recently, in a compilation of Encyclopedia of Flora and Fauna of Bangladesh were done by Ahmed et al. 2008 listed 85 taxa of Zygnemataceae from Bangladesh (based only on published literature) although the search missed few works as: Zaman, 1991; Hasan, 2000; Salam, 2004; Fatima, 2005 and Rashid, 2006. The literatures related to Zygnemataceae focus that much of the area yet to be explored for algal study in Bangladesh. The members of Zygnemataceae thrive well in diversified habitat of Bangladesh and a lacuna also exists for studying brackish water Zygnemataceae of Bangladesh. Bangladesh with its rich aquatic resources along with a population density of 953 / Km^2 are constantly facing anthropogenic pressure seeking the global attention. Hence the documentation of algal diversity is an important part of biodiversity. The studies of biodiversity are thus assuming greater significance as ecologists try desperately to document global biodiversity in the face of unprecedented perturbations, habitat loss and extinction rates (Giller and Donovan, 2002).

References

Ahmed ZU, Begum ZNT, Hassan MA, Khondker M, Kabir SMH, Ahmed M, Ahmed ATA, Rahman AKA, Huq EU (eds). 2008. Encyclopedia of Flora and Fauna of Bangladesh. Vol.3. Algae, Chlorophyta (Aphanochaetaceae-Zygnemaceae). Asiatic Society Bangladesh, Dhaka.

Fatima SK. 2005. Phytoplankton of Barind waters in relation to physico-chemical conditions. Ph. D. dissertation, Department of Botany, University of Rajshahi, Bangladesh, p. 1-451.

Giller PS, Donovan GO. 2002. Biodiversity and Ecosystem Function. Do species matter? Biology and Environment. Proceedings of the Royal Irish Academy **102B (3),** 129 – 139.

Hasan MA. 2000. Assessment of diversity of algal plants in Chalan Beel in relation to physico- chemical conditions. Ph.D. dissertation, Department of Botany, University of Rajshahi, Bangladesh, pp. 1-420.

Islam AKMN. 1965. Occurrence of the genus *Sirocladium* in East Pakistan. Pakistan Journal of Agriculture and Biological Sciences **8(2),** 264-270.

Islam AKMN. 1969. A preliminary report on the phytoplanktons and other algal flora of Chittagong Hill-Tracts. Journal of the Asiatic Society of Pakistan **14(3),** 343-363 + pls. 1-13.

Islam AKMN. 1972. New and rare species of some green algae from Bangladesh. Nova Hedwigia **23,** 655-663 + pls. 14.

Islam AKMN. 1977. Studies on the members of Zygnemaceae from Bangladesh: I. *Mougeotia*, *Zygnema* and *Sirogonium*. Dacca University Studies **B 25(1),** 7-22.

Islam AKMN. 1984. Studies on the members of Zygnemaceae from Bangladesh. II. *Spirogyra* Link. Bangladesh Journal of Botany **13(2),** 194-213.

Islam AKMN, Hossain M. 1979. Preliminary studies on the algal flora of Bagerhat, Khulna. Journal of The Asiatic Society of Bangladesh (Sc.) **5(1),** 37-45.

Islam AKMN, Irfanullah HM. 2005. Hydrobiological studies within the tea gardens at Srimangal, Bangladesh. III. Chlorophyceae (excluding desmids). Bangladesh Journal of Plant Taxonomy **12(2),** 19-37.

Islam AKMN, Sobhan MA. 1976. Ecology and periodicity of the members of Zygnemaceae in Dacca district. Journal of The Asiatic Society of Bangladesh (Sc.) **1(2),** 113-116.

Kim Jee-Hwan, Kim YH, Cho GY, Boo SM. 2006. Plastid rbcL gene phylogeny of the genus *Spirogyra* (Chlorophyta, Zygnemataceae) from Korea. Korean Journal of Genetics **28 (3),** 295-303.

Kunin WE, Lawton J. 1996. Does biodiversity matter? Evaluating the case for conserving species. In K.J. Gaston (ed.) Biodiversity. A biology of numbers and difference. Oxford Blackwell, pp. 283 – 308.

Naskar NM, Naskar KR, Talai S. 2009. Addition to the list of Brackish water Zygnemaceae of Sundarbans and its adjoining areas, India. Genus: *Spirogyra* link. Our Nature **7,** 187-192.

Oksanen M. 1997. The moral value of biodiversity. Ambio **26**, 541 – 545.

Randhawa MS. 1959. Zygnemaceae. I.C.A.R. New Delhi, pp. 1-478.

Rashid MA. 2006. Ecology and floristic diversity of Hydrophytes in Chalan Beel wetland. Ph. D. dissertation, Department of Botany, University of Rajshahi, Bangladesh, p. 1-360.

Salam MA. 2004. Limnological profile and seasonal succession of algal plants in some Marshlands of Bagha, Rajshahi. Ph.D. dissertation, Department of Botany, University of Rajshahi, Bangladesh, pp. 1-233.

Sobhan MA. 1966. Study of the taxonomy and ecology of the members of Zygnemataceae of Dacca district. M. Sc. dissertation, Department of Botany, University of Dhaka, Bangladesh, p. 1-73.

Transeau EN. 1951. The Zygnemataceae. Ohio State Univ. Press, Columbus, U.S.A. pp. 1-327.

Wehr JD, Sheath RG. 2003. Freshwater Algae of North America, p. 1-363.

Zaman M. 1991. Studies on the algal flora of Chalan Beel in relation to its physico-chemical condition. Ph.D. dissertation, Department of Botany, University of Rajshahi, Bangladesh, p. 1- 441.