CHAPTER - 2

REVIEW OF LITERATURE

Water is the driver of Nature.
- Leonardo da Vinci
REVIEW OF LITERATURE

Since the early part of the 20th century, lakes have been classified according to their trophic state. Different organizations of different countries around the world which are involved in water resources control are using a regular form of Physico-Chemical indices for water quality assessment. These indices have been the product of efforts and research development from governmental agencies and academic institutions. Among the first prominent comparisons of water quality indices were Landwehr & Deininger (1976), followed by Ott (1978), who revised water quality indices used in the USA, besides publishing a detailed discussion about the practices and theories of environmental indices. In Europe contributions have come from van Helmond and Breukel (1997), who demonstrated that at least 30 water quality indices are of common use around the world.

The broader and generally accepted conception of limnology involves the study of all inland aquatic ecosystems including the biological aspects (Brezonik 1996; Strom 1929; Wetzel 2003). Forbes (1887) described the physicochemical and biological composition of lentic water bodies and called such standing water bodies as microcosms. The discovery of plankton by Victor Henson (1887) was a milestone in the field of limnology. Birge and Judey (1911) studied the physicochemical and biological characteristics of lake Mendotta and they concluded that eutrophication of lakes is due to increased human interference by discharging waste water into aquatic ecosystem. West and West (1912) studied the periodicity of phytoplankton on account of variation in physicochemical characteristics for the first time in some British lakes. Fritsch (1913) established the first mobile biological research station in United Kingdom for the survey and study of aquatic ecosystems for their physicochemical and biological characteristics. Pearsall (1921), Storm (1924), Howland and Lucy (1931), Hutchinson and Pickford (1932) and Yoshimura (1932) conducted studies on fresh water lakes. Prescott (1938) recorded the objectionable algae and their control in lakes and reservoirs. Bailey (1938) studied the ecology of phytoplankton of lake Michigan in United States of America. Thresh et al. (1944) studied the chloride content of surface waters and concluded that higher level of chloride content is due to higher pollution. Prescott (1952), after
studying fish mortality rate in lakes concluded that the toxic substances released during death and decay of plankton was the cause for increased fish mortality. Gerloff and Skoog (1957) studied the ecological aspects of Lake Wisconsin in United States of America. Shannon and Brenzoic (1972) developed a trophic state criterion using multivariate approach. The important contribution to hydrobiology in India include those of Gonzalves and Joshi (1946) who studied the seasonal occurrence of algae in a tank at Bandra, Mumbai; Patrick (1948) observed the factors affecting the distribution of diatoms and Rao (1955) discussed on the distribution of algae in six small ponds of Hyderabad. Krishnamurthy (1954) studied the diatom flora of south India. Gandhi (1955) worked on the fresh water diatoms of Pratapagad, Rajasthan. Philipose (1960) worked on fresh water phytoplankton of inland fisheries; Singh (1960) recorded the phytoplankton ecology of inland water of Uttar Pradesh. Munnawar and Zafar (1967) studied the distribution pattern of phytoplankton of polluted and unpolluted lakes of Hyderabad. From these studies they pointed out the impact of physicochemical parameters on algal growth. Hydrobiological studies of a temple tank, Devikund in Deoband by Verma and Shukla (1968) was a break through in the study of limnology. This has encouraged Vyas (1968) to do phytoplankton study in Picchola Lake and Zaffar (1969) to study ecology of algae in the ponds of Hyderabad.

Hydrobiological studies in India were geared up during 1970 to 1980. Venkateswarulu (1970) conducted the ecological study of algae in river Moosi, Hyderabad with special reference to water pollution and periodicity of some common algal species. Seenayya (1971) studied the plankton composition in fresh water lakes, while Munnawar (1972) was the first person to report Euglenoids as indicators of organic pollution. The significant contribution to limnology has been made by Bharathi and Hosmani (1973) who conducted hydrobiological studies in ponds and lakes of Dharwar. They observed gradual decrease in total production towards summer in polluted ponds and blooming of different species of algae causing the water unfit for drinking. Bharathi and Hosmani (1974) studied the slightly polluted ponds disturbed by animal and human population and found increase in total algal production with the increase in number of species. Dillon and Rigler (1975) showed total nitrogen and phosphorus ratio as growth limiting factor.
for algae. They pointed out that a ratio of 12 indicates that phosphorus is the limiting factor, while a ratio less than 12 indicates that nitrogen becomes limiting factor. Hosmani (1976) reported the increased phosphates, calcium, oxidisable organic matter, albuminoid ammonia, low pH and high degree of organic pollution causes the death and decay of Myxophyceae and this will accelerates the bloom of *Franceia ovalis*. Bharathi and Hosmani (1977) studied the ionic composition of 16 lakes of Hassan and Chitradurga districts. Santini and Savatore (1979) studied the distribution of phytoplankton in three lentic water bodies of Brasilica(Italy) and reported profound effects of the levels of phosphorus on chlorophyll content of algae. The significant contribution to fresh water ecology has been made by Bharathi Singh and Swarup (1979) who made limnological studies of Surah lake (Ballia) with special reference to periodicity of phytoplankton. The other noteworthy publications in the field of Indian limnology were those of Goel *et al.* (1980) who studied the impact of sewage on fresh water ecosystem and Hosmani and Bharathi (1980) using Palmer pollution indices reported algae may be used as pollution indicators in fresh water bodies. Rekha Purohit and Singh (1981) studied on the physicochemical aspects of Nainithal Lake.

