Chapter II

REVIEW OF LITERATURE

In the long history of algal studies, Carolus Linnaeus, the great taxonomist of all time was first to allot the name Algae to a group of plants in his epoch-making literature "Species Plantarum" in 1754. (Gledhil, 2008). The definition of the term Algae came to existence in the year 1789 for the first time when De Jussieu demarcated the word in his Genera Plantarum. Nevertheless, for a period of time the study of algae remained stagnant. The algal studies were again resumed after a long halt by Link who was one among the pioneer algologists who studied the algal flora of Germany during the year 1820-1833 (Sambamurty, 2005). However, the effort of Kuetzing (1843-1849) was considered very momentous, for his first ever report on maximum numbers of algal genera than any other contemporary algologists (John, 2013). Existing literature counted the contribution of the famous algal taxonomists Borger, Lagerheim, Lemmerman, Nordstedt etc. during early to late part of the nineteenth century (Bordoloi, 1973). They were all pioneer workers who prepared a rigid foundation for the study of Phycology (Bordoloi, 2016).

Of the pioneer algal researchers, the contributions of British scientists were noteworthy too (Bordoloi, 2016). Borzi (1878-1894), De Toni (1888-1905) on the other hand were the pioneers who begin the study on Cyanophyta (Kakati, 2011). G.S. West (1899-1916) and W. West (1889-1909) enumerated a number of new species from extensive study of fresh water algae from Tanganyika, Victoria, Egypt, Southwest Africa, Madagascar, West Indies, Ceylon, Burma, Bengal and Madras. Fritsch and Rich (1907-1937) were another to explore fresh water algae from South Africa (Bordoloi, 2016). The lakes of England were investigated and

documented by Pearsall (1932) in the twentieth century. Prescott in the year 1938 worked for controlling a few noxious algae in some fresh water bodies (Bordoloi, 1973).

In the nineteenth century, the algal study took a new turn when Agardh (1824) put an effort to classify algae based on contemporary available literature (Wehr and Sheath, 2003). He divided algae into six distinct orders and twenty genera. The other contemporary workers Kuetzing (1843-1849), Naegeli (1847) and Robenhorst (1849-1868) also put forward their design on algal classification (John, 2013). However, the most accepted classification for algae was given by Fristch (1935, 1945) where he divided algae into 11 classes based on certain characters. Fritsch's (1935 & 1945) "The Structure and Reproduction of the Algae" was considered as a remarkable contribution to the field of Phycology. There he studied algal morphology and reproduction in details. Later in 1955, Smith further divided algae into seven divisions with fourteen classes. Likewise, several classifications and works have been undertaken by many authors following them (John, 2013).

Advancement of technology, including introduction of electron microscope and other essential visual aids took another leap to the area of algal studies where possibilities for more clear, fine and detailed observation of algal structures became much easier. Round in the year 1973 divided algae into two divisions and twelve classes which was considered as the most valuable contribution of advanced technology.

Study of algae in freshwater bodies wraps algal studies in different wet habitats other than oceans and estuaries. Smith (1950) described about the abundance and diversity among different groups of algae like Cyanophyta, Chlorophyta, and Charophyta within fresh water

bodies. Remarkable contributions came forward from many eminent researchers in the field of freshwater ecology.

Aquaculture is practiced globally in more than 150 countries and its importance has created new demands. Investigation of algal production in fish ponds was an early practice. Some comparative study on phytoplankton of several fish ponds has been made by Wiebe (1930) and Komarvosky (1953). A successful evaluation of role of plankton community in inland fishery ponds in Brazil was conducted by Norchechotta*etal*. (1990). In a similar way, Howard *et al.* (1996) in different parts of the world carried out the study on cyanobacteria and their bloom in fish ponds. Sabu *et al.* (1991) examined the physico-chemical characterization of Mississippi flood plain of USA (Saikia, 2014).

Algae have also gained enormous attention since its quality of being one among the biological indicators. Water quality assessment can be done with the help of presence of some exclusive algal genera and species. The first attempt to distinguish algal community between pure and polluted water bodies was done by Cohn in 1853 (Bordoloi, 2016). Similar works were reported by Kolkwitz and Marsson (1908), Storm (1924). Ruth Patrick and C. Mervin Palmer were the foremost to work on algae-based monitoring of rivers in North America (Patrick, 1949; Patrick *et al.,* 1954; Palmer, 1969). Investigation of the health equilibrium of a water body based on algal bio indicators was done by several researchers (Butcher, 1947; Zelinka and Marvan, 1961; Sladecek, 1973; Lowe, 1974; Lange-Bertalot, 1979). Palmer (1969) for the first time made an interesting attempt to identify and prepare a list of 60 algal genera and 80 species that are tolerant to organic pollution. Depending on the level of pollution tolerant capacity each genera and species was given points against its name. Fay (1983) reported about presence of algae as disturbance indicator of biological equilibrium in some tanks. Similarly, the contribution of Rice

(1938), Prescott (1939), Nygaard (1949), Kratz and Meyers (1955), Brook (1965) were some noteworthy in this regard. Study on ecology of freshwater algae helps to establish productivity in the water body. Several workers like Lund (1965), Hutchinson (1957), Ruttner (1963), Gessner (1955, 1959) presented their works in this context (Bordoloi, 2016).

