Current status and scope of Algal diversity research in major water bodies of India - A review

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ABSTRACT

The present paper is an attempt to prepare a check list of the algal diversity of India. It is largely based on the information available from published literature. Five main groups of algae, viz., Diatoms, Myxophyceae, Isokontae, Heterokontae and Rhodophyceae, have been studied by Mr.Abdul Majeed, Dr. S.L.Ghose and M.S.Randhawa in Northern India. Diatoms are very abundant during the winter months from the middle of November to the end of February. *Synedra, Navicula, Cyclotella,Cocconeis* and *Gomphonema* are commonly found in large numbers in stagnant or slowly-flowing sheets of water, free-floating, or attached to the rotting branches of water plants. The landscape of South India is dotted with innumerable man-made lakes. They differ vastly in age, physiography, water flow characteristics, chemistry and trophic state, yet maintain a phytoplankton overwhelmingly dominated (43-93%) by blue green algae; the subdominants are diatoms or Chlorococcales and Euglenoids. The lakes of Southern India have been investigated by Zafar(1966), Seenayya & Zafar (1979), Cynthia(1980), Khannum(1980), Mohan(1980), Rao(1980), Selvam(1981) & P.Manikya Reddy(2013). In the chemically more oligotrophic lakes, the peaks are constituted by *Raphidiopsis mediterranea S*kuja*, Navicula cryptocephala* Kutz.*, Melosira granulata* (Ehr.) Ralfs, and others and in hypereutrophic lake by *Microcystis aeruginosa Kutz., Synechocystis aquatilis Sauv., Oscillatoria spp., Burkillia coronate West & West and Euglena acus* Ehr.

KEY WORDS: current status, scope, algal diversity, research, major water bodies, India.

INTRODUCTION

The Indian subcontinent extends between latitudes 8º4' and 37º 6' North and longitudes 68º 7' and 97º 25' East, with the tropic of Cancer bisecting it almost in the middle. It is well marked off from the rest of Asia by mountains and the sea which give the country a distinct climatic unity. The southern half of India is a triangular- shaped peninsula (2090 km wide at its base) that tapers southwards and is flanked laterally by two relict type mountains called the Western Ghats and Eastern Ghats. The former have a profound impact on the pattern and intensity of rainfall as they are huge in size stretching over 1600 km in length and rising in places to the height of 2400-2700m.The algae are tremendously diverse. India is one of the mega biodiversity countries with 7310 algal species (BSI ENVIS). Many phycologists explored algae from diverse habitats throughout India from 1950s.There are at least seven distinct phylogenetic lineages that arouse independently during geological time and that evolved at different rates based upon molecular clocks. Consequently, the algae as a whole do not form a single, cohesive group, and they must be considered a polyphyletic assemblage. The red algal lineage has approximately 5000 recognized species that are extant, and an estimated 500 to 15000 new species remain to be described. The green algal lineage has approximately 16000 recognized extant species and up to 100000 species that remain to be described. The chromophyte lineage has

approximately 15000 recognized extant species and from one to ten million species that remain to be described. The dinophycean lineage has approximately 3000 recognized, extant species and workers estimate that from 500 to 8000 species remain to be described. The euglenophyte lineage has approximately 900 recognised extant species, and experts estimate that up to 1000 species remain to be described (R.A.Anderson, 1992). Gandhi (1956) explored the soil diatoms of Kolhapur and Randhawa (1958) observed five new green algae from India; *Sirocladium vandalurense, Zygnema lahaulense, Mougeotia indica, Oedogonium terrestris and Sphaeroplea annulina*. Subrahmanyan et al (1965) discussed the importance of blue-green algae in rice soils. The diatom flora of Allahabad was explored by Pandey and Pandey (1980). Bongale (1981) studied the abundance of algal species in relation to soil types and major crops in cultivated soils of Karnataka State. They concluded that Cyanophyceae dominated over Chlorophyceae and Bacillariophyceae and appeared to be more resistant to desiccation. Marathe and Chaudhari (1975) explained algae as pioneers in the lithosere and its role in rock corrosion. Their results indicated that the algal community had a considerable corroding action and led to corrosion of rocky substratum equivalent to fifteen times the weight of the algae. The algal community also had a high moisture absorbing power, absorbing water almost equal to its weight. Prasad et al (1982) observed some desmids from Andaman Islands. Megharaj et al (1987) evaluated the influence of *Parthenium hysterophorus* on native soil algal flora. Blue-green algae from the rice fields of Kerala was extensively studied by Anand and Hopper (1987); Dominic and Madhusoodanan (1999). Kumar and Rai (2005) contributed to the algal flora of Namchi, Sikkim Himalayas. Zarina et al (2006) studied the class Ulvophyceae from certain areas of Punjab. Jena and Adhikary (2007) studied the Chlorococcales of eastern and north-eastern states of India. Nayak and Prasanna (2007) studied the role of pH on Cyanobacterial abundance and diversity in rice field soils. The study highlighted the successful colonization of Cyanobacteria in rice field soils of diverse pH and the need for enrichment of the native flora as a means of exploiting the full potential of Cyanobacterial biofertilizers in agriculture. Misra (2008) reported desmids from Garhwal region of Uttarakhand. Dwivedi et al (2009) studied on desmids of Himachal Pradesh of Indo-Western Himalaya. The occurrence of blue-green algae in the paddy soils of Bihar was studied by Choudhary (2009, 2011). Bahaar and Bhat (2011) studied the aquatic biodiversity in the paddy fields of Kashmir Valley. Kumar and Sahu (2012) studied the diversity of algae (Chlorophyceae) in paddy fields of Lalgutwa area, Ranchi, Jharkhand. Yadav et al (2012) studied the soil algae of beed district, Maharashtra. Kumar et al (2012) observed Chlorophyceae of district Kangra of Himachal Pradesh. Deb et al (2013) studied the algal diversity in soil crusts of Assam University, Silchar Campus. Baruah et al (2013) studied the Chlorophycean diversity of Deepor Beel Wildlife sanctuary. Guru et al (2013) studied the algal population in the tropical fresh water shallow lakes. The

ecological studies on lentic environments in India include contributions of Zafar(1959), Munawar(1972), Jana(1973), Suxena &Venkateswarlu(1966), Dakshini & Soni(1979), Mohan&Zafar(1986), Pulla Reddy(2004), Puttaiah et al.(2005), Kamath et al (2006), Mathew & Deviprasad (2007), Ananthaiah(2010) and Srivastava.(2010).