Significant quantum of research work was done in this field during 1981 to 1990. Archibald and Lee (1981) established the fact that the ratio of inorganic nitrogen to orthophosphate is indicative of algal growth limiting factor. Rai and Hill (1982) classified the central Amazon lakes using the physicochemical and microbiological parameters. They classified the lakes as oligotrophic and eutrophic based on electrical conductivity, pH, dissolved oxygen, silica, phosphohte content and bacterial density. Barroin *et al.* (1982) investigated the physicochemical aspects of a eutrophic water body, the lake Lemen, France. Hosmani and Bharathi (1982) classified the water bodies using various algal populations. Prasad and Yashpal Singh (1982) studied the indicator organisms of water pollution. Mohanty (1983) also reported algae as indicators of pollution. Other important publications on lentic water bodies include the investigative works on Lalpuri Talab at Rajkot by Kaul and Siddarth (1983); the works on desmids of Karnataka and Goa states by Bharathi and Hegde (1983). Schroeder *et al.* (1983) recorded the biogenic calcium carbonate production in an oligotrophic lake in Austria. Forsyth *et al.* (1983) studied on
limnological aspects of Roangaio Lake of Newzealand. Koshel et al. (1983) reported that calicite precipitation decreases the phytoplankton population, dissolved oxygen and total phosphate in the lake of Breiber, Lucin, Germany. Raina et al. (1984) made a detailed study of water quality and reported that biological oxygen demand values indicated that the water was not heavily polluted, but nutrient elements play an important role in determining the trophic status of the water bodies. Bhatnagar (1984) studied the limnology of lower lakes of Bhopal with reference to sewage pollution and eutrophication. Zutshi et al. (1984 and 1988) worked on eutrophic gradient in Dal Lake and concluded that the low dissolved oxygen may be due to increased rate in the decomposition of organic matter by microbes and low pH during summer may be due to conversion of carbon dioxide in to carbonic acid. Chandra et al. (1984) reported the total absence of plankton occurred due to acute toxicity of the combined effluents having toxic constituents of chlorine and mercury. Dakshini and Gupta (1984) made an ecological survey of three lakes of Delhi. Chan (1985) studied the effects of water pollution on the flora and fauna of a fresh water pond at Aligarh. He reported that chlorophycean members were dependent on nitrates, diatoms were controlled by phosphates while the excess growth of Microcystis aeruginosa, which is an indicator of eutrophic nature of pond stimulated the growth of Euglenaceae and Bacillariophyceae. Hosmani and Mallesha (1985) reported algal species as indicators of water pollution. Kanungo et al. (1985) made observations on the physico chemical characteristics of some ponds of Raipur city. Khan (1985) published algal flora of Sultanpur and reported 79 species of aquatic algal taxa comprising Cyanophyata, Rhodophyata, Xanthophyta, Chlorophyta and Euglenophyta. Puttaiah and Somashekar (1985) studied the limnological aspects of Mysore city ponds. Sharma et al. (1985) reported 2 species of Pediastrum from Gwalior. Chaturvedi (1985) published the diatom flora of Bareilly district and reported 53 species of diatoms and 46 taxa of desmids.Chaturvedi (1985), Sharma et al., (1985), Hegde and Bharathi (1986) while studying fresh water ecosystems reported the presence of various species of algae. Sharma et al.,(1986),Chitranshi and Bilgrami (1986) have studied the lentic water ecosystems and discussed on the importance of physicochemical characteristics of water in relation to the distribution pattern of phytoplankton. Hegde and Bharathi (1986) investigated the euglenoid blooms in relation to physicochemical characters in ponds and lakes of Dharwar.
Srivastava and Sen (1987) while studying fresh water algae of Narmada River near Jabalpur reported 64 new forms. These studies reported new algae from different parts of India.

