Study of Algal Biodiversity of the CoochBehar Block, District CoochBehar, West Bengal

Dr. Dipayan Chattopadhyay, *Associate Professor, PG Dept. of Botany, Bethune College*
Dr. Sritama Mukherjee, *Assistant Professor, PG Dept. of Botany, Bethune College*
Dr. Sanghamitra Sanyal, *Assistant Professor, PG Dept. of Botany, Bethune College*

Abstract
About 100 species of algae were recorded from different water bodies of CoochBehar Block; district Cooch Behar in West Bengal. The algal flora of this area was clearly dominated by green algae, diatoms and blue green algae. The large number of algal taxa recorded suggests that the water bodies of the area are rich in algal diversity.

Key words: algal flora, different water bodies, CoochBehar Block, CoochBehar district, West Bengal.

Introduction

Algae are ubiquitous, highly diversified group of plants, placed at the lowest step of the ladder of evolution of life. Algal flora of the CoochBehar Block is very rich due to its climatic and diverse habitat.
In CoochBehar district five distinct ecological habitats of algae are mainly observed viz., terrestrial, epiphytic, aquatic, parasitic and aerial.

1. **Terrestrial:** Growing on moist humus condition of the soil. The common genera are *Vaucheria, Botrydium, Oedocladium* etc.
2. **Epiphytic:** Growing on the attached form belonging to genera *Choleochaete, Bulbochaete, Gloeotrichia* etc.
3. **Aquatic:** Majority of the algae growing in the aquatic environment are *Spirogyra, Volvox, Hydrodichtion, Ulothrix, Cladophora, Odeogonium, Zygnema, Spirulina, Oscillatoria, Phormidium, Gloeocapsa, Lyngbia, Rivularia, Phacus,* etc.
4. **Parasitic:** *Cephaleuros* is the only genus growing as parasite growing on the leaves of *Thea*.
5. **Aerial:** Growing above the ground on the wall is *Trentepohlia.*

In the taxonomic survey approximately 100 genera and species have been identified spread over 6 classes of algae. The classes, orders, families and genera of algae have been arranged according to Fritsch's system of Classification (1935, 1945). Taxonomic keys for different classes [Chlorophyceae, Bacillariophyceae and Myxophyceae (Cyanophyceae)] have also been provided.

Materials and Methods

The fresh water algae shows an ability to tolerate a wide range of environmental conditions. Under natural conditions, they usually grow in mixed communities which may include many species and genera. Field study provides information about the site, environment, season, size and shape of the living algal thallus in its natural surroundings. Many Algae can be tentatively identified by their appearance, shape, and color of thallus in a particular habitat.

Collection of Materials

A good number of containers are first required for the collection of algal specimens. Approximately, 30 ml Tarson Specimen tubes and 100 ml specimen container were used for the collection of algae. The tubes made up of plastics are satisfactory for algal collection.
Quarterly, collections were made over 18 months from the various localities of the Cooch Behar Block. Methods for collection of algal samples differ with the habit and habitat of algae. Filamentous algae were collected from mass growths by hand. Subaerial algae growing attached to tree barks, on damp walls, or other such substrata were collected by scrapping with a scalpel and then picked up with the help of a forceps. Soil Algae have been collected with the help of a sharp scalpel or knife. While collecting such samples, the soil should be avoided as far as possible and should not be allowed to dry. Phytoplankton have been collected by towing a plankton net. Microscopic forms of algae were also collected by squeezing of aquatic angiosperms especially those which feel slippery or slimy.
Algal samples were collected from various fresh water biotops viz. ditches, puddles, pools, ponds, reservoirs, rivers, paddy fields, moist soil, swamps and marshes of Coach Behar Block. The specimen tubes are filled with algae to not more than quarter of their capacity. To avoid deterioration corks have been removed immediately after return from the collection site, so that they may be well aerated. Apart from collecting algae, submerged twigs, stones and dead culm of aquatics were also collected because some algae may also remain associated with these materials. The specimen

tubes were numbered and requisite notes were maintained in a field book for future reference.
Rivers are poor source of algae in comparison to stagnant water. About 100 algal samples have been collected from the various localities of CoochBehar Block.