Byproducts of algae and its economic value are numerous. Algae serves purposes like food products and sources of fish food but their uses are limited till today. An extensive account of algae as food and food products was given by Tilden (1935); Boney (1965); Dawson (1966); Dixon (1973); Johnston (1970, 1976); Saikia (2014); Bordoloi (2016). Their findings concentrated on the valuable products that are the yields of algal forms. One to be mentioned in this regard is *Spirulina* which have high contents of protein, β-carotene, vitamins and minerals and hence at the World Food Conference in 1979 was considered as best future food for mankind by UN.

The study of algae in Indian context sets a late remark in history as compared to the other parts of the world. The works on Indian Phycology can be distinguished into three phases. The first period was during 1798 to 1854 when the British phycologists laid the foundation and contributed the most base level information being the pioneer workers. The classical works of the time were explanations of seaweeds, *Chara* etc. Royal's (1837-1839) contribution to algal study in North India was considered as the earliest record in Indian Phycology (Kakati, 2011). Then came the second period from 1858-1907, when several valuable work pieces were presented by a few professional algologists like Wallich (1860), Lagerheim (1888) and Turner (1883). Studies in Diatoms have always attracted researchers from the very preliminary time (Kakati, 2016). Agardh (1824) was the one who initiated and published his works on Diatoms including Desmids. A descriptive account of desmids, diatoms, several species of blue green and

some red algae was illustrated by West and West (1897). Some other contemporary workers of that time were Hobson (1863), Martens (1871), Zeller (1873), Dickie (1882), Joshua (1888) etc. (Sharma, 2003). Then arrived the third phase of Indian Phycology from the year 1919 till date. In this period, the Indian workers took the initiative to work on algae. Most of the appreciable works were performed during that period. Ghose (1919-1927) worked on blue green algae of Burma and Punjab. Works on Volvocales, Chaetophorales, Zygnemales and Blue green algae and several new species of India were published by Prof. M.O.P. Iyenger (1920-1954) who has been known as "The Father of Modern Algology in India" (Awasthi, 2015). One of the major and noteworthy contributions of his work was the discovery of the species *Fritschiella tuberose*. Bruhl and Biswas (1922-1926) studied extensively on algal communities of Eastern India (Kakati, 2011). Another piece of extraordinary effort was given to Indian Phycology when Bharadwaja (1933-1940) founded a school of algal research at Banaras Hindu University (Bordoloi, 2016).

With this momentum to Indian Algology, several works were reported by many algologists whose efforts were considered as assets in the concerned field. Randhawa (1959) was one among the important contributors who carried out exploration on species of Zygnemaceae, Oedogoniales and Vaucheriaceae. The freshwater diatom flora of South India was for the first time reported by Krishnamurthy (1954). Desikachary's (1959) "The Cyanophyta" was an exclusive monograph for the researchers till date. Work on Myxophyceae with two new species and one new variety was reported by Vasistha (1960). A specific detailed account on diatoms from Sagar and some temporary ponds of India was well executed by Gandhi (1959, 1960). He also discovered many new taxa. Prasad *et al.* (1976) made the discovery of a new genus report first time in India named *Pseudochaete.* He also studied in details about stages of sexual

reproduction in the genus *Tetraedron*in the year 1977. Other than the study of algae on general basis, many workers also worked on the aspects like algal cytology, physiology, taxonomy, ecology, evolution, productivity, response to toxicity, response to environmental changes, role in economy etc.

Some of the commendable works were also contributed towards the study of ecology of fresh water bodies in relation to physical, chemical and biological parameters therein. Relation of phytoplankton communities with the abiotic factors in Veeranam Lake in the Cuddalore district of Tamil Nadu was documented by SenthilKumar and SivaKumar (2008). Ecology of some lakes of Kashmir was studied by Das (1970, 1971). Moreover, Anand (1988)discovered that physical and chemical characteristics showed considerable effect on algal populations. They also stated that pH, total alkalinity and Carbon-di-oxide of water might lead to phytoplankton succession resulting algal bloom.

After an extensive study of the physicochemical and biological survey in water bodies, many researchers reported that wastes or pollutants from any source received by the aquatic body alters the physicochemical properties of the water body that harms the aquatic lives living therein (Parvateesam and Gupta, 1994). The adverse impact of pollution on algae in Thrissurkol wetlands, which is a Ramsar site of Kerala, was studied by Tessy and Sreekmar (2008). Trivedy*et al.* (1985) stated that the pollution tolerant Cyanophycean algae are quite common to most of the water bodies in India. The change in species diversity is the corresponding result of change in quality of the water body (Khan, 1991). Cyanophyceae and Euglenoid flagellates were mostly dominating and found to be associated with those water bodies which are organically very rich and have low oxygen content. Similar works on ecological studies of the water body in

relation to plankton community were also reported by Joshi *et al.,* 1981; Rai, 1990; Alam*et. al.*, 1996; Frempong, 1981; Sudhakar *et. al.,* 1981(Kumar *et al.,* 1974).