Singh (1987) during his investigations on Ox-bow lake found that high temperature coupled with higher concentrations of phosphorus enhances the rate of reproduction of *Microcystis aeruginosa*. Puttaiah and Somashekar (1987) reported that high concentrations of carbon dioxide and low concentrations of oxygen are the causes for abundance of Euglenoids in fresh waters of Mysore. Singh and Mahajan (1987) discussed the role of temperature, nitrate and phosphorus on plankton variations in lakes of Himachal Pradesh. Similarly Kurata *et al.*, (1987) studied seasonal changes of various physicochemical parameters in lake Notoro Hokkaido, Japan. Other publications include June and Fred (1987) who studied physicochemical and biological characteristics of lake Sharpe, South Dakota, USA. Zusti and Khan (1988); Anand (1988); Bhattacharya (1988); Saifulla *et al.*, (1988) who did a lot of work on chemical composition of standing water bodies. They concluded that physicochemical characterization of water significantly affect the algal population and they emphasized the importance of pH, total alkalinity, CO₂ content of water on the succession of phytoplankton leading to eutrophication. Hosmani (1988) studied seasonal changes in phytoplankton community in fresh waters and found that blooms of *Franceia ovalis*, *Euglena elastica*, *Euglena gracilis* and *Trachelomonas charkoweinsis* had a significant effect in reducing the number of species in ponds. Tripathy (1989) recorded maximum diatom population during summer and monsoon.

Khatavar *et al.* (1989) established the relationship between phytoplankton and some nutrients especially during summer months. They reported the concentration of chloride, sulphate and organic carbon plays a vital role in accelerating the blooms and they also showed that phosphorus concentration has a profound effect on bloom formations. Similar observations were made by Ahluwalia (1989), Srivastava *et al.*, (1989), Gosh and George (1989) and Varadaraj and Ayyappan (1989). Though many studies have been conducted on fresh water ecosystems during 1990-91, most of them were concentrated on algal systematics.
Some of the reports were those of Naik and Hegde (1990) at estuary of the river Sharavathi, Mathur and Pathak (1990) on rock shelters, Srivastava and Othawani (1990) from semi arid region of Rajasthan. Ashok kumar and Patel (1990) studied desmids of Gujarat and reported 32 taxa of *Cosmarium* from different fresh water habitats. Ibrahim Banat (1990) studied productivity of algae in waste water treatment plants. Ikonnikov(1990) pointed out the problem of toxic pollution of Ladoge lake in Russia and suggested that increased discharge of toxic substances in to the lake has caused water quality deterioration, changes in species composition and other deterious effects on the aquatic ecosystems. Various scales for determination of trophic state of water on the basis of phytoplankton biomass and chlorophyll levels has been presented by Trifonova (1990).Naganandini and Hosmani(1990) studied certain inland waters of Mysore district and found that the cyanophycean bloom was dominated by *Microcystis aeruginosa*. They reported the influence of dissolved organic matter, carbon dioxide, phosphorus, calcium, dissolved oxygen coupled with death and decay of *Spirulina nordestedtii*. These observations were supported by Swarnalatha and Narasing Rao (1991) who were in the opinion that cyanophycean blooms are indicators of pollution. Surendra kumar and Sharma (1991) in their studies on Picchola Lake pointed out that the trophic level of water rises due to high electrical conductivity, pH, total alkalinity and nitrates. Molot and Dillon (1991) discussed nitrogen phosphorus ratio in relation to chlorophyll production in the lakes of central Ontario. Some of the works of this kind include study of the distribution of phytoplankton and water chemistry of fresh water bodies near Srinagar by Sarwar and Wazir (1991); investigation on periodicity of planktonic algae by Kaushik *et al.*, (1991); functional interaction between phytoplankton and zooplankton in Green Bay lake by Sagar and Richman; study of seasonal diversity of desmids in lakes of Denmark by Nyagard (1991).