Methodological considerations

Algal collection and sample analyses have relatively standard methods based on the region and habitat being assessed. Phytoplankton, periphyton, and sedimentary diatoms are three common communities of interest for assessment, but their inclusion in assessments varies among lakes, streams, wetlands, and coastal zones. Analyses of algae from different habitats and climates can vary; for example, assessments of phytoplankton and periphyton commonly emphasize the characteristics of all algae in the sample (Stevenson and Bahls 1999), whereas sediment analyses commonly focus on diatom identification. Because all the algae cannot be identified, a pre-determined number of 300–400 natural algal units documented per site is used as a "stopping rule" for periphyton and phytoplankton in the United States Environmental Protection Agency (USEPA) and United States Geological Survey (USGS) protocols. Samples for diatom analyses are usually cleaned with oxidants to remove organic material before the diatoms are mounted on slides in a highly refractive medium. The number of diatoms identified in counts varies from 200 to 600 valves for most bioassessment programs. The analysis of all algae in a sample is usually performed using a settling chamber with an inverted microscope or a Palmer-Maloney counting chamber with a regular microscope. Protocols for the taxonomic analysis of all algae in large-scale assessments by the USEPA and USGS (Fitzpatrick et al. 1998, Moulton et al. 2002) call for the identification of non-diatom algae to the lowest possible taxonomic level, which is usually the genus or species level. The level of identification of non-diatom algae varies among groups and depends primarily on sexual reproductive structures to identify species. Routine SEM observation of diatoms for bio assessment is not practical, although SEM has been applied for the clarification of ecologically important yet unknown taxa (Morales et al. 2012). In many protocols, diatoms are identified as alive (having plastids evident in frustules) or dead (Moulton et al. 2002). In addition, assessments of the taxonomic composition of diatoms from cleaned samples (or samples with removed organic material as a result of an oxidation process, Stevenson and Bahls 1999) are used to characterize the taxonomic composition of the live diatom proportion of all algae. Because so many algae occur in colonies and filaments and because the cell density on slides is patchy, the number of cells identified and counted in a sample is determined by natural units, which are cells for unicellular algae, colonies, or filaments. Documenting the identical number of taxa for samples collected and processed under the same protocol allows for meaningful

comparisons (Charles et al. 2002). Morphological identification is a process used by most scientists and follows standard protocols (Stevenson and Bahls 1999, APHA 2012). As in other sciences, taxonomic research requires hypothesis testing, analysis of data, and taxonomy-specific tools for algal identification that include research-quality microscopes, a set of taxonomic keys, initial training, and expertise.

Distribution patterns

FINDINGS

During the study of periphytic algal community in terms of species composition and density of Dal lake a total of 31 taxa belonging to three major classes namely Bacillarophyceae, Chlorophyceae and Cyanophyceae were recorded by Ashok K. Pandit, Saleem Farooq and Javaid Ahmad Shah(2014). The most common periphytic species encountered across all the study sites were *Diatoma sp., Cymbella sp., Synedra sp., Fragillaria sp., Oedogonium sp., Tabellaria sp., Cosmarium sp., Scendesmus sp. and Oscillatoria* sp. Among 31 species observed the maximum number of species were recorded at site 3 (Ruplank) followed by site 2 (Nishat basin) and at site 1 (Hazratbal basin) with equal number of species and site 4 (Gagribal basin). Bacillarophyceae dominated quantitavely at each site followed by Chlorophyceae and Cyanophyceae in terms of species richness. The overall percentage contribution in terms of population density of the three classes of periphytic algae at all the four studied sites were as, Bacillariophyceae 45%, Chlorophyceae 36% and Cyanophyceae 19% The*Pediastrum* species shows high diversity in its species composition. Most of the species prefer alkaline and slightly high organic environment. A total of 22 species of *Pediastrum* were identified and described by K. Navatha, P. Manikya Reddy (2013). Shannon's diversity index of algal flora was calculated to analyse the algal community in Wular lake, Kashmir by A.R.Mir, Ashwani Wanganeo et al (2010). All the selected five stations did not show any difference in the mean values of diversity index, but the values of each month showed slight variation. It showed positive correlation with Transparency and negative correlation with conductivity, carbon dioxide, hardness and nitrate. The ANOVA was highly significant with respect to site and season. Shannon's index may hold good index for determining the degree of pollution.

Pangong Tso is a land locked lake situated in eastern part of Ladakh (Indian Tibet), at an altitude of 4,266 m A.S.L. and remains frozen for about three months during winter. There is no outlet to the lake and loss of water is only through evapotranspiration. Twenty-three identified and some unidentified taxa of phytoplankton were recorded in the lake while as the periphytic community in the stream was represented by 34 taxa. No fish was observed in the lake while as in the stream three fishes *Schizopygopsis stoliczkae, Triplophysa stoliczkae and Triplophysa gracilis* were recorded by F. A. Bhat, A. R. Yousuf et al (2011).The low biodiversity in the lake was found due to high salinity and

harsh environmental conditions prevailing in the lake. Microalgae of India particularly Himachal Pradesh appear to have not been studied intensively. Investigation has provided necessary basic data on the phytoplankton diversity of Sheer Khad stream an unexplored tributary of River Sutlej by Uday Bhan Singh and Sharma C (2014). 19 taxa have been identified and includes Cyanophyta (8 taxa), Chlorophyta (7 taxa), and Bacillariophyta (4 taxa)

In Pichhola Lake, Udaipur, Rajasthan 36 genera of algae were recorded by Varun Mishra, S.K.Sharma et al (2017). Out of the total 36 genera, 12 were from Cyanophyceae, 9 from Bacillariophyceae, 12 from Chlorophyceae, and 3 belongs to Desmidiaceae. Among phytoplankton Chlorophyceae were dominant over others. The fresh water bodies of Sawaimadhopur district, Rajasthan were also surveyed for enlisting of different phytotoplankton diversity. Forty two species were recorded and described from study area during January 2014 to Dec. 2015 by Lakhpat Meena(2017). The fluctuation and blooming of Chlorococcales are important criteria to describe healthy condition of water bodies. Chlorococcales are group of micro-algal species and are abundantly found in various lakes of Sawaimadhopur district. The most common planktonic and bloom creating species are *Scenedesmus quadricauda* (Turnip) Brebisson, *Scenedesmus abundans* (Kirchner) Chodat, *Scenedesmus bijugatus* (Turnip) Küetz, *Coelastrum microporum* Naeg., *Pediastrum simplex* Meyen, *Pediastrum duplex* Meyen, *Ankistrodesmus spiralis* (Turnip) Lemmermann, *Chlorella vulgaris* Beijerick, *Hydrodictyon reticulatum* (Linn.) Lagerheim *Pediastrum* species commonly found in oligotrophic water bodies like Lake Salim Lake RNP and Gilai Sagar, *Scenedesmus* species create bloom condition in Eutrophic water bodies like sewage canal while *Chlorella vulagaris* Beijerick, abundantly found in Mesotrophic water body like ponds. *Hydrodictyon* species create bloom condition and form thick blanket on water surface in slowly running water bodies or most commonly in drainage of various lakes like Gilai Sagar, Salim Lake RNP during Dec- March. It was also noted that Chlorococcalean bloom replaced by Cyanobacterial bloom after winter season. *Characium acuminatum* A. Braun ex Küetzing found attached on larger hydrophytes or larger filamentous algae like *Cladophora* sp. and *Pithophora* species.So the knowledge about the dynamics of Chlorococcales will be useful towards self purification methods. The short work on the algae distribution in the alwar district of Rajasthan was done and a lot of the work can be done on it, however there are huge seasonal variations in the algae composition in the river area. Some of the genera are dominant and they form the large net on the water body. In soil microbiology they may play a vital role but more research work needs to be done (Teena Agarwal, 2018). Kota district situated in the southeastern parts of Rajasthan has a total area of 5198.15 sq. km. Chambal is the principal perennial river of the district. The Algal flora of Kota still remains unexplored hence the main focus is to document the Algae belonging to various groups. Though the selected water bodies namely Abhera pond, Kishore Sagar, Kota barrage, DCM factory and Rice