Algologists also found variations in distribution and composition pattern of algae in pure and polluted water bodies (Seenaya, 1972; Rama Rao *et. al.*,1978). Verma and Dalela (1975) nominated the genus *Oscillatoria, Spirogyra* and*Stigeocloniu*mas pollution indicator genera. Likewise, *Anabaena, Scenedesmus, Closterium, Navicula, Euglena gracilis, Phacus*etc.were designated as pollution indicator algae while exploring Moras River in Madhya Pradesh. Rajkumar *et al.*(1994) stated that there lies a difference in species association in urban and rural areas. In the former case it is related to the physico-chemical aspects of environment whereas in the latter case it depends upon the nutrient availability. Works like biomonitoring of algae in water quality assessment of different pond ecosystems of India have been undertaken by many researchers of that time (Kakati, 2011; Bordoloi, 2016).

The North Eastern region of India was bestowed with significant works and exploration conducted by the algologists in different time. Several works have been accounted since the British era in this part of the region. The first report of algal studies dates back to the twentieth century. Biswas (1922-1950) documented some of the algal flora of Assam while studying the algal flora of Bengal (Bordoloi, 1973). This was one of the foremost pioneer works in Phycology in Assam. With the flow, Bruhl and Biswas (1929); Biswas (1934); Bordoloi (1976); Reddy *et al.* (1986); Alfred (1978); Changkakati (1989); Jena and Adhikary (2007); Baruah and Kakati (2009); Baruah*et al.* (2009); Yasmin *et al.* (2011); Baruah and Kakati (2012); Bordoloi and Baruah (2014); Baruah*et al.* (2014); Bordoloi and Baruah (2015) also conducted investigations and reported different taxa from different parts of North East (Bordoloi and Baruah, 2015).

One important name in the history of algal studies in Assam was Parukutty (1940). She initiated the phycological studies in Assam in the mid of twentieth century collecting and describing some species of Chlorophyceae and Cyanophyceae exploring different parts of the state. Fresh water algal flora of Assam was studied in details by Bordoloi (1973). Devi (1981) and Hazarika and Gogoi (1985) worked on algal community in Darrang District of Assam and hot springs in Assam respectively. Yadava *et al.* (1987) studied the productivity and limnology of DighaliBeel of Assam. The study on physico-chemical and biological parameters of some drains within the city Guwahati was accounted by Baruah and Bordoloi (1988) who verified some organic pollution tolerant algal genera. Hazarika (1988) choose to work on the distributional pattern of cyanobacterial flora of Golaghat district rice fields of Assam. A great deal of work and research was also conducted on the famous Ramsar site of Assam Deeporbeel. Kakati and Bhattacharya (1989) and Baruah and Bordoloi (1990) observed the water quality status and phytoplankton composition using Nygaard indices along with pollution status respectively of the beel. Algologists paid their massive interest towards studying algal diversity of rice fields of Assam. 28 species of blue green algae were reported by Saikia and Bordoloi (1995); whereas 64 species of blue green algae from Kamrup district were reported by Talukder (1997). Myxophycean algal biodiversity of Lakhimpur district of Assam was also reported by Hazarika *et al.* (2002). Areas polluted with oil refinery effluent drains of Guwahati city were enumerated with 24 algal species, where genus *Oscillatoria* was found to be dominant (Baruah *et al.*, 2009).

Assessment of water quality using Palmer's index was studied by Bordoloi and Baruah (2014) in a historical pond of Tinsukia district of Assam. On the other hand, eight historical ponds of Kamrup district reporting 462 algal species under 125 genera was documented by

Kakati (2011). With a record of 45 species of phytoplankton community Baruah and Kakati (2012) enumerated the algal diversity in the Gopeswar temple pond of Kamrup District (undivided) Assam. A wide range of study of diatom flora in ponds, lakes and rivers of the Sivasagar district of Assam was conducted by Phukan and Bora (2012). With the same perception, a good number of findings were reported one after another which contributed tremendously towards the growth fate of Phycology in Assam.

Assam is enriched with diverse flora and fauna all around. Despite of its massive exploration in the field of Phycology, many works are still lagging behind in this particular region. Conserved evidences account the study of algal flora of some fresh water ponds and some historical ponds of Assam. Recently, Kakati and Baruah (2009) worked at the SobhagyaKunda (pond) of Kamakhya temple; they reported a list of 74 algal species. However, very limited work has been recorded in the study of algal diversity with reference to fish ponds, especially in North Guwahati region. Das (2015) recently worked on heritage of North Guwahati and described the historical importance of the place and its rich culture. Rahman *et al.* (2014) studied the ornamental fish diversityof North Guwahati in lentic water bodiescontemplating entrepreneurship possibilities to the villagers. They also evaluated the food value of the fishes. And, the most surprised aspect is that no one initiated to document the algal flora of North Guwahati region of Assam. The present endeavor was therefore aimed to study the algal diversity in a few fish ponds of the area in the context of prevailing environmental situations.