Nirmalakumari (1991) did biochemical studies on river Moosi, Hyderabad and reported glycolic acid and total carbohydrates was maximum during summer when the *Chlorella vulgaris* dominated in the water. Choudary (1991) noticed that optimum diversion rates of pH and temperature had a profound influence on diatoms. Jyothi *et al.*, (1992) studied Cyclotella bloom and found higher concentration of chlorides, phosphates and organic matter during the bloom. The
succeeding contributions to the field of limnology were, Vaisya and Adoni (1992) who studied Sagar Lake and inferred that lake had become hyper eutrophic due to unbalanced physical and chemical parameters. The other similar researches carried out includes the study on cyanophycean bloom by Swarnalatha and Rao (1992); study of lake near Marma Goa by Borker et al., (1992). Adhikari and Sahu (1992) studied the Chilka Lake and concluded that temperature above 20°C along with alkaline pH was responsible for Trichodesmium bloom during summer months. Belsare et al., (1992) studied on numerical and volumetric variation in plankton population of a polymictic trophical lake in Bhopal; Biswas (1992) recorded phytoplankton periodicity in Ogelube Lake, Nigeria and reported maximum density of desmids during summer. Dixit et al.,(1992) conducted extensive studies on diatoms and revealed that they can be used as bio indicators for a variety of aquatic issues including lake acidification, eutrophication as well as climate changes. Mohapara and Mohanty (1992) determined the water quality of two water bodies using algal bioassay method and reported that Chlorella was found more efficient than Anabaena in reducing nutrient load and pollution. Jones et al., (1993) studied water chemistry and trophic status of 8 lakes in Costa Rica. Parvateesham and Mishra (1993) studied algae of Pushkar Lake including the pollution indicating forms. Rao et al., (1993) classified Ooty Lake as eutrophic based on the nutrient status and phytoplankton production. Swarnalatha and Narasing Rao (1993) studied Banjara Lake, Hyderabad and described the various factors responsible for the appearance of the bloom Microcystis aeruginosa. Heckey (1993) concluded that nutrient loads to lakes are mainly due to atmospheric deposition and land run off which accounts for 90% of phosphorus and 94% nitrogen input in to the lake.

Shaji and Patel (1994) studied phytoplankton ecology of a polluted pond at Anand, Gujarat and reported that temperature, total alkalinity, dissolved oxygen, calcium, chlorides, nitrates, phosphorus and silicon have profound effect on algal flora. Khan and chowdhary (1994) investigated the physical and chemical limnology of Lake Katpai, Bangla Desh; Uman and Jimeaney (1994) studied basic limnology of a lake at Costa Rica. Changes in physico chemical environment of water causes significant changes in the phytoplankton community structure. Flores and Barone (1994), Uku and Mavuti (1994) showed that this process results in the domination of
zooplankton communities such as rotifers and small bodied cladocerons. Lehman et al., (1994) observed increase in chlorophyll.a concentration of algal blooms during rainy season. Bratli (1994) studied the lake Froylandsvatn, Norway and pointed out that phosphorus input results in frequent blooms of blue green algae which in turn produce toxins. Mc Cormic and Cairns (1994) studied water bodies of Florida and showed that algae can respond rapidly and predict the presence of wide range of pollutants that can be used as warning signals in water quality determination. Miyajima et al., (1994) reported higher diatom population and biogenic composition of silica in an eutrophic water body, the lake Biwa, Japan. Swarnalatha and Narasing Rao (1994) while investigating two ponds observed that the pond which experiences continuous bloom of cyanophyceae was more polluted and the pond that supported more desmids was less polluted. Bairagi and Goswamy (1994) also reported the similar observations. Goel et al.,(1994) reported the dependance of blue green algal dominance on phosphorus and nitrogen ratio.