field exhibit narrow fluctuations in pH, alkalinity, total hardness, and fluoride contents but considerable variation were observed in the TDS values. The aquatic bodies harbor 63 algal species belonging to 41 genera. Chlorophyceae dominated while Bacillariophyceae was subdominant. The quantitatively determined growth of algal density was found to be maximum during winter and monsoon seasons while minimum growth was observed in summers.

River Yamuna, which flows through the national capital region of Delhi, is an important wetland ecosystem of national and mythological significance. Thirty eight samples of periphyton and phytoplankton were collected in four different seasons i.e., winter, spring, summer and monsoon from five sites of Yamuna River by Vivek Chopra, Dinabhandu Sahu and Jai Gopal Sharma(2007). A total of 74 species under 47 genera of algae were recorded from four major groups Chlorophyta, Bacillariophyta, Euglenineae and Cyanophyta. Phytoplankton diversity was found variable in different seasons and collection sites. *Kirchneriella, Hydrodictyon, Crucigenia, Spirogyra,Mougeotia, Melosira, Cyclotella, Navicula, Oscillatoria and Microcystis* are the most dominant genera in the Yamuna River in Delhi. The first contribution to our knowledge of the Bacillariophyceae from high altitudes of India comes, perhaps, from DICKIE (1882) who had collected algae from pools and lakes in the Upper Batong Valley, Sikkim at 15000-18000 feet above sea-level. He reported 28 species of diatoms along with other algae. CARTER (1926) also recorded some diatom species, collected at fairly high altitudes, varying from 2000-10000 feet, from the Himalayan region. R. S . RAO (1963) published a paper on `A Botanical tour in the Sikkim State, Eastern Himalayas' in which along with other higher plants 14 species of algae are recorded. Out of these 11 species belong to the Bacillariophyceae . He also collected 21 samples of algae from icy cold waters of lakes, ponds and streams between Mt. Everest and Mt. Cho Oyu, from an altitude varying from 3000-5200 m during the Indian Cho Oyu Expedition of 1958. In this communication 69 species of diatoms were identified from 6 samples. The samples were collected between April and June, 1958 from the icy cold flowing waters of the rivers Bhute Kosi, Dud Kosi, Imja Khola and Lobuje Khola and also from still waters of glacier lakes like the Mazamba lake and Dud Pokhri lake. Of the taxa described 2 species, 6 varieties and 5 forms are new to science. Apart from these, 39 species are for the first time reported from this country (M. R. Suxena V. Venkateswarlu). Gurudongmar Lake situated in North Sikkim at an altitude of 17,800 ft. above sea level is the most sacred lake in Eastern Himalaya. This lake is phycologically unexplored but fifteen taxa have been recorded under the following twelve genera: *Oscillatoria* (1), *Nostoc* (1), *Stigonema* (1), *Stigeoclonium* (1), *Spirogyra* (1), *Ankistrodesmus* (1), *Closterium* (3), *Cosmarium* (2), *Hyalotheca* (1), *Penium* (1), *Pleurotaenium* (1) and *Phacus* (1). *Penium phymatosporum* Nordstedt is reported first time from India by Debjyoti Das and Jai prakash Kesh.

The ecological study was done on the river Sutlej Punjab at Ropar Headworks (30°32' N; 76°78' E) Phytoplankton was composed of members of Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae. In all 43 species of planktons were recorded by C. Sharma, R. Jindal, Uday Bhan Singh, A.S. Ahluwalia and R.K. Thakur(2013). Bacillariophyceae among phytoplankton, and Rotifera among zooplankton showed highest abundance and diversity. The values were maximum during summer and post monsoon, and minimum during winter and monsoon. Phytoplankton in upper lake of Bhopal composed of 9 species of Chlorophyceae, 5 species of Bacillariophyceae, 6 species of Cyanophyceae, Euglenophycae, Charophyceae (Meenu Singh,2008). The major phytoplankton species which created problem in the water treatment as observed were *Spirogyra, Ulothrix, Cyclotella, Syndera, Microspora*. Taxonomic study of micro and macro flora of major rivers of Chandrapur district Maharashtra state was conducted from 2013 to 2015 period by Mallesh Reddy & Alka chaturvedi (2017). Total 12 taxa of 8 genera of fresh water algae which were isolated first time from India. Among these, one genus *Amphikrikos* is a new report for the country.

