REVIEW OF LITERATURE

Lentic waterbodies harbour very rich flora and fauna and maintain a self sustaining ecosystem. Judicious exploitation of these waterbodies provides unending resources for the sustenance of dependent organisms. However, rapid urbanization, industrialization, overexploitation and simultaneous disregard to the environmental degradation have tremendous impact on the lentic waterbodies all over the globe. Studies on lakes have been made from a very long time as water is a vital resource for all kinds of living organisms. It is a medium for life processes, and source of nutrients and oxygen to the atmosphere. Considerable hydrobiological investigations are carried out on the natural and artificial or man made lakes all over the world.

Physico-chemical parameters

Physico-chemical parameters play a vital role in determining the distributional pattern, qualitative and quantitative abundance and inter-relationships among organisms inhabiting a particular aquatic ecosystem. Abiotic conditions of a water body also reveal the diversity and habitat condition of organisms acquiring different niches in an aquatic medium thus providing information about biological, physiological and chemical requirements of inhabiting fauna, needed for their better growth and survival. A considerable amount of literature is available on physico-chemical properties of lentic water bodies.

Forel is considered as the founder of modern limnology. He worked on swiss lakes and in 1892 published the book, "Le leman". He also published first limnological text book, "The text book of limnology" in 1901 which provided an impetus for investigation in the limnological field. After him, Thienemann (1926) published the book "Limnologie". Subsequently several authors published books on limnology (Welch, 1952; Ruttner, 1953; Hynes, 1960; Needham and Needham, 1962; Macan, 1963; Hutchinson, 1967; Wetzel, 2001).

Barret (1957) revealed that the water temperature affects other physico-chemical characteristics of water body. Elmore (1961) stated that an increase in temperature of water results in the decrease of dissolved oxygen and increase in sediment concentration hampers photosynthesis and reduce dissolved oxygen level. Cooke and Kennedy (1970) studied the

eutrophication of Northern Chic lakes. McColl (1972) studied water chemistry and trophic status of seven New Zealand lakes. Hannan and Young (1974) reported the influence of a deep storage reservoir on the physico-chemical limnology of a central taxas river. Khalaf and Mc Donald (1975) studied the physico-chemical conditions in temporary ponds in the New Forest.

Egborge (1979) reported the effect of impoundment on the water chemistry of Asejire Lake of Nigeria. Wright *et al.* (1985) studied the effects of physico-chemical parameters and seasonal changes in micro invertebrates in some rivers in Great Britain. Lerman and Wevner (1989) found that the diffusion of carbon dioxide from the atmosphere to lakes caused increase in alkalinity of water. Harper (1992) published the book, "Eutrophication of freshwaters."

The biogeochemistry of a cirque lake has been well studied by Michael *et al.* (1997). Latifa and Acharya (2001) studied the physico-chemical parameters of a freshwater pond (Jagir pond) in Manikganj, Bangladesh. They reported neutral to slightly alkaline pH 7.0-7.5, DO 2.0 mgL^{-1} and free CO_2 6.0 mgL^{-1}.

In India the extensive studies on water quality of a closed basin has been done by many workers. History of the studies on aquatic life in India can be traced back to 19th century when survey of fish fauna was made (Hamilton, 1822; Mc Clelland, 1839). The survey on water quality related with its habitat characteristic and their relationship was discussed earlier by Prasad (1916). The Yale North Indian strengthens the foundation for detailed limnological works (Hutchinson, 1933, 1937). Ganapati (1941) studied chemistry and biology of ponds in Madras city. Das (1957) studied some physico-chemical parameters of Kathura Tal, Lucknow and reported their ranges, viz. water temperature (15^{0}C – 30^0 C), pH (7.2-9.2), dissolved oxygen (4 - 6 mgL^{-1}) and free carbon dioxide (17 -39 mgL^{-1}). Motwani *et al.* (1956) reported the pollution of river Sone by the factory effluents of the Rohtas Industries at Dalmianagar (Bihar). Banerjea and Motwani (1960) studied the pollution of the Suvaon stream by the effluents of a sugar factory, Balrampur (U. P.).