There were few publications in this field during 1995, which include the works of Agbeti and Smol (1995) who studied physicochemical and biological characteristics of high mountain lakes. Pandey et al., (1995) studied the seasonal abundance of phytoplankton in relation to ecological conditions in the stretch of Cosi River. Das and Verma (1996) studied algal flora of Chitwan and Nawalpoosi districts of Nepal. Anna-lisa Holopainen et al., (1996) studied the trophic state of Lake Ladoga and their relation to phytoplankton. Boris et al., (1996) surveyed the toxicity of cyanophycean blooms in the same lake and found that Anabaena circinalis, Anabaena flos-aquas, Anabaena lemmermani, Gloeotrichia cichimilata, Microcystis aeruginosa and Oscillatoria species are the causative species for such toxic blooms. Ravikumar and Puttaiah (1996) studied ecology of lakes of Hassan district. James and Havens (1996) investigated the occurrence of algal blooms in lakes of Okeecobes, Florida and they found that the occurrence of these blooms is strongly and positively related to nitrogen and total phosphorus concentrations. Hosmani and Vasanthkumar (1996) studied biochemical aspects of water pollution and inferred that Kukkarahalli Lake is highly productive in terms of biochemical products whereas Dalvoi Lake is productive in terms of plankton.
The seasonal variations in the physicochemical parameters like dissolved oxygen, chloride, salinity and planktonic composition of Kurichi pond were studied by Arivozhagan et al. (1997). Takano and Hino (1997) from their studies on an hypertrophic lake Barato, Japan concluded that high temperature promotes the growth of diatoms. Iqbal Habib and Chaturvedi (1997) made a systematic study of chlorococcales at Ramanagar, Kumaun Himalayas. They reported 18 taxa of chlorococcales. Hosmani et al., (1997) studied the occurrence of *Euglena sanguina* and reported that temperature above 26° C, high pH, carbon dioxide, albuminoid ammonia, phosphate with low concentrations of carbonates, nitrates and free ammonia accelerated the bloom. Other such reports were those of Swarnalatha and Narasing Rao (1998), Pandey et al., (1998) who are of the opinion that inflow of nutrients and consequent algal growth deteriorates the water quality. Correl (1998) discussed the role of phosphorus in the eutrophication of lake, which results in the excessive production of autotrophs mainly cyanophycean members. Arvind et al., (1998) studied correlation coefficients of some physicochemical parameters of river Thungabhadra, Karnataka. Singh et al., (1998) investigated the hydrobiology of some eutrophic ponds of Rohtas, Bihar. Taar et al., (1998) made ecological studies in water bodies of Nagapur. Wani (1998) studied the seasonal dynamics of phytoplankton in Himalayan lakes and reported that the diatoms were the most represented species. Seema et al., (1999) studied eutrophic status of some lakes in Amaravathi district. Chidambaram (1999) conducted biochemical evaluation of coastal aquaculture using marine cyanobacteria and observed the continuous bloom as an indication of pollution and eutrophication of coastal water.

Borse and Bhave (2000) studied the influence of temperature on dissolved CO₂ and pH. They reported higher level of CO₂ in summer and lower level during winter and it was depended on carbonates and bicarbonates in water. Nandan et al.,(2001) worked on Hartala lake of Jalgaon district of Maharastra and inferred the abundance of blue green algae was due to higher concentration of dissolved CO₂, carbonates, total alkalinity, chlorides and phosphates. Noor Alam (2001) physicochemical parameters of a pond at Hatwah, Bihar and recorded variations in free CO₂, dissolved oxygen, pH and alkalinity and suggested measures to prevent deterioration. Rajkumar (2001) studied the seasonal distribution of plankton in a
fresh water pond of Pollachi, Tamil Nadu. He reported the minimum number of phytoplankton during the winter months. Anilkumar et al., (2001) studied the important factors of organic pollution which affect primary productivity in wetlands of Jarkhand. Variations in the level of phosphorus and CO₂ in Ambegosale lake was studied by Madhuri Pejavar et al., (2002). Nagarathna and Hosmani (2002) studied the factors influencing the bloom of *Nitzschia obtusa* in a polluted lake. Correlation matrix and cluster analysis indicated that most of the physicochemical parameters were inversely proportional to the growth of diatoms. Karthikeyan et al., (2002) studied the physicochemical, biological and bacteriological study of Kadathur canal water of Amaravathi River, Tamil Nadu and concluded that all the parameters are in high level and the water is unsuitable for drinking and irrigation purposes. Mamatha Rawath and Jakhoy (2002) conducted limnobiological study of a few reservoirs of Jodhpur, Rajasthan and reported that they had low DO and the quality of water was poor.

Carvalho and Kirika (2003) reported a decline in inflow of nutrients reduces phosphorus concentration in lakes which in turn reduces phytoplankton biomass. Xie et al., (2003) reported persistent coincidence between the occurrence of *microcystis* bloom and that of phosphorus in an enclosure experiment in a Chinese lake. Bozena Bogaczewicz-Admczak et al., (2003) have used the OMNIDIA softwatre to calculate diatom indices to assess water pollution in the Puck bay of Southern Baltic Sea. Jutner et al., (2003) used diatom indices to assess water quality in Kathmandu valley and middle hills of Nepal and India. Poulickova (2003) has studied the indicator role of diatoms in the littoral regions of eutrophic shallow lakes in the Czech Republic. Maria José Dellamano-Oliveira et al., (2003) studied limnological characteristics and seasonal changes in density and diversity of the phytoplanktonic community at the Caco pond, Maranhão state, Brazil. They recorded highest number of cyanophyceae and chlorophyceae groups during rainy and dry seasons. Ariyadej et al., (2004) studied phytoplankton diversity and its relationships to the physico-chemical environment in the Banglang reservoir, Yala province. They found that light limitation by high turbidity is another factor that frequently controls phytoplankton growth either during the whole year or seasonally. Indicator role of diatoms is studied by Poulickova et al., (2004) in Austrian Alpine
lakes and Blanco et al., (2004) in the Spanish lakes. Mahadev and Hosmani (2005) made an extensive study of Langlier’s index and its relation to fresh waters. They found that phytoplankton growth in saturated waters had a tendency of changing the pH of the water. Nandan and Aher (2005) studied algal communities for the assessment of water quality of Haranbaree dam and Mosam river of Maharashtra and recorded 22 pollution tolerant genera of phytoplankton. Algal biodiversity in fresh water and the related physicochemical parameters were studied by Veereshkumar and Hosmaini (2006). They inferred that occurrence of desmids in fairly good numbers is an indication that the lakes are oligotrophic and are tending to become eutrophic and they were also depended on high temperature, pH and bicarbonates. Moreno-Ostos et al., (2006) studied spatial distribution of phytoplankton in thermally stratified Andalusian reservoirs, Spain. They showed that thermally stratified reservoirs are dynamic, complex and heterogeneous ecosystems.