Phytoplankton in the lake Jaisamand(Rajasthan) consists of 52 taxa, out of which 25 belong to Chlorophyceae, 12 to Bacillariophyceae, 2 to Euglenophyceae, 1 to Xanthophyceae and 12 to Myxophyceae. The highest phytoplankton density occurred in July, i.e. in the beginning of monsoon, and the lowest in November. The dominant Chlorophyceae were *Spirogyra elliptica, Closterium and Hydrodictyon*. *Navicula lanceolata, Pinnularia viridis* and *Synedra ulna* were dominant amongst Diatoms. Xanthophyceae was represented by a single species of the genus *Botryococcus* and Euglenophyceae by *Phacus longicauda and Euglena viridis*. The dominant Myxophyceae were *Microcystisaeruginosa* and *M. flosaquae*(Dr.P.S.Rao & V.S.Durve 1987). The systematic study conducted on the microalgal flora of Western Ghats and other parts of Eastern Ghats revealed a rich wetland algal resource for biotechnological exploration mainly focusing on the diversity of microalgal flora in the region of Kodaikanal (10°14' N, 77°28' E), Gudalur (9°19'N 77°12'E), Agasthiyar falls (9°58'N, 78°10'E) and Kolli hills (10°12'N, 77°56'E). A.Suresh, R.Praveen kumar, D.Dhanasekaran & N.Tajhuddin(2012) collected samples in May 2011. In total, 97 species of micro algae belonging to three taxonomic groups were identified, of which 41 species belonging to Cyanophyceae, 38 species from Chlorophyceae and 18 species from Bacillariophyceae. The predominant species in Cyanophyceae were *Aphanothece microscopica, Chroococcus minutus, Coelospharium dubium, Hydrococcus rivularism, Oscillatoria princeps, Nostoc muscorum, Nostoc puncteforme, Nostoc commune, Gleotricha gausii, Calothrix braunii, Rivellaria sp., Tolypothrix tenuis, Scytonema schmidtii,* whereas in Chlorophyceae, *Chlorella sp., Scenedesmus sp., Pediastrum duplex, Cosmarium consperum, Euastrum elagans, Micrasterias americana* and in Bacillariophyceae, *Navicula hallophyla, Rhophaldia gebrella, Fragellaria intermedia, Pinnularia virdis, Nitzchia palliate*. Based on the correlation coefficient data, the micro

algae showed positive relationship with dissolved oxygen, salinity, nutrients and negative relationship with temperature and turbidity.

Thirty six algae species were found in all ten ponds of coal mining city Dhanbad, Jharkhand by Amit Kumar and Radha Sahu, (2012). According to the indices ten ponds has low dominance of species. From the study it is concluded that the ten ponds within coal city Dhanbad needs more care in quality parameters to check pollution for a healthy environment of the area. The distribution of Chlorophyceae (Green algae) in relation to seasonal variation of paddy fields at Lalgutwa area, Ranchi, Jharkhand has been under taken for the first time. Total 24 chlorophycean taxa with wide range of thallus structure collected belonging to various orders i.e., Chlorococcales, Ulotrichales, Cladophorales, Oedogoniales and Zygnematales. The study reveals that comparatively lesser number of Chlorophycean members is growing in summers in comparison to rainy and winter seasons. A total of 35 marine algal species were recorded during a survey of the subtidal flora of Dwaraka, Gujrat. Maximum number of species were found at 5-8 m depth. Red algal species were dominant (20), followed by green (8) and brown (7). The biomass at 5 m depth was 2.044 kg/m and comprised of species of *Caulerpa, Dictyota and Spatoglossum*. The similarity index calculated between intertidal and subtidal species of Dwaraka was 43.40, indicating that the subtidal floral composition is as diversified as that of the intertidal region (V.k Dargalkar & Geetanjali Deshmukhe, 1996). Phytoplankton of the River Narmada consisted mostly of Chlorophyceae and Bacillariophyceae (Sohani S,2015). In river Narmada the temporal series of phytoplankton groups is remarked as Chlorophyceae > Bacillariphyceae > Cyanophyceae > Euglenophyceae. The species distribution, abundance and composition of phytoplankton community are governed by various physico-chemical elements of the water body. The population of Plankton varies in different seasons and months.

Algal spectrum and physico-chemical factors of the water of the selected wetland pond of Vaishali district in Bihar, known even before to Buddha regime, was studied for two successive years by Gyanesh Krishna and Rita Sinha, (2014). 49 different algal species belonging to 32 genera of arbitrarily considered dominant three classes namely, Cyanophyceae, Chlorophyceae and Bacillariophyceae were identified with other pollution tolerant and bioremediant algae. The spectrum was dominantly represented by the algae belonging to the class Chlorophyceae as compared to the other two classes Cyanophyceae and Bacillariophyceae. Vikramsila Gangetic Dolphin Sanctuary is a 60 kms stretch of the Ganges River between Sultanganj to Kahal-gaon under the authority conferred in the Wildlife Pro-tection Act of 1972 by the Government of Bihar in August 1991 established specially for the protection of Gangetic dolphin (Platanista gangetica gangetica Roxb.), the national aquatic animal of India. A total of sixty five algal taxa belonging to class Cyanophyceae, Chlorophyceae, Euglenophyceae, Dinophyceae, Xanthophyceae and

Bacillariophyceae, were recorded. These include 13 taxa of Cyanophyceae of 11 genera Benthic algal assemblages in riverine ecosystems remained stable throughout the downstream of the water. On contrary, the phytoplankton and periphyton change with variations in the hydrochemistry and nutrient status of the water (Stevenson & al. 1996). Repetative occurrence of diatom taxa, e.g. *Aulacoseira alpigena, Achnanthidium minutissimum, Fragillaria gracilis, Gomphonema gracile, Rhopalodia gibba and Nitzschia recta* in more than one locality indicated stability of benthic algal communities. Maximum number of taxa was recorded in near Jagatpur and Bhagalpur cities located in the middle of the sanctuary. Hence the algal richness in these sites was possibly due to organic loading as a result of anthropogenic activities (Sudipta Kumar Das & Onkar nath Maurya, 2015). Jagatpur wetland in the Middle Ganga flood plain in Bihar supports higher phytoplankton density and diversity. Chlorophyceae was dominant and had numerical superiority over the others with regard to density and diversity. Shannon and Weaver (1963) diversity index was calculated from the phytoplankton data recorded during the survey, and was found to be in the range of 2.8-4.7. Species diversity values when compared to the scales of Wilhm and Dorris(1968), and of Staub et al.(1970) suggested the wetland to be slightly or moderately polluted (Braj Nandan Kumar & Sunil Kumar Choudary, 2010)

The study under-taken for *Pediastrum* species in Tapti Pond Multai, District Betul Madhya Pradesh in which total 11 species of *Pediastrum* have been identified by Lakhanlal Raut(2018). Phytoplankton encountered in River Mutha, Pune reflects the average ecological condition and therefore, they may be used as indicator of water quality (Jafari NG & Gunale,2006). Algal Diversity of Kaziranga National Park and Majuli River Island Hot Spots in Assam reveals seventy algal taxa belonging to 32 genera. The algal diversity in Majuli Island was higher compared to Kaziranga national park. In Majuli a total of 50 algal taxa belonging to 26 genera were recorded. Only two species, *Phormidium chalybeum* (Mertens ex. Gomont) Anagnostidis et Komarek and *Ankistrodesmus falcatus* (Corda) Raffs were common to these localities showing location specific occurrence of most algal taxa in these two important hot spots (S. P. Adhikary & M. Jena,2012).