Preservation
Formalin-acetic acid-methyl alcohol (FAA) has also been used for preservation. It is suitable if the material is later to be prepared for staining. The samples were preserved in a mixture of 50 ml of 95% ethyl alcohol, 5 ml of glacial acetic acid, 10 ml 40% commercial formalin, and 35 ml of water.

Study Method
The present taxonomic study has been undertaken on a calibrated compound microscope with 10, 40 and 100X immersion objectives and 10 and 15 X eyepiece. The standard size of slide (25x75xl mm) and cover glass (l5x15xO.17 mm) have been used throughout the work.
Algal study requires an accurate and detailed camera lucida drawing. The drawings have been made with Prism type Camera Lucida using pencil. Accurate measurement are essential for determination of species and variety which have been taken with the help of a calibrate ocular and stage micrometer.
Algae have been studied in preserved state. The color, shape and size of vegetative cells, nature and number of chloroplast, ornamentation and reproduction are the taxonomic parameters which are employed in the identification of algae.
The identification of different taxa has been done with the help of pertinent literature (West et al., 1923; Desikachary, 1959; Philipose, 1967; Bold and Wynne, 1978; Sarode and Kamat, 1983; Prasad and Srivastava, 1992; Sen and Gupta; 1998; Gandhi, 1998; Mahajan et al., 2008; Mahajan and Nandan., 2008; Habib, 2009 and Das et al., 2009; Raghuwanshi et al., 2011; Noura et al., 2014).

Results
The floristic list of algal taxa recorded during study period in Cooch Behar block, district: Cooch Behar, West Bengal has been presented in Table.1:

Table 1: List of Algal genera in different water bodies of CoochBehar Block and Tea garden (August 2008 to July 2009)

Chlorophyceae	**Bacillariophyceae**
Cladophora	*Fragilaria*
Pithophora	*Achnanthes*
Rhizoclonium	*Amphora*
Trentepohlia	*Cymbella*
Oedogonium	*Gomphonema*
Zygnema	*Navicula*
Spirogyra	*Pinnularia*
Chara	*Pleuorsigma*
Pediastrum	*Hantzschia*
Oedocladium	*Nitzschia*
Vaucheria	*Surirella*
Cephaleuros	*Ctenophora*
Schizomeris	*Synedra*
Stigeoclonium	*Melosira*
Ulothrix	*Stauroneis*
Cosmarium	**Myxophyceae(Cyanophyceae)**
Desmodesmus	*Chroococcus*
Scenedesmus	*Gloeocapsa*
Closterium	*Chamaesiphan*

Euastrum
Hydrodictyon
Chaetophora
Botrydium
Coleochaete
Bulbochaete
Euglenophyceae
Euglena
Phacus
Dinophyceae
Ceratium
Lyngbya
Microcoleus
Oscillatoria
Phormidium
Schizothrix
Spirulina
Nostoc
Gloeotrichia
Rivularia
Scytonema
Microcystis
Merismopedia
Calothrix
Aphanocapsa
Coelosphaerium

Class: Chlorophyceae

Thallus motile or nonmotile, unicellular, colonial, palmellate, coccoid, heterotrichous, siphoneous, unbranched or branched filamentous; free floating or attached; cell contain chloroplast of various shapes which dispersed differently in each group of organisms; chlorophyll predominant with A and B; reserve food starch; pyrenoid one or many; nucleus one or many; vacuole present; cell wall composed of cellulose or pectose; asexual reproduction by zoospores, akinete, aplanospore etc.; sexuality iso, aniso or oogamous.
Chlorophyceae (Green Algae) constitutes one of the major group of algae occurring in various freshwater, marine, and terrestrial habitats.