Anithadevi and Singaracharya (2007) studied the phytoplankton of lower Maniar Dam and Kakathiya canal, Karimnagar, A.P. They concluded that chlorophyceae and bacillariophyceae are the indicators of a healthy ecosystem while cyanophycean members indicate the bad quality of water. Ranjani et al., (2007) made hydrobiological studies on physicochemical parameters of Ghariyarwara pond of Birganj, Nepal. They found the dominance of chlorophyceae throughout the year and seasonal occurrence of other phytoplankton. Bhuian and Gupta (2007) conducted comparative hydrobiological study of few ponds of Barak Valley, Assam. They inferred that quality of an aquatic ecosystem is dependent on physicochemical qualities of water and also on the biological diversity of the water body. They reported the highest dissolved oxygen and nearly neutral pH in the water body was due to the diversified plankton population. Tas and Gorulol (2007) studied the lake Cemek, Turkey. They observed the lake supported about 104 taxa of cyanophyceae, bacillariophyceae, chlorophyceae, cryptophyceae, dinoflagellates and xanthophycean members among which bacillariophyceae and chlorophyceae were dominant. Tiwari and Shukla (2007) while studying temporary water bodies of Kanpur observed high values of alkalinity, phosphate, ammonia and chloride which indicate the eutrophic nature of these water bodies. Mathivanan et al., (2007)
conducted pollution assessment of Cauvery River with reference to pollution in Annamalainagar, Tamil Nadu. They observed fluctuations in the occurrence of phytoplankton and their productivity was high during June and low during December. They further noticed that the productivity was depended on temperature, turbidity and nutrients. Manikya Reddy (2007) studied on algae as ecological indicators for the assessment of water quality in Hyderabad. He observed that benthic algae will serve as indicators in lotic waters and bacillariophyceae dominates the benthic group. Jose John and Francis (2007) investigated on the algal flora of Thodououzha taluk, Kerala, India. Yogendra and Puttaaiah (2007) reported that BOD and COD demand decreases with the increased nitrogen due to nitrification process of water. Dhembare (2007) studied physicochemical parameters of Mula Dam water in Ahmadnagar and observed the role of calcium on the aquatic flora. He also noted phosphates causes eutrophication of water bodies. Venkata Subramani et al., (2007) while studying lakes of Bodham, reported chloride as indicator of pollution and also opined that increase in sulphate in water was due to discharge of sewage. Khare et al., (2007) have studied water quality at Komph-Niwari Lake at Chhatarpur, Madhya Pradesh. They observed that dissolved oxygen level of water constantly changes due to organic matter. Smitha et al., (2007) reported that the high sodium levels contribute to salinity problems and can interfere with mg++ and ca++ availability. Taylor et al., (2007) conducted diatom studies of Vaal river, South Africa. They opines that diatom communities, when analysed, provide an accurate assessment of water quality, but these diatom communities also provide an integrated reflection of past water quality. Ewelina Szczepocka (2007) while studying diatoms of Bzura River, Poland observed the appearance of pollution sensitive diatoms which were not found earlier and concluded that the regeneration process of this aquatic body started with the liquidation of local industry, primarily textiles and the construction of several dozen sewage treatment facilities in major towns and at larger industrial plants located along the course of the river.