Chilika is the largest brackish water lagoon in Asia situated in the east coast of India between 19°28′ and 19°54′ N latitude and 85°06′ and 85°35′ E longitude. Algal flora of Chilika Lake (Odisha) has been studied several times during the last century. Most of these works were repetitive in nature and none of the authors have studied the algae of the lagoon in every season covering the entire catchment area in a particular year. Further, there is also no report available containing information about all the algal forms including both macro and micro algal species occurring in the Chilika Lake during a particular time covering a year, and also no detail taxonomic account of each of the species available. Therefore, the algal forms occurring throughout the lake in different seasons for two consecutive years were

surveyed with a view to study the different algal forms occurring in the lake. Macroalgae were collected in several collection trips during 2000–2001, analyzed and an authentic algal distribution map of the lake was prepared by J. Rath & S. P. Adhikary(2000). One hundred and five taxa belonging to 40 genera were recorded from different sites of Loktak Lake, Manipur by M. Jena & S.P. Adhikary (2011). Out of these, six species belong to four genera of Cyanophyceae, two species to a genus of Euglenophyceae, 90 species to 28 genera of Chlorophyceae, one species to a genus of Charophyceae and six species to six genera of Bacillariophyceae. The number of Chlorophyceae was about 80 % of the total algal taxa. The members of Desmids (Zygnematales) are more diversified amounting to 87% of Chlorophyceae. In 2007 during survey of Loktak Lake, 85 additional algal forms were recorded from this habitat. However, several algal taxa reported earlier in the lake were not observed in the study. Tropical wetland paddy fields are well known for their high algal diversity. Algae of intensively cultivated wetlands are expected to be unique. Since green algae, in general, are cosmopolitan in distribution, ecology of them in specific environment will be interesting to algologist world over. Kuttanadu is a unique tropical wetland and the green algal community of these lands remains unexplored. Therefore, the same in relation to different soil-regions, seasons, and crop-growth-stages are identified. High green algal diversity of 87 species, with Zygnemales as the dominants (33%) is observed in the fields (Vijayan & Ray,2015).

Studies were made on the occurrence and standing crop of algae from six localities in Muthupet estuary Tamil Nadu for a period of six months from March to August 1988 by S.Balakrishnan, M.Ravichandran and N. Kaliaperumal (1992). Totally 19 algae belonging to the groups Chlorophyta, Phaeophyta, Rhodophyta and Cyanophyta were recorded. The green algae numbered more than other algae in all the stations. Kolleru is one of the largest fresh water lakes in India. So far no authentic report was available on the algal population of Kolleru Lake. It is located in the deltas of Godavari and Krishna River. 49 algal forms including micro algae and macro algae were reported by G.M.Narasimha Rao (2009). Dominant forms in macro algae were *Chara, Oedogonium, Spirogyra, Ulothrix and Zygnema*. In microalgae, *Chlorella, Scenedesmus, Volvox, Pediastrum, Melosira, Navicula, Nostoc and Spirulina* were dominant forms during winter season. Among the algal flora, some pollution indicator species were also reported in this lake.

The periodicity of algal populations at four different stations of the River Moosi was observed over a period of two years and the influence of the various physico-chemical factors on different algal groups was studied by V. Venkateswarlu (1969). The algae as a whole reach their maximum during winter (December–January) and touch minimum during the rainy season (September–November). High water temperatures seem to accelerate the growth

and multiplication of Chlorococcales. Diatoms, which form the main bulk of algal populations at all the stations, attain their maxima in winter (December or January) and minimum during Summer (May) and rainy season (September to November). These algae show an inverse relationship with temperature. Blue-green algae attain their maximum during the summer months and become rare in winter and rainy seasons. These show a direct correlation with the oxidizable organic matter and water temperature and an inverse relationship with dissolved oxygen. Euglenoid flagellates, like the blue-greens, are more during summer but with an optimum temperature of 28\dg\2–31.5\dgC. High summer temperatures seem to be unfavorable for their development. The periodicity of algae and its possible causes in two freshwater ponds of Hyderabad was studied by A. R. Zafar(1964). Chlorococcales order is represented mainly by species of *Characium, Tetraedron, Oocystis, Kirchneriella, Ankistrodesmus, Pediastrum, Sorastrum, Cruciginia, Scenedesmus and Coelastrum*. As far as qualitative distribution is concerned, all these forms are present in both the ponds under investigation but quantitatively pond B appears to be better habitat for their development. Higher atmospheric or water temperature is concerned to be one of the important factors in the periodicity of Chlorococcales. Griffiths (1912), FRITSCH &RICH(1913) WIEBE(1930), HOWLAND(1931), TRESSELER & DOMOGALLA(1931), HODGETTS (1922) & RAO(1955) have observed maximum growth of one or the other species of Chlorococcales during warmer months of the year. An ecological study of three freshwater ponds of Hyderabad shows that data were collected over a period of two years to study the ecology of algae in three freshwater ponds lying in the vicinity of Hyderabad by V. S. Rao (1971). It discusses only the temperature lags and ionic composition of the waters studied and brings forth the following: It is not the size of the body of water alone that controls the temperature lag in time and amplitude but the salinity of water and the density of its phytoplankton also alter the thermal behaviours. The ionic proportions of the waters studied differed considerably from those proposed for lakes in general by RODHE (1949). The ionic composition of the same body of water also differed from season to season and it was felt that the seasonal fluctuations which have secondary importance in lake become more significant in small freshwater bodies. Therefore, it is stressed that the ionic composition assessed from a limited number of observations may lead to wrong conclusions. Mohiuddin Munawar (1970) based on a two-year study of the distribution of phytoplankton in three freshwater, polluted and unpolluted ponds of Hyderabad revealed that the distribution of several groups of algae like Volvocales, Chlorococcales, Desmids, Diatoms, Dinoflagellates, blue-greens and Euglenineae exhibited interesting relationships to the physico-chemical complexes of the ponds, and throws much light on the algal distribution in Indian waters. Ecological studies of Euglenineae in certain polluted and unpolluted environments were investigated for two years in certain polluted and unpolluted environments of Hyderabad by

Mohiuddin Munawar (1970). Sewage and Garden Ponds were found to be considerably polluted, whereas, the Typha Pond was comparatively pure and less polluted. Sewage Pond exhibited the highest percentage of Euglenineae harbouring 13 species and Garden Pond harboured 2 species in large numbers. Typha Pond harboured typically *Trachelomonas hispida* and *Euglena* Sp. which were totally absent in the other two ponds. It seems that high average concentrations of free CO2 were favourable for euglenoid growth in Sewage Pond and the oxygen deficiency was helpful to trigger the oxygen-iron-phosphate complex, releasing larger quantities of phosphorus and iron. Higher average values of percent Cl + NO3 ratio were found to be responsible for the luxuriant growth of these flagellates and it was suggested that inorganic sources of nitrogen might be more important in their ecology as fluctuations of nitrate coincide closely with those of Euglenineae in all ponds. These flagellates were found to be abundant during the periods when water was not rich in total sulphides and concentrations higher than 2.0 ppm adversely effected the euglenoid development. Higher concentrations of oxidizable organic matter showed a direct relationship to euglenoid population in Sewage Pond. It is suggested that certain species of Euglenineae, which very often developed in the polluted waters of Sewage Pond, could be used as biological indicators of pollution in the present investigation.