Sreenivasan (1964a) studied physico-chemical and hydrobiological characteristics and fish production of three upland lakes of Tamilnadu, viz., Kodaikanal Lake in Palini Hills, Yercaud Lake in Shevaroy Hills and Ooty Lake in Nilgiri Hills during the period of May,1962 to September,1963. Sreenivasan (1964b) studied the hydrobiology of a tropical impoundment, Bhavanisagar reservoir, of Madras State. A brief physico-chemical and fishery survey of the Logtak Lake of Manipur was conducted by Chaudhuri and Banerjee (1965) which revealed slightly acidic pH (6.2-6.4) and low total alkalinity (24-36mgL^{-1}) of the lake. Zafar (1966) studied the limnology of the Hussainsagar Lake, Hyderabad.

Sreenivasan (1969) reported that in soft water reservoirs like Amaravathy, Bhavanisagar, Stanley, Aliyar and Sandynulla, free carbon dioxide and methyl orange alkalinity increased while carbonates and pH decreased with depth. In hard water reservoirs such as Sathanur and Krishnagiri, however, although wide changes occur in carbonates and bicarbonates, the pH value does not show marked variations. Surface water often develops a high pH due to photosynthesis while waters below the zone of effective light penetration show low pH values. David *et al.* (1969) found that the dissolved oxygen values of Tungabhadra reservoir ranged between 6-9 mgL^{-1} and chloride varied from 11.9-42.1 mgL^{-1}. Zutshi and Vass (1972) studied the limnology of some high altitude lakes of Kashmir, India. Munawar (1970) made a comparative study on the physico-chemical conditions of three ponds of Hyderabad and observed that in shallower water body water temperature changed more quickly. Nasar and Datta Munsi (1971) found direct correlation between bicarbonate alkalinity and pH. Bhatnagar and Sharma (1973) studied the physico-chemical features of a sewage polluted lower lake, Bhopal. Verma and Dalela (1975) studied the pollution of Kali nadi by industrial wastes near Mansurpur. Qadri and Yousuf (1978) investigated the seasonal variation in the physico- chemical factors of a subtropical lake of Kashmir.

A strong positive correlation was found between atmospheric temperature and water temperature by Kant and Anand (1978). Swarup and Singh (1979) reported high chloride during summer season. Bhatia (1979) studied the ecology of Logtak Lake under the Man and Biosphere Programme of UNESCO. He observed lake perturbations in bicarbonate and chloride values both in the open and closed parts of the lake in monsoon 1976 and

winter 1978, which were not attributable to seasonal or diurnal rhythms. Vass and Zutshi (1980) studied limnology, morphometry and physical features of Dal Lakes of Kashmir. Laal (1981) studied the ecology and productivity of swamps in North Bihar in relation to production of fishes and other agricultural commodities. He reported narrow range of pH in swamps. Das (1981) studied seasonal fluctuation in physico-chemical parameters of Nainital Lake. He reported maximum range of surface water temperature and pH in summer and minimum in winter. Limnological study of a freshwater reservoir, Jamwa, Ramgarh (Jaipur) was done by Gopal *et al.* (1981).

Singh *et al.* (1982) studied the seasonal and diurnal changes in physico-chemical features of the river Brahmaputra at Gauhati. Alkalinity was maximum in winter season and minimum in autumn season. They reported that high free carbon dioxide concentration was related to low concentration of oxygen and vice-versa.