Key to the Orders

1a. Nodes and internodes present	9. Charales
b. Nodes and internodes absent	2.
2a. Thallus unicellular or colonial	3.
b. Thallus branched or unbranced	4.
3a. Thallus motile in vegetative condition	1. Volvocales.
b. Thallus nonmotile in vegetative condition	2. Chlorococcales.
4a. Sexual reproduction by conjugation	7. Conjugales
b. Sexual reproduction not by conjugation	5.
5a. Thallus heterotrichous	
5. Chaetophorales	
b. Thallus not heterotrichous	6.
6a. Cells coenocytic	8. Siphonales
b. Cell not coenocytic	7.
7a. Cap cell present	6. Oedogoniales
b. Cap cell absent	8.
8a. Chloroplast elaborate; multinucleate	4. Cladophorales
b. Chloroplast parietal or girdle shaped; uninucleate,	3. Ulotrichales

Order: Cladophorales
Filaments unbranched or branched; attached or free floating; cells cylindrical; cell wall thick; lamellate; mucilaginous layer absent; apical cell rounded; setae or hair absent; chloroplast elaborate covering whole cell; multinucleate; pyrenoids numerous; reproduction by fragmentation; zoospores, aplanospore or akinetes; sexually isogamous.
Under this order 3 genera *viz. Cladophora, Pithophora* and *Rhizoclonium* have been found from the collected samples.The taxonomic descriptions of the three genera are as follows:

Genus: *Cladophora*
Filaments profusely branched forming feathery tufts; attached; branch originate just beneath the septum, with alternate, opposite or dichotomous; apices slightly tapering; cells cylindrical; cell wall thick or lamellate; chloroplast parietal or reticulate; densely packed; multinucleate; pyrenoids many.
Genus: *Pithophora*
Thallus branched; originated from beneath the septum; attached or free floating; cells cylindrical or slightly swollen; chloroplast parietal covering entire wall; multinucleate; pyrenoids many.
Genus: *Rhizoclonium*
Filaments coarse and wiry tangled floating mats; unbranched or with 1-2 celled branched; cells cylindrical; cell wall thick or thin; chloroplast parietal; reticulate, dense or loosely arranged; multinucleate; pyrenoids many.
Order: Chaetophorales
Thallus heterotrichous, differentiation consist of prostrate and erect system or branched or unbranced filaments; cushion shaped; attached or parasites; setae present or absent; rhizoids present or absent; chloroplast parietal or girdle shaped; pyrenoids one or more or absent; uninucleate; sporangia present or absent. Under this order the genus *Trentepohlia* is found.
Genus: *Trentepohlia*
Thallus cushion shaped; filaments irregularly branched; prostrate and erect system developed or not well developed; erect branch alternate, opposite or unilateral; hematochrome present; uninucleate; cell cylindrical or slightly swollen; wall thick; chloroplast one to several; pyrenoids absent.
Order: Oedogoniales
Thallus uubranched or branched; monoecious or dioecious; macrandrous or nannandrous; free floating or attached; holdfast or rhizoid present; cells cylindrical or slightly swollen; terminal cell rounded or acute; cell wall smooth, rigid and homogeneous; chloroplast parietal, reticulate; uninucleate; pyrenoids one or several; cap cell present. Under this order several species of *Oedogonium* have been noticed.
Genus: *Oedogonium*
Filaments unbranched; monoecious or dioecious; attached or free floating; cells cylindrical; cell wall smooth; chloroplast parietal, reticulate; uninucleate; pyrenoids many; terminal cell rounded or acute; cap cells present.
Order: Conjugales
Thallus unicellular, colonial, or unbranced filaments; exclusively freshwater; filamentous conjugalean forms slimy, called "pond scums", motile cells completely absent; ce 11 wall smooth or ornamented; chloroplast bar shaped, asteroid, spiral ribbon shaped, axial plate shaped, or stellate; uninucleate; pyrenoids present or absent.
Under this order several genera are established; *viz*, *Zygnema, Spirogyra* (several species of Spirogyra have been noticed from different collections). Taxonomic description of *Zygnema* and *Spirogyra* are as follows:
Genus: *Spirogyra*
Thallus unbranched; cell cylindrical, longer than broad; nucleus one, centrally situated; chloroplasts 1-16, loosely or tightly spirally coiled; pyrenoids. are numerous in linear series, sexuality shows both scalariform and lateral conjugation; zygospores ellipsoid, ovate, subglobose, lenticular, or oblong.
Genus: *Zygnema*
Thallus unbranched; cell cylindrical longer than broad; chloroplast 2-stellate; connected by cytoplasm containing one centrally situated nucleus; pyrenoids two.
Order: Charales
Thallus macroscopic; erect, branched dimorphic, highly elaborately organized; rhizoids multicellular; chloroplast numerous; uninucleate; pyrenoids absent; nodes and internodes present; whorls of laterals present at each node; internode corticated; sex organs complex; enclosed by sterile sheath; oogonium large; ovoid or subglobose; antheridia small, globose.Under this order the genus *Chara* is found.
Genus: *Chara*
Plant macroscopic; stem and branches corticated; branchlets 4 or more segements; bract cell 4 or more at node; oogonia and antheridia are produced one above the other from periphery or branchlet nodes; antheridium below the oogonium.
Class: Bacillariophyceae
Thallus unicellular, colonial or loose chains; cells constituted· by epitheca and hypotheca; striae present or absent; cell wall impregnated with silica; polar nodules and vacuole present; food reserve oil; uninucleate; chloroplasts disc or stellate; pyrenoids one or several; reproduction by cell division; auxospores, microspore or statospores, sexuality iso, aniso or oogamous.
Members of Bacillariophyceae (golden brown) commonly known as diatoms; occur wide range of ecological habitats and play an important role in aquatic vegetation.