Ecological investigations in the rivers Moosi, Manjira, Tungabhadra, Kagna and Godavari have been made over a number of years. Physical, chemical and algal parameters were analysed at both unpolluted and polluted stations in the rivers and yearly averages, ranges and percentages of algae are presented. The significance of benthic algae in river monitoring and pollution studies is emphasized by V.Venkateswarlu(1986). Certain metals have been investigated in paper mills effluent channel and in the river Tungabhadra in relation to their distribution, seasonal fluctuations and their effect, if any on algae by P Manikya Reddy & V Venkateswarlu. The concentrations of various metals analysed are in the order of Zn>Cu>Pb>Ni>Co>Mn. In general these metals indicated an increase in their concentration along with the increase in the concentrations of chlorides, total hardness, sulphates and total alkalinity. Blue-greens and diatoms seem to be more tolerant to these ions than Chlorophyceae. *Stigeoclonium* exhibited very good growth at high concentrations of zinc, copper and nickel and at low concentrations of cobalt and lead. *Schizomeris* attained good growth when the lead concentration was high and cobalt was low. Role of diatoms as indicators of pollution gradients: The impact of liquid wastes from a paper mill on the benthic diatoms in flowing waters has been studied for a period of two years. Water and algal samples were analysed at monthly intervals at three sites along the course of the river, along with raw effluents. The water before the confluence of effluents was well oxygenated with an alkaline pH. Organic matter, NH3 and nutrients were recorded at low concentrations. At the entry of effluents, the water showed considerable decline in dissolved oxygen content, increase in organic matter,

hardness, Cl, HCO3 and total dissolved solids. Diatoms constituted 61% by numerical abundance and were reduced to 25% of total algae at the entry of effluents. Multiple regression analysis was employed to discover the relative importance of various physicochemical variables on the abundance and distribution of diatoms at various sampling stations. Mathematical equations were derived involving the physicochemical variables for better prediction of algal number. (G. Sudhakar B. Jyothi V. Venkateswarlu, 1994) The investigation was undertaken to elucidate certain aspects of ecology of algae and physicochemical characteristics of water with reference to water quality in Mir Alam lake. The lake provides a wide scope of identification of algal diversity existing in it. The lake is an important source of water for zoological park and, it is essential to assess the quality of water. The analysis of the physico-chemical characteristics indicates that the water is alkaline, and carbonates were recorded in high concentration.. The phytoplankton is dominated by Chlorophyceae. The species *Chlorella, Scenedesmus, Crucigenia, Pandorina, Euglena, Phacus and Trachelomonas* were dominant, and can be used as good indicators of water quality and pollution. (Amin Hossaini Motlagh, K. Navatha and P. Manikya Reddy, 2013)

A survey of the algal flora of the Osmania University campus revealed that it was rich. The total number of algal genera recorded were 68, out of which 32 genera belonged to Cholorophyceae; 19 to Cyanophyceae; 13 to Bacillariophyceae; 3 to Euglenophyceae; 2 to Charophyceaea and 1to Dinophyceae. It was very interesting to note that on *Cladophora; Oedogonium, Characium* &*Stichosiphon* were epiphytic. However highest number of genera were represented by Chlorophyceae. Epiphytic algae were present on unbranched filamentous Oedogonium and on branched filamentous *Cladophora* and *Pithophora.* It was *Gomphonema* and *Achnanthes* are attached to the other algal members by mucilaginous pad at their base (Mary Esther Cynthia Johnson, 2016) The ecology of freshwater mat-forming algal communities around Hyderabad was studied by Atiya Khanum(1982). The most common mat-forming algae in the water surveyed were *Cladophora, Spirogyra* and *Rhizoclonium.* However, their sociability was less than that of *Oedogonium, Zygnema* and *Oscillatoria*. Spirogyra had a strong tendency to form unialgal mat whereas most of the other forms were bialgal and very rarely polyalgal. The fall in the ambient temperature resulted in the sudden disappearance of *Rhizoclonium* and *Spirogyra*. *Cladophora* and *Hydrodictryon* were found to be more sensitive to the changes in pH,CO- - and HCO--. The results also indicated that there was a strong negative correlation between the surface spread and mineral content of filamentous algae.. The highest production rate (27.5 mgC/ml/day) was recorded for *Spirogyra,* while *Rhizoclonium* showed the lowest production rate of about 6.8mg C/ml/day.

A total of 105 algal members were reported from two freshwater reservoirs of Warangal (Telangana) including phytoplanktonic and euplanktonic algae belonging to 71 genera, in which 21 Cyanophyceae, 28 Chlorophyceae, 18

Bacillariophyceae and 4 Euglenophyceae genera were identified by B. Kumaraswamy, L. Dup Singh, M. Ramesh Babu and B. Digamber Rao (2013). Waddepally reservoir was observed with 67 species followed by Bhadrakali reservoir with 83 species of algae under investigation. This is a first report of freshwater algae from Warangal, as the previous reports were related to only Cyanophyceae from paddy fields and wet soil sample.Triveni sangamam is a holy place in Renzal Mandal of Nizamabad district in Telangana State.Triveni Sangamam is confluence of River Godavari, River Manjeera and River Haridra .The study period Sept 2013 to Dec 2014 observations were made and different groups of algae were identified. Observation of phycological studies of water samples revealed the abundant growth of three groups of algae belonging to Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae altogether 35 genera 40 species algae were recorded in present investigation. . During investigation of Rice Fields of Jammikunta Region, Karimnagar District, Telangana out of total 25 taxa of Cyanophyceae 14 species and 8 families, Chlorophyceae belonging to 10 where, Chlorellaceae represent cladophoraceae 2 species, desmidaceae 1 species, following Oedogoniaceae 1 species Zygnemataceae have been found with 2 species, 2 species from Characeae etc.1species from Naviculaceae under class of Bacillariophyceae. *Cosmarium*, species were high, observed during the period of August to October, during these months the water level declined gradually in rice field. (G. Odelu, 2014)