Comparative studies on lakes and reservoirs of India with those in other tropical countries are reported by Serruya and Pollingher (1983). Limnological studies on Badkhal and Peacock lakes of Haryana, was reported by Verma *et al.* (1984). Goel *et al.* (1985) studied the limnology of fresh water bodies in Southern Maharashtra, India. Bhowmick and Singh (1985) found that the low values of DO in the summer season were mainly due to high temperature as well as due to microbial demand for oxygen in decomposition of suspended and dissolved organic matters. The lake ecosystem with emphasis on Himalayan lakes has been studied by Zutshi (1985). Pant *et al.* (1985c) studied the physicochemical limnology of Nainital Lake of Kumaun Himalaya. They found substantial effects of it on the community structure. Tiwari *et al.* (1986) studied the correlation among water quality parameters of groundwater of Meerut district. Bhowmik (1988) reported physico-chemical parameters of water of ten lakes of West Bengal. He recorded temperature variations from 18^0 C - 32^0 C, pH from 6.8 - 9.1, total alkalinity from 68 -120 mgL^{-1}, and DO from 3 - 7.2 mgL^{-1}. Dobriyal and Singh (1989) observed negative correlation between free CO_2 and DO and positive correlation between free CO_2 and temperature. Singh (1990) studied distribution and seasonal fluctuation of certain physico-chemical features of water of the river Brahmaputra. He reported high bicarbonate alkalinity during winter months. In 1990

Ministry of Environment and Forest published "Wetlands of India Directory" in which some of the large lakes and man-made reservoirs of India were listed. Pathak and Bhatt (1990) studied the pollution of river Gomti of the uplands. A comparative study of diurnal variation of physico-chemical characteristics of river, well and pond water at Rourkela Industrial Complex of Orissa was reported by Panda *et al.* (1991). Water quality assessment and pollution aspects in a stretch of river Gomti (Kumaun: Lesser Himalaya) was done by Bhatt and Pathak (1992). Hydrobiological study of a domestically polluted tropical pond was reported by Verghese *et al.* (1992).

Rawat *et al.* (1993) first studied the abiotic profile of a Garwal Himalayan lake, Deoria Tal, and observed presence of only bicarbonate alkalinity and hardness of the surface water fluctuating positively in accordance with total alkalinity of water. They also found negative correlation between dissolved oxygen and free carbon dioxide. Jindal and Kumar (1993) observed inverse correlation of temperature with DO. Gupta and Srivastava (1994) studied the water quality of Varuna River. They found that pH was increased when DO decreased. Patralekh (1994) studied physico-chemical properties in river, spring and pond. Lower hardness was observed in monsoon in all the ecosystems. Minimum amount of free CO2 was observed during summer in pond and maximum during winter in thermal spring.

Haque and Khan (1994) studied extensively the temporal and spatial distribution of cladocerans along with the impact of certain physico-chemical characteristics of the environment on them. The maximum total alkalinity was noted during post winter months and low during monsoon months. The DO concentration was noted lower in winter than in spring. Sinha *et al.* (1994) studied the biodiversity and pollution status in relation to physico-chemical factors of Kawar Lake of North Bihar from November 1991 to October 1993. They reported various chemical factors viz. pH (6.3-7.23), DO (2.15-7.6 mgL^{-1}) and free CO_2 (2.8-12.75 mgL^{-1}). Sharma *et al.* (1994) studied ecology of Kawar lake wetland, Bihar from 1993 to 1994. They reported the range of physico-chemical properties of water, viz. pH (6.65-7.08), DO (2.15 - 6.77 mgL^{-1}), free CO_2 (0.0- 9.68 mgL^{-1}) and total hardness (158.27-428.4 mgL^{-1}). Rawat *et al.* (1995) studied morphometry and physico-chemical profile of high altitude lake Deoria Tal of Garhwal Himalaya. Singh and Singh (1995)

studied physico-chemical conditions of river Sone at Dalmianagar (Bihar). Srivastava and Singh (1995) observed the algal flora of Rapti River of Gorakhpur in relation to industrial pollution. Pandey and Lal (1995) studied seasonal variation in physico-chemical factors of Garhwal Himalayan hill stream Khanda gad. They found positive correlation between atmospheric temperature and water temperature. DO was maximum in winter, when temperature was low. However, free CO_2 was found maximum during monsoon with high temperature and turbidity. Hydrogen ion concentration was observed moderate throughout the year. Srivastava and Singh (1995) observed the algal flora of Rapti River of Gorakhpur in relation to industrial pollution. Sharma (1996) studied ecology of the Koshi River in Nepal- India (North Bihar). He reported quite suitable physico-chemical characteristics of the Koshi river water with a high degree of ecological efficiency and enormous potential for biotic development. Singh *et al.* (1998) observed the physico-chemical characteristics of water in relation to pollution of river Ramganga. Jana (1998) has summarized the limnological data for about 60 lakes and reservoirs of India.