Key to the Orders

1a. Valves circular	1. Centrales
b. Valves elliptical or oblong	2. Pennales

Diatoms/Bacillariophyceae

During investigation several genera under the order Pennales have been noticed. The taxonomic description of the different genera are as follows:

Order: Pennales

Valves isobilateral; valve view boat or needle shaped; chloroplasts laminate, pyrenoids present; reproduction by auxospores formed by conjugation.

Genus: *Fragilaria*

Frustules quadret or rectangular in girdle view; attached side by side to form ribbons; valves linear to fusiform; bilaterally symmetrical; chloroplasts discoid or platelike; reproduction by auxospores.

Genus: *Synedra*

Valves solitary or in colonies; free floating or epiphytic; frustules elongate with truncate apices in girdle view; valves linear to linear lanceolate; straight or curved; reproduction by auxospores.

Genus: *Achnanthes*

Frustules longitudinally curved in girdle view; free floating or attached by gelatinous stalks or sessile and united into bundles; valves linear to lanceolate or elliptic; hypotheca concave; epitheca convex; central nodule present; reproduction by auxospores.

Genus: *Amphora*

Cells solitary, free floating or attached at ends of gelatinous stalks or gelatinous mucus; valves asymmetric; convex with truncate ends; rapphe gibbous with central nodules close to concave margin, reproduction by auxospores. Celis solitary, free floating or attached at ends of gelatinous stalks, valves asymmetrical; lunate, elliptic, dorsally convex and ventrally concave; axial field wide or narrow; raphe curved with nodules; reproduction by auxospores.

Genus: *Cymbella*

Cells solitary, free floating or attached at ends of gelatinous stalks; valves asymmetrical; lunate, elliptic, dorsally convex and ventrally concave; axial field wide or narrow; raphe curved with nodules; reproduction by auxospores

Genus: *Gomphonema*

Cells free floating or epiphytic; transversely asymmetric; valves clavate, lanceolate or straight; central and polar nodules present; reproduction by auxospores.

Genus: *Gyrosigma*

Cells solitary, free floating, elliptic, lanceolate in girdle view; valves sigmoid; raphe sigmoid; reproduction by auxospores.

Genus: *Navicula*

Cells solitary, free floating; frustules symmetrical, rectangular in girdle view; valves elongate, attenuated towards poles with capitate rounded or rostrate ends; raphe straight; polar nodules present; axial area narrow; central area rounded, elliptical or rectangular; reproduction by auxospores.

Genus: *Pinnularia*

Cells solitary, free floating, symmetric, rectangular in girdle view; valves with straight margins with smooth rounded ends; axial area broad; raphe sigmoid; reproduction by auxospores.

Genus: *Pleuorsigma*

Cells solitary, elliptic, lanceolate in girdle view; valves sigmoid, gradually tapering to subacute or rounded ends; raphe sigmoid with small polar nodules; axial area narrow; cental area rounded; reproduction by auxospores.

Genus: *Hantzschia*

Frustules rectangular; valves straight or sigmoid; apices capitate or attenuated; reproduction by auxospores.