Phytoplankton distribution was investigated in 15 small lakes of T. Narasipur taluk in Mysore district of Karnataka by S. Umamaheshwari (2011). The data were subjected to PAST software program. Bray-Curtis Similarity Index was also calculated. Nine diversity indices were obtained that include Dominance index, Shannon and Weiner index, Simpson's index, Pielou's Evenness index, Menhinick and Margalef's index, Equitability index, Fisher a index and Berger-Parker dominance index. Sixty two species of algae were recorded of which Chlorococcales and Euglenophyceae members dominated. Species richness was observed in Harave Katte and Baw Kere, and species dominance in Holan Kere and Halgudu Kere. In five species of *Sorastrum* kutzing including a new species *Sorastrum philiposiarum* have been described from Bankura and Purulia districts of West Bengal. Amongst these species *S.indicum* Bernald and *S.hathoris* (Cohn) Schimdle are being reported for the first time from India. Moreover *S.americanum* (Bohlin) Schmidle is an addition to West Bengal algae. All the specimens have been collected from desmids habitats of West Bengal having a low pH (5.0-6.5) and those were growing lodged on submerged portions of the aquatic weeds like *Ceratophyllum demersum* L, *Hydrilla verticillata* (L.f) C.Presl and *Ipomea aquatic* Forssk. S. PHILIPOSIANUM (JAI PRAKASH KESHRI AND PRASANT MALLICK 2013). Lonar Lake is one of the youngest Lake and is unique in the world for its alkalinity and salinity of the water. An attempt has been made to examine environmental analysis of Lonar Lake by Vyankatesh B. Yannawar and Arjun B Bhosle (2013). The physical and

chemical parameters were analyzed as per APHA. It is found that major *Spirulina* species of algae was found in lake water. This species occupied the Lonar lake water phytoplankton about 90.0% and above. Rests of 10 % are other members of Chlorophyceae, Cynophyceae and Bacillariophyceae also found in this lake. Lonar lake water was found to be very rich in mineral nutrient contents. Hence this World heritage lake should be preserved for its alkalinity and salinity.Some Observations on the Morphology and Cytology of Indian Charophyta have been made by Ramjee & Y. S. R. K. Sarma(1971) Out of the several Indian Charophyta studied cytologically from seven States, ten taxa, five belonging to the genus *Nitella* and five to the genus *Chara*, are new records for which brief morphological descriptions have been given. Occurrence of cytological races in *N. tenuissima f. transilis* and *C. fibrosa* are recorded.

Visakhapatnam is one of the important localities for algae on the east coast of india, with rocky outcrops scattered along the coastline on which algae grow luxuriantly. In all, 80 species and varieties of marine algae are recorded from the intertidal regions of the Visakhapatnam coast. Out of these 18 are new records for India and seven are first records for the east coast. *Boodlea strureoides, Derbesia turbinate, Bachelotia antillarum, Ralfsia expansa,Rosenvingea nhatrangensis, Erythrotrichia obscura, Porphyra vietnamensis, Peyssonnelia obscura, Peyssonnelia conchicola, Gracilaria textonii,]Gracillariopsis sjoestedtii, Aglaothamnion cordatum, Spremothamnion speluncarum, Ceramium fimbriatum, Herposiphonia secunda, Chaetomorpha brachygona, C.linoides,C.tortam, Cladophora patentiramea* are new records for India by M.Umamaheshwara rao & T.Sreeramulu (1970).The phytoplankton belonging to 40 species under 27 genera was recorded from Ayyanakere lake, Chikmagalur, Karnataka during the period from April 2008 to March 2009 by N B. Mruthyunjaya , M.Venkateshwarlu ,B. R. Kiran & D.S.Somashekar (2016). Results revealed that, Zygnemophyceae was found to be the dominant group of phytoplankton (25.0 %) followed by Chlorophyceae and Bacillariophyceae with 22.5 % and 20.0 % respectively and Euglenophyceae with 15%. Ayyanakere Lake is found to be rich in phytoplankton diversity and hence productive. The lake is said to be moderately oligotrophic.

An investigation on river Pandu in the year 2009-2010 was carried out to explore its current status in terms of physico-chemical and phycological profile by Sunita Verma, Divya Tiwari & Ajay Verma(2013) The study revealed that algal spectrum of the river was connected with the intensity of pollution in the river. Maximum number of species existed at station-1 followed by stations-4 and 6 and then at station-5. Lowest species representation has been noticed at stations-2 and 3. Species number and algal population too declined sharply at stations-2 and 3 as compared to station-I. Sharp decline in algal population at stations-2 and 3 may be attributed to certain obvious reasons such as low transparency and reduced illumination as a consequence of residual fly ash discharged by PTPP drain at station-2. Except station-1, all downstream stations show grossly polluted condition of the river.

Algal diversity of Central India was studied by Neha Srivastava , M.R. Suseela, Kiran Toppo and Rubina Lawrence (2018).A total of 34 algal taxa belonging to 25 genera were identified from 30 samples of 6 water bodies. These microalgae belonging to three major classes Chlorophycae (green algae), Bacillariophyceae (diatoms) and Cyanophycae (blue green algae). Maximum algal taxa belong to green algae followed by blue green algae and diatoms. Among the green algae dominant forms were *Scenedesmus* at Mandakani river, *Chlamydomonas* and *Chlorella* at Chabi pond and *Spirogyra* in Atiyatal, where as commonly found green algae were *Chaetophora, Ulothrix, Nannochloropsis and Oedogonium* in Atiyatal. Rarely found green algae were Caracium at Mandakini river, *Cosmarium, Geminella and Pediastrum* at Atiyatal. Among the blue green algae *Microcystis* was dominant and only alga at Mahil pond whereas *Oscillatoria, Phormidium* were dominant and *Spirulina* was very common in Ramkund and in Atiyatal *Merismopedia* was a very rare form. Among the diatoms *Fragillaria* was dominant form found in Ramkund, whereas *Navicula, Gamphonema, Synedra* were common in Chabi pond, Ramkund and Mandakini river respectively and *Cymbella,* was found rarely in Ramkund. Every temple in India has a pond associated with it. Pond ecosystem has a rich microalgal diversity with other aquatic organisms. The microalgal diversity study was conducted in Parthasarathy temple pond, Chennai by B. Sankaran and E. Thiruneelagandan (2015). It showed a rich diversity of phytoplanktons. About 67 species from 31 genera of microalgae were identified in the study.