Jain *et al.* (1999) reported positive correlation between pH and DO of water of a sacred lake, Khecheopalri of Sikkim. They also reported positive correlation of water temperature with pH and DO but negative correlation with free CO_2 and alkalinity. Mishra *et al.* (1999) worked on the limnology of a freshwater tributary during the year 1994 and reported maximum amount of DO, total alkalinity and chloride in winter season and free CO_2 in monsoon season. Singh *et al.* (1999a) observed the biochemical and chemical oxygen demands of certain polluted stretch of the river Ganga. Dhanapakiam *et al.* (1999) recorded lower value of chloride of the water of Cauvery during rainy season. Singh *et al.* (1999b) studied the impact of industrial and sewage wastes on water qualities in middle stretch of the river Ganga from Kanpur to Varanasi. Their investigation revealed that average pH was low at confluence point indicating higher concentration of H^+ ion in the effluent thereby reducing the pH. High alkalinity during summer and sharp decline of alkalinity during monsoon were also observed by them. Sharma and Agarwal (1999) studied the water quality of the river Yamuna at Agra in light of the heavy pollution in reserves and the river was found to be highly polluted. Surface water quality of the river Moma at Akola was studied by Musaddie (2000). Koshy and Vasudevnayar (2000) studied the water quality of

river Pamba at Kozhencherry. Sastri (2000) studied the physico-chemical characteristics of river Mosam of North Maharashtra and found maximum free carbon dioxide in August and total absence in June and also studied a wide range of fluctuation in methyl orange alkalinity. Dutta and Dutta (2000) reported the physico-chemical parameters of potable water of Chaibasa urban area and found positive correlation between conductivity and bicarbonate alkalinity. Paria and Konar (2000) studied the physico-chemical parameters of pond water in different blocks of Purulia district of West Bengal. Hydrobiological study of Dahikhuta reservoir was done by Shastri and Pendse (2001). They observed strong correlation between pH and DO. Lower chloride in rainy season was also recorded. Physico-chemical characteristics of Narmada for the stretch Sandia to Mola in Madhya Pradesh, in the context of construction of reservoirs on the river or its tributaries, was studied by Nath and Srivastava (2001). They observed higher conductivity in summer months.

Pathak *et al.* (2001) studied the ecological status and production dynamics of a stretch of river Mahanadi. Singh *et al.* (2002) studied the hydrobiological characteristics of two ponds of Satna city (M.P.). Correlation coefficients of some physico-chemical parameters of drinking water ponds in Eastern part of Sivagangai district, Tamilnadu was done by Mariappan and Vasudevan (2002). Das (2002) evaluate the productive potential in a Peninsular reservoir, Yerrakalva. Evaluation of the role of physico-chemical factors of pond water on the outbreak of Epizootic Ulcerative Syndrome of fish was done by Roy and Pal (2003). Palui *et al.* (2003) studied the eutrophication in Kaithkola Ox-bow lake, North Bihar. Bhowmik *et al.* (2003) studied the ecology and production potential of Barnoo reservoir in Madhya Pradesh and found higher range of DO in winter (5.5-8.75 mgL-1) but lowest in summer (4.9-8.4 mgL^{-1}) and comparatively higher concentration of free CO_2 observed in winter. Sakhare and Joshi (2004) studied physico-chemical properties of some reservoirs in Maharashtra. Bhadra *et al.* (2005) studied some basic water quality parameters of the river Kaljani. Ashfaque (2004) studied the physico-chemical properties of the river Padma at Mawa Ghat, Bangladesh. Angadi *et al.* (2005) studied different physico-chemical and biological status of Papnash pond, Bidar (Karnataka). Samal and Mazumdar (2005) studied the hypolimnetic oxygen depletion scenario in the two National