Genus: *Nitzschia*

Cells solitary or clustured, elongate, rectangular or sigmoid in girdle view; free floating; valves asymmetric, straight; sigmoid or linear elliptic; poles acute or capitate, reproduction by auxospores.

Genus: *Surirella*

Valves "linear, elliptic, ovate or spirally twisted, solitary, rectangular, naviculoid, cuneate or sigmoid in girdle view; reproduction by auxospores.

Class: Myxophyceae (Cyanophyceae)

Thallus unicellular, coccoid, filamentous or multicellular; cell wall thin or gelatinization; very thick; prokaryotic; flagella absent; food reserve glycogen and cyanophycean starch; chromatoplasm and centroplasm present; heterocyst present or absent; reproduction by fragmentation, hormogones, endospbres, akinete, etc. sexuality absent. Members of Cyanophyceae commonly known as Blue Green Algae or Cyanobacteria occur in wide range of ecological habitat.

Key to the Orders

la. Thallus with homogones	2.
b. Thallus without hormogones	3.
2a. Thallus nonheterotrichous	4. Nostocales
b. Thallus heterotrichous	5. Stigonemales
3a. Thallus pseudoparenchymatous	3. Pleurocapsales
b. Thallus unicellular or colonial	4.
4a. Thallus free floating	1. Chroococcales
b. Thallus attached	2. Chemosiphonales

Myxophyceae

During the investigation different genera under the class myxophyceae were found from the different collections of the materials. The taxonomic descriptions of some of lhe genera which were found in abundance are given below:

Genus: ***Aphanocapsa***

Thallus soft. amorphous, gelationous, spherical, hemispherical or flattened forming hyaline yellowish brown colonies; cells spherical, loosely arranged.

Genus: ***Chroococcus***

Cells spherical, subspherical or hemispherical in small groups of 2-4 individuals in a gelatinous matrix; sheath of individual cells are lamellated.

Genus: ***Gloeocapsa***

Thallus crustaceous, leathery, mucilaginous; cells spherical or ovoid, 2-8 in colonies; sheaths lamellated or unlamellated; cell contents coloured or colourless, homogenous.

Genus: ***Chamaesiphon***

Cell ovoid, pyriform or cylindrical, enclosed by sheath; epiphytic; sporangia with or without stalks attached by mucilage discs.

Genus: ***Lyngbya***

Filaments free or entangled forming expanded thallus; sheath thin or very thick; trichomes single, constricted or unconstricted; filaments straight with large number of hormogones; end cell rounded or flat with outer membrane.

Genus: ***Microcoleus***

Trichomes coiled or contorted like ropes; sheath homogenous; cells cylindrical or quadrate; cell contents homogenous; end cell conical, rounded or pointed.

Genus: ***Oscillatoria***

Trichomes single or forming flat, spongy thallus; sheath absent; terminal cell pointed, bent, coiled or screw shaped; cells cylindrical, oval, disciform.

Genus: ***Phormidium***

Filaments forming leathery stratum with torn margins; sheath firm, diffluent or thin; trichomes cylindrical or constricted; apices attenuated, straight, capitate or noncapitate.

Genus: ***Schizothrix***

Trichomes enclosed in thin or thick, lamellated or unlamellated colorless to yellow--brown sheath; trichomes 2 or more twisted around one another; cells quadrate or barrel shaped; end cell rounded.

Genus: ***Spirulina***

Trichomes loosely or tightly arranged; cross wall between cells not clear; sheath absent; apex not attenuated; terminal cell rounded.

Genus: ***Nostoc***

Thallus mucilaginous, gelatinous, various shapes; attached or free floating; trichomes flexuos, contorted entangled; sheath distinct or diffluent; cells spherical, barrel shaped or cylindrical; heterocyst intercalary; spores spherical, ellipsoidal or oblong.

Genus: ***Gloeotrichia***

Thallus spherical or hemispherical, solid or hollow; filaments radially or parallely arranged; sheath firm; trichomes with hair; heterocyst basal.

Genus: ***Rivularia***

Thallus spherical; filaments radial or parallel; compactly arranged; sheath thin, colorless, trichomes ending with hair; cells at base broader barrel shaped, towards tip narrower or cylindrical; heterocysts basal, spherical or oval.