The Indian Characeae have been the subject of a large number of publications. As many as 25 species, 3 varieties and 5 forms of Chara, 31 species, 4 varieties and 2 forms of *Nitella*, 1 species each of *Lychnothamnus and Nitellopsis* and 3 species of *Tolypella* are known from the Indian region. Of these only a few have been reported from South India (5 species, and 2 varieties of *Chara* and 1 species and 3 varieties of *Nitella*). A new species of *Nitella* is been described by Prof. Iyengar and will be published elsewhere. The other genera are not yet recorded from South India. The above records from South India are mainly found in the works of older Charophytologists such as Wildenow (1806) and Braun (1849), etc. A few records are also found in Groves Indian Charophyta (1924). Thus our present knowledge of the South Indian Characeae is not in any way comparable to that of the Characeae of the rest of India.(V.S. Sundaralingam,1957)

Microphytoplankton of the Pitchavaram mangals, southeast coast of India was studied by L.Kannan &K.Vasantha(1992) Species richness of phytoplankton of the Pitchavaram mangals was high. There were 82 species constituted by 67 species of diatoms, 12 species of dinoflagellates and 3 species of bluegreen algae. Phytoplankton population density exhibited a wide seasonal fluctuation with the minimum during monsoon and the maximum during summer, suggesting the possible differential influence of various environmental factors Seasonal variation in the

biomass, quantity and quality of agar from *Gelidiella acerosa* (Forsskal) Feldmann et Hamel (Gelidiales, Rhodophyta) from the Gulf of Mannar Marine Biosphere Reserve, India. Ganesan Meenakshisundaram, (CRK Reddy, Karupannan Eswaran). The Gulf of Mannar on the southeast coast of India, which has recently been declared as biosphere reserve, is the main harvesting place of *Gelidiella acerosa* for the Indian agar industry. The study reports the seasonal variation in the biomass and agar yield and quality from *G. acerosa* in four different habitats such as Rameswaram (rocky intertidal), Ervadi (lower intertidal), Sethukarai (subtidal) and Krusadai Island (lagoon reef area). A maximum biomass of 260 ± 26 g DW m−2 was recorded from Ervadi, whereas Sethukarai showed the highest percentage cover (69.83 ± 4.83%) and density (208.20 ± 30.16 plants m−2). Biomass, percentage cover and density were lowest in Rameswaram and significantly lower (P < 0.001) than the other three stations. A single peak in biomass was observed with autumn maxima in Ervadi and Rameswaram and southwest monsoon maxima in Sethukarai and Krusaidai Island. Length of G. acerosa was maximum (9.65 ± 0.25 cm) in Ervadi and the branch index value was maximum (24.70 ± 4.01 br−1 g−1 DW) for Rameswaram. Agar yield (37.24 ± 7.59%) and gel strength (448.66 ± 6.50 g/cm2) were higher in Sethukarai plants. The agar yields attained a peak in the northeast monsoon and decreased in summer, whereas a reverse trend was observed for gel strength. Evidently, agar yield showed a strong negative correlation with gel strength (P < 0.0001) and gelling (P < 0.0001) and melting temperatures (P < 0.01). The findings of this study reveal that a single harvest during the autumn months (January to March) could yield optimum biomass with moderate agar and that would be the best for sustainable usage and conservation of this resource from this region Dakshini & Gupta (1979) reported the relation between population of phytoplankton and seasonality of three freshwater lakes of Delhi in1976. In July and August months, dense phytoplankton decreased in all the study lakes, due to high flushing of rain water. On the other hand, in the month of September, the phytoplankton count increased with low turbidity and wavy actions in the lakes. In Damadama, Badkhal and Peacock lakes of Delhi, *Microcystis* blooms dominated between October and December and between May and July. The authors concluded that physical, chemical and biological factors of three lakes varied from each other while, their climatic and geological conditions were same. Verma and Munshi (1983) described phytoplankton composition in Badua lake of Bihar. Phytoplankton composition dominated the blue-green algal blooms which influenced with seasonal variations. Sarwar, 1996 presented that, the epiphytic algal flora attached to *Myriophyllum spicatum* L. in Dal, Wular, Anchor lakes of Kashmir. Rich and varied epiphytic algae derived moisture and nutrients from the air and rain (Sarwar, 1996). Threats to coral reef diversity of Andaman Islands, India was reviewd by Sayani Datta Majumdar, Sugata Hazraet al (2018) The coral reefs of Andaman Islands with an area of 948.8 km2 have an affinity to the South-East Pacific Coral Triangle in terms

of species diversity. These reefs are of fringing; channel and patch types with 588 species of hard corals. The mass coral bleaching event induced by sea surface temperature (SST) anomalies coupled with the El Niño Southern Oscillation (ENSO) phenomena in 2010 led to a loss of almost 70% of live coral in the South Button Island, Havelock Island, North Bay, Chidiyatapu and Redskin Island. Between 28th March and 30th April 2016, in-situ temperatures of 31.80 ° C to 32.30 ° C were reported at North Bay leading to bleaching of Acropora fungoid. The crustal upliftment and crustal subsidence associated with the mega earthquake during December 2004 Tsunami led to loss of 30% coral cover in north Andaman and 20% loss in south Andaman, respectively. The study reviewed the recovery status of different coral species from existing literature and observed that massive species like the Porites sp. were comparatively stress tolerant, and showed good resilience to bleaching and with better recovery potential due to higher thermal thresholds. In contrast, species like the Fungiid sp. were reported to be susceptible to bleaching with capabilities to regenerate and recruit slowly.

SUMMARY

The algal species identified in India included members of Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae.The common diatoms present are species*of Synendra, Coconeis, Amphora,Cymbella and Mastoglia*. Chlorophyceae are represented by the species of *Chlorella, Pediastrum,Golonkinia, Coelastrum, Oocystis,Tetraedron and Scenedesmus*.The species of *Euglena, Phacus* and *Trachelomonas* are common among Euglenophyceae. Cyanophyceae is mainly represented by species of *Merismopedia, Gomphosphaeria, Anabena, Oscillatoria* and *Chroococcus*. India appears to be rich in Algal flora but still needs extensive survey for the exploitation of this beautifully ornamented group from all possible habitats and various states which have so far not been explored.

CONCLUSION

For many groups of microalgae, our knowledge about species distribution and about the factors which govern their distribution is still fragmentary. The main reasons for the situation are, on one hand, the lack of floristic lists for many region of the world and on the other hand, the low level of taxonomic knowledge in many groups. In India, although much excellent work has been done on algae, this has largely followed morphological and systemic lines, and relatively little attention have been paid to their activities and possible economic importance. Recent advances in the study of the submicroscopic morphology of algae were reviewed by T.V.Desikachary, who also discussed the structure of diatom frustules in the light of his own electron microscope investigation. There is an utmost need to systematically conduct studies of water bodies to know their biodiversity and complete ecological status and suggest preventive measures to conserve those as lifeline

for survival of the human civilization Research efforts should be focused on utilizing the enormous wealth of microalgae of India.

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