lakes, Rabindra Sarobar and Subhas Sarobar in India. Zargar and Ghosh (2005) studied the impact of warm water discharge from Kaiga Nuclear Power Plant on Chlorophyll-A and primary productivity of the Kadra reservoir. Kumar *et al.* (2006) studied the water quality asesment of river Tunga, Karnataka and found electrical conductivity varies between 40-137 μmhos/cm, hardness from 8.6-43.4 mgL^{-1}. Sachidanandamurthy and Yajurvedi (2006) studied the physico-chemical parameters of Bilipere Lake of Mysore. Yousuf *et al.* (2006) reported the limnological features of the river Jhelum and its important tributaries in Kashmir Himalayas. Morphometric and physico-chemical study of Sarkoot pond of Kishtwar, Jammu and Kashmir was done by Jyoti and Akhtar (2007).They reported the maximum and minimum values of various parameters like water temperature (2-8^{0}C), pH (5-7.9), free carbon dioxide (1.3-7.0 mgL^{-1}) , DO (2.0-8.6 mgL^{-1}) etc.

Limnological survey of some fresh waterbodies in Kupwara region of Kashmir Himalaya has been studied by Pandit *et al.* (2007). Yousuf *et al.* (2007) studied the limnology of some lotic habitats of Uri, a tropical region of Kashmir Himalaya. Physico-chemical limnology of Dagwan stream in Kasmir has been studied by Munsi and Yousuf (2007).
Jain *et al.* (2008) studied the effect of different salinity treatments on physico-chemical and biological characteristics of grow out pond water. Akin *et al.* (2008) reported the physico-chemical, toxicological and ecological analysis of Gocekaya Dam lake. Singh *et al.* (2008) studied the impact of Lakhwar hydropower project on the physico-chemical characteristics of water of the river Yamuna. Their study revealed that the values of most of the water quality parameters were within the permissible limit of National River Standards and Bureau of Indian Standards (BIS). At all the measuring station the temperature varies from 16.2 ^{0}C to 23.0 ^{0}C and electrical conductivity (EC) from 119- 286 (μscm^{-1}). Some parameters like Mg are found slightly higher than the limit.

Plankton

Hensen (1887) first used the term 'Plankton' which include all organic particles ' which float freely and involuntarily in the open water, independent of shores and bottom. Birge (1895) studied the plankton of lake Mandota. Murray (1906) reported some rotifera from Sikkim Himalaya. Gulati (1925) reported some freshwater ciliates from Lahore. Pearsall

(1930) reported the phytoplankton in the English lakes. Campbell (1941) studied the vertical distribution of plankton Rotifera in Douglas Lake, Michigan. Roy (1955) found that the higher pH is associated with the phytoplankton maxima. Chakrabarty *et al.* (1960) reported a quantitative study of the plankton and the physico-chemical conditions of the river Yamuna at Allahabad. Moitra and Bhattacharya (1965) observed some hydrobiological factors affecting plankton production in fish pond at Kalyani. Laksminarayana (1965) studied phytoplankton of the river Ganga. Pehwa and Mehrotra (1966) observed the fluctuation in the abundance of plankton in relation to certain hydrobiological conditions of the river Ganges. George (1966) reported about the comparative plankton ecology of five fish tanks in Delhi. Biswas (1966) reported five species of Daphnidae from Simla Hills in India. Vyas (1968) studied the phytoplankton ecology of Picchola Lake, Udaipur. An ecological study of algae of river Moosi, Hyderabad (India) with special reference to water pollution was reported by Venkateswarulu (1969).

Govind (1969) while studying the plankton in Tungabhadra reservoir, divided the year into three planktonic periods, *i.e.*, i) the reproductive period (December to April, 85 to 233 unit/L), ii) the retardation period (May to July, plankton 14 to 27 units/l) and iii) the recovery period (August to November, 49 to 74 units/l). Zooplankton also exhibited four peaks, which fell in November, February, April and September. The February peak comprised of Rotifera (24.7% of the total plankton) while other picks consisted of Copepoda (8.3-33.8% of total plankton).