Genus: ***Scytonema***

Filaments caespitose, tufts; two false branch arising between dead cells for intercalary heterocyst; trichomes single with firm sheath.

PHOTO

PHOTO

PHOTO

Discussion

Altogether 100 species belonging to Chlorophyceae, Cyanophyceae, Euglenophyceae, Dinophyceae and Bacillariophyceae were recorded from different water bodies of the Cooch Behar Block. The members of Chlorophyceae outnumbered the other groups. Bacillariophyceae were next to Cholophyceae, Cyanophyceae members followed the Bacillariophyceae . The Euglenophyceae and Dinophyceae were poor in distribution. The Chlorophyceae were dominant species accounting for more than 50% of the total algal population. Bacillariophyceae and Cyanophyceae made up approximately 27% and 20% respectively while the Dinophyceae and Euglenophyceae made up approximately 0.5% and 2% respectively. Chlorophyceae present the greatest diversity and it is indicator of relatively good health of different waterbodies of CoochBehar Block.

Acknowledgement

The first author, Dr. Dipayan Chattopadhyay thanks the University Grant Commission, Govt. Of India for financial assistance.

References:

1. Bold, H.C. and Wynne, M.J. (1978). "Introduction to Algae". Prentice Hall of India Pvt. Ltd., New Delhi: 706.
2. Das, S.K., Samad, L.K., Ramanujam, P. and Adhikary, S.P. (2009). "Freshwater Algae of Meghalaya". J. Indian bot. Soc. 88(1 & 2): 102-118.
3. Desikachary, T.V. (1959). "Cyanophyta", ICAR. Monograph on algae, New Delhi, pp. 686.
4. Gandhi, H.P. (1998). "Freshwater diatoms of Central Gujrat with a review and some others" Bishen Singh Mahendra Pal Singh Publication, Dehradun, India. 324.
5. Habib, I. (2009) "Morphotaxonomic enumeration of Desmids from Hardoi district (Uttar Pradesh, India)" J. Indian bot. Soc. 88(29): 27-31
6. Kumar, B.N. and Choudhary, S.K. (2009) "Diversity of Macrophyte Species of Jagatpur Wetland in the Middle Ganga Flood Plain Near Bhagalpur, Bihar". J. Indian bot. Soc. 88(3 & 4): 8-11
7. Mahajan, S.R. and Nandan, S.N. (2008). "Morphology of Desmids from Jalgaon, North Maharashtra". J. Indian. Bot. Soc. 87: 213-217
8. Mahajan, K.D., Pawar, N.N. and Nandan, S.N. (2008). "The Diatom Flora of the North Maharashtra Region: Genus *Navicula*". J. Indian Bot. Soc. 87: 185-199.
9. Noura, H., Mohammed, C., Mostafa, C.I. and Tojo, N. (2014) "Contribution to the algal biodiversity study in the Moroccan Atlantic coast". International Journal of Innovative Research in Science, Engineering and Technology.3(5): 12507-12523.
10. Philipose, M.T. (1967) "Chlorococcales". ICAR, Monographs on algae, Krishi Prhawan, New Delhi, pp. 365.
11. Prasad, B.N. and Srivastava, M.N. (1992). "Fresh water algal Flora of Andaman and Nicobar Island's Vol.I", B. Singh and M.P. Singh, Dehradun, India: 369.
12. Raghuwanshi, R.K., Patil, P. and Verma, A. (2011) "Biodiversity of Algae in River Narmada at Hoshangabad" .Current World Environment. 6(1),91-93.
13. Sarode, P.T. and Kamat, N.D. (1980b). "The Diatom flora of Bidarbha India I". Bibliotheca phycologica J Cramer 66:259-359
14. Sen, C.R. and Gupta, D. (1998). "The genus Oscillatoria voucher from lower Gangetic". Phykos. 37(1 & 2): 89-93
15. Vikal, P. (2008). "Limnobotanical Investigation of Lake Pichhola with special reference to Algal Biodiversity". J.Indian bot. Soc. 87: 116-119
16. West, W., West, G.S. and Carter, N. (1923). "A monograph of the British Desmidiaceae". Royal Soc. London.