Shamsul Islam M (2008) studied phytoplanktonic diversity index with reference to Mucalinda Sarovar, Bodh Gaya and classified it as mildly polluted based on Shannon and Weaver’s diversity index. Sivakumar K and R. Karuppasamy (2008) made the study on physicochemical parameters and their effects on plankton
productivity with reference to increase in fish productivity in the selected areas of Cuddalore district, Tamil Nadu. They observed the decrease in nutrients after high productivity of phytoplankton. Hosmani (2008) studied the ecology of Euglenaceae from Dharwar and reported that they responded to high temperature, oxidisable organic matter and low concentration of dissolved oxygen. Taweesak Khuantrairong and Siripen Traichaiyaporn (2008) studied diversity and seasonal succession of the phytoplankton community in Doi Tao Lake, Chiang Mai Province, and Northern Thailand. They found phytoplankton communities had the highest and lowest Shannon-Weaver diversity indices in the winter and summer seasons respectively. Pramila Kumari et al., (2008) conducted bio monitoring of plankton to assess quality of water in the lakes of Nagpur city.

Basavarajappa et al. (2009) studied the water quality parameters of four freshwater lakes of Mysore based on CCME WQI. Arvind Kumar and Varma (2009) studied the spectrum of plankton abundance in certain lotic eco systems of Jarkhand, India. Ayoade et al., (2009) studied two regulated high altitude rivers of Garhwal, Himalaya, India and reported higher planktonic population density and fauna diversity in lentic portion of Tehri dam reservoir area is due to favourable environment unlike the riverine zones where fast current and higher turbidity affect the growth. The least fauna diversity and density below the dam (downstream) may be due to wide fluctuation in the water level brought about by flow regime of water from reservoir as regulated by authority. Hasan Kalyoncu et al., (2009) used diatoms for the assessment of water quality in two streams of South Turkey. They reported that Darioren stream was not polluted while the sampling sites on Isparta stream was polluted. They concluded that diatom assemblages were useful for assessing the stream ecological status. Joanna Żelazna-Wieczorek and Maciej Ziulkiewicz (2009) have used benthic diatoms for the assessment of spring water quality in suburban areas of Poland and they found that the selected diatom indices for determination of the quality of the spring water does not reflect changes in the quality of the studied springs. Devi Prasad et al., (2009) studied the fish diversity in major wet lands of Mysore. Rajashekar et al., (2009) studied zooplankton diversity of three freshwater lakes with relation to trophic status in Gulbarga district, North-East Karnataka. Chaiwat Prakirake et al.,(2009) attempted to develop a specific water
quality index for water supply in Thailand. Silvia Tavernini et al., (2009) studied trophic state and seasonal dynamics of phytoplankton communities in two sand-pit lakes of Italy. Ma Roselia et al., (2009) by studying phytoplankton diversity and strategies in regard to physical disturbances in a shallow, oligotrophic, tropical reservoir in Southeast Brazil, concluded that Intermediate Disturbance Hypothesis (IDH) is a powerful mechanism towards understanding the complex phytoplankton structural changes under spatial and temporal scales and thus to proceed towards predictability.

Sawanth et al., (2010) made limnological study of Atyal pond in Kolhapur, Maharashtra and reported the pond is rich in nutrients and has become eutrophic. Aiyaz et al., (2010) studied the biodiversity index of algal flora in Wular Lake, Kashmir and reported significant correlation between diversity, conductivity, carbon dioxide, total hardness and nitrate. Shinde et al., (2010) studied seasonal variations in physicochemical characteristics of Morsool Savangi Dam, Aurangabad district, India. They reported that water is fit only for fish culture. Hosmani (2010) made an extensive study on phytoplankton diversity in lakes of Mysore district and reported the uniform distribution of algal species and low in diversity within the population. Bhosale et al., (2010) dealt with the diversity of plankton in water bodies of Miraj Tahsil, Maharashtra. There were great variations in the physicochemical complexes as well as the phytoplankton population. Elif Neyran Soylu and Arif Gonulol (2010) studied seasonal succession and diversity of phytoplankton in a eutrophic lagoon (Liman Lake). Edokpayi et al., (2010) attempted to assess temporal fluctuations in water quality of the coastal waters of Training Mole, Tarkwa Bay, Nigeria. They observed the distribution of dissolved inorganic nutrients may be very much influenced by factors like tidal and physical stirring by currents and benthic invertebrates as well as drainage discharged from industries and human settlement around the Training Mole. Ingole et al., (2010) studied phytoplankton of Fresh water reservoir at Majalgaon. Mukherjee et al., (2010) studied plankton diversity and dynamics in a polluted eutrophic lake of Ranchi. They observed no limiting nutrient as such in the lake to control the growth of organisms. One of the reasons to define such dynamics is the low availability of free carbon dioxide. Siddaraju et al., (2010) assessed the water quality of Arakere and Thaggahalli lakes of Mandya
district, Karnataka using NSFWQI. They categorized water of both the lakes as bad to medium. Sharma et al., (2010) used Carlson’s trophic state index for the assessment of trophic state of Mansi Ganga Lake at Mathura and classified the lake as eutrophic.