Sreenivasan (1969) studied 17 reservoirs of Tamil Nadu and observed that deeper reservoirs like Amaravathy, Aliyar and Tirumoorthy not only developed blooms of blue-green algae as soon as they were impounded but also maintained them almost round the year. Contrary to expectation, the shallow reservoirs such as Vidur, Poondi, Vaigai and Krisnnagiri, despite their shallowness showed poor production of plankton. He reported that in most of the South Indian reservoirs diatoms and blue green algae were most abundant. Desmids were reported to be present in cold nutrient poor reservoirs such as Pykara, Hope Lake and Sandy nulla, Krishnagiri. Blue green algae were, however represented very poorly in Sathanur, Vidur, Poondi and gomukhi top waters in major part

of reservoirs and cyanophyceae dominated towards the dam. Michael (1969) reported the seasonal trends in the physico-chemical factors and plankton of a freshwater fish pond and their role in fish culture. Seasonal distribution of freshwater zooplankton of four tanks of Chandigarh was reported by Vasisht and Dhir (1970).

Pandey (1973) studied the distribution, periodicity and some ecological aspects of phytoplanktons of some ponds of Kanpur. The zooplankton fauna of a freshwater pond of Bhagalpur was studied by Nasar (1977). Singh and Sahai (1978) studied the seasonal fluctuation of zooplankton population in relation to certain physico-chemical factors of a pond. Hosmani and Bharati (1980) mentioned that algae could be used as indicator of organic pollution. Certain physico-chemical features, phytoplankton population and chlorophyll concentration in a high altitude lake of Kumaun Himalaya was done by Sharma and Pant (1979).

Kloet (1982) studied the primary production of the Lake Vetcher. Pant and Sharma (1983) observed nanoplankton of Lake Nainital. Pant *et al.* (1985a) observed that in the Lake Nainital, the ratio of phytoplankton to herbivorous zooplankton is 4:6 which indicated that primary production remained mostly unutilized by the herbivores. Pant *et al.* (1985b) reported the species composition, temporal abundance and community structure of zooplankton in Sat Tal Lake of U.P., India. Hegde and Bharathi (1985) studied the comparative phytoplankton ecology of freshwater ponds and lakes of Dharwad, Karnataka, India. Shukla *et al.* (1989) studied the physico-chemical and biological characteristics of the river Ganges from Mirzapur to Ballia. Comparative limnology of Sambhar and Didwana lakes of Rajasthan was studied by Jakher *et al.* (1990). Gajbhiye and Desai (1991) recorded the variability of zooplankton in polluted and unpolluted wastes of nearshore waters of Bombay. Singh (1993) studied the density, productivity and species composition of phytoplankton in relation to abiotic spectrum of Ganges at Sahibganj.

A comparative study on seasonal changes in phytoplankton community in the Sagar Lake and Military Engineering Lake was done by Bais *et al.* (1995).The model for the eutrophication with reversible and irreversible changes was given by Caropenter *et al.* (1999). Pandey *et al.* (2000) studied the nutrient status and Cyanobacterial diversity of a

tropical fresh water reservoir, the Udai Sagar Lake, and found that eutrophic condition was responsible for the elimination of sensitive cyanobacterial species from the substations receiving urban industrial effluents. Rustadi *et al.* (2002) studied the water quality and plankton of Sermo reservoir in Yogykarta, Indonesia to monitor the eutrophication of the reservoirs used for fish cage culture. Husnah and Lin (2002) studied the responses of plankton to different chloride concentrations and nutrient enrichment in low salinity shrimp pond. Garumayum *et al.* (2002) studied the physico-chemical qualituies of water and plankton of selected rivers in Meghalaya. Shrivastava *et al.* (2002) investigated the phytoplankton primary production and fish production potential of Tawa reservoir. Sultan *et al.* (2003) studied the physico-chemical status and primary productivity of Pahunj reservoir, Uttar Pradesh.

Comparative studies on community structure, biodiversity of plankton and zoobenthos in four lakes of different trophic states in China were conducted by Gong *et al.* (2003). Chakrabarti and Das (2004) recorded 21 species of planktonnic rotifers from six fresh water culture ponds of Tripura. Jain *et al.* (2005) investigated the plankton community dynamics of Khecheopalri Lake in Sikkim Himalaya. Nandan and Aher (2005) studied the algal community in relation to the assessment of water quality of Haranbaree dam and Mosam river of Maharashtra. Studies on the phytoplankton of Olero creek and parts of Benin River, Nigeria were done by Adesalu and Nwankwo (2005). Ugale and Hiware (2005) carried out limnological study of an ancient reservoir Jagtunga Samudra located at Kandhar, Nanded, Maharashtra. Singh *et al.* (2006) studied the role of plankton in freshwater aquaculture development. Lunar rhythim in the planktonic biomass of the Nicco Park Lake, Bhubaneswar was studied by Dhua and Patra (2006). They observed that the lunar cycle imparted certain stimulatory effects on the rhythmic behaviour of plankton and their life processes. Sakhare and Joshi (2006) investigated the plankton diversity in Yeldari reservoir, Maharashtra. Islam (2007) studied the physicochemical condition and occurrence of some zooplankton in a pond of Rajshahi University. Sharma *et al.* (2007a) studied the zooplanktonic dynamics in Ban Ganga, Katra (Jammu).

Sharma *et al.* (2007b) investigated the diversity of phytoplankton inhabiting the lake Mansar, Jammu and Kashmir and reported 46 genera of Chlorophyceae, 18 genera of Euglenophyceae and 1 genus of Dinophyceae.Yousuf *et al.* (2007) reported 41 species of phytoplankton of which 21 belonged to Bacillariophyceae, 13 to Chlorophyceae and 5 to Cyanophyceae and one each to Euglenophyceae and Dinophyceae. Mir and Pandit (2007) studied the plankton production as indicator of tropic status of Wular Lake, Kashmir. Diversity and seasonal fluctuation of Zooplankton in fish pond of Bhadra fish farm, Karnataka was studied by Kiran *et al.* (2007).

Bacteriology

Water receives its bacterial content from air, soil, sewage, organic wastes, dead plants and animals etc. Most of the bacteria find conditions unfavorable and soon die. Those species which survive and are constantly present constitute the natural flora of water. To assess the quality of water in terms of pathogenic and parasite organisms indicating a health risk for the human population, the use of an indicator system is considered to be indispensable, due to the vast variety of these organisms. The coliform bacteria, especially the thermo-tolerant types are considered to be a convenient indicator for the exposure of a water body to the faeces of warm blooded organisms, including man. Since human water- borne diseases are mainly transferred by exposure to fecal matter, the health risk can be associated by measuring the presence of these bacteria (De Zwart and Trivedy, 1994).

The occurrence of coliform group, total coliform, and fecal coliform has been used as principal ecological indicators of water pollution (Carpentor *et al.*, 1966, Holden, 1970; Rodrigue *et al.*, 1977; APHA, 2005). For many years, the fecal coliform *Eschericia coli* have been used as an indicator of human enteric pathogens (Goldreich, 1966). However, it is now well established that E. coli is not limited to humans but also exists in the intestines of many other warm blooded animals (Orskov and Orskov, 1981). Pant *et al.* (1981) reported presence of *Escherichia coli* at a concentration of 11×10^5 /100 mL of water in Lake Nainital which attributed to pollution due to release of domestic effluents containing fecal matter of human and non- human origin. Coliform organisms, while relatively harmless themselves, are most invariably present in waters, they live longer than the

disease producing organisms. Consequently, these organisms have been considered to be the prime indicators of water quality and potential health hazards (Millipore, 1986).

Several studies have reported that the growth and survival of fecal indicator bacteria are susceptible to environmental factors, such as water temperature (Berry *et al.*, 1991; Geldenhuys and Pretorius, 1989), sunlight (Burkhardt *et al.*, 2000; Pommepuy *et al.*, 1992) and rainfall (Crabill *et al.*, 1999; Kistemann *et al.*, 2002).

Prakasam and Joseph (2000) studied the pollution of Sastham Cotta Lake, Kerala due to presence of coliform bacteria, especially