Ravikumar and Puttaiah (2011) studied the physio-chemical status of four fresh water bodies of Hassan District, Karnataka. Siddaraju and Devi Prasad (2011) have used the epiphytic diatoms as ecological indicators to assess the water quality of two lakes of Mandya. As per the diatom indicators the water of the lakes were classified as hypoeutrophic. Offem et al., (2011) studied the influence of seasons on water quality, abundance of fish and plankton species of Ikwori Lake, South-Eastern Nigeria. They recorded more number of species during dry season than the wet. Sharma Riddhi et al., (2011) carried out studies on limnological characteristics, planktonic diversity and fishes in Lake Pichhola, Udaipur, Rajasthan (India). They observed a high rate of primary production, diversity of phytoplankton, zooplankton and fish species. Shaaban et al., (2011) studied the relationships between total chlorophyll and phytoplankton individuals of Rosetta branch of river Nile, Egypt. They found positive relationship between the fluctuations of total chlorophyll contents of the phytoplankton and those of total number of individuals. Umamaheshwari (2011) studied algal biodiversity in a group of fifteen small lakes of T. Narasipur taluk, Mysore district. Bere & Tundisi (2011) conducted diatom based water quality assessment in streams influenced by urban pollution using natural and two selected artificial substrates. They found that the use of a natural substrate is better compared to artificial substrate.

Hosmani and Mruthyunjaya (2012) studied the distribution of phytoplankton in four lakes of Tirumakudal Narasipura of Mysore District. They found abundance and blooms of cyanophyceae and bacillariophyceae indicating their tendency of Lakes becoming eutrophic. Shivanna et al., (2012) conducted water quality assessment of six selected tank waters for irrigation in Tiptur taluk, Karanataka and found that no water sample in the study area is ideal for irrigation. Vijayvergia (2012) studied Udaisagar lake of Udaipur city with reference to its physicochemical environment. Sana Akhtar and Mohammad Nawaz (2012) studied Impact of Water
Quality on Aquatic Life in River Ravi, Pakistan. Divya and Rakhi (2012) conducted Assessment of Water Quality in Terms of Total Hardness and Iron of Some Freshwater Resources of Kanpur and its Suburbs. Siddaraju and Devi Prasad (2012) assessed the water quality of two lakes of Mandya using CCME water quality index and categorized the water of both the lakes as poor quality. Krishna et al., (2012) studied physico chemical and bacteriological parameters of Kaveri river at Talakaveri region and recorded maximum of 21 MPN count per 100ml during summer. Akshatha (2012) has assessed the water quality of a polluted pond at Mysore using NSF water quality index. Siddaraju and Devi Prasad (2012) recorded the increased diversity of phytoplankton in two lakes of Mandya during summer and inferred that it may be due to increased nutrients level in water. Sarma and Dutta (2012) studied the two riverine wetlands of Goalpara district, Assam. Alaka et al., (2012) studied the phytoplankton diversity in perennial reservoirs of dry tahsils of Sangli district, Maharashtra. They found that the phytoplankton diversity is mainly influenced by seasonal conditions and anthropogenic activities in the reservoir. Hosmani (2012) studied the ionic composition of and its implications on aquaculture in Hadinaru Lake and concluded that the lake water is not suitable for aquaculture. Sitre (2012) studied the biodiversity of rotifers in Ambazari lake of Nagpur city with respect to water quality. He observed the seasonal rotifer biodiversity which showed peak in density and diversity during summer season, while lower values were recorded during rainy season.

Although more than 400 references have been made during this study some of the literature review pertaining to sub chapters has been discussed at the respective topics to avoid redundancy and references have been quoted at the end of the thesis. As limnology comprises physical, chemical and biological aspects of aquatic water bodies comprehensive research papers on fresh water biota have been published occasionally. Some researchers have gave more emphasis on physico chemical factors of the water body, some have concentrated on unicellular and colonial phytoplankton while others have discussed about the causes of pollution, interrelationship between the nutrient concentration and the occurrence of algal blooms in the water bodies. In recent years statistical approach and multivariate analysis have been done and precise conclusions have been drawn.
Nowadays a vast number of research journals have been published both at national and international levels. Based on the records that could be procured through various agencies as well as referring to various literatures available in the subject, it has been possible to obtain the present data. It has provided sufficiently high percent of references to constitute the review of literature. But avoiding too early data and taking into account the references available from (1900) to the present day (2012); the review has been done.

Figure 2.1 References during 1901 to 2012 (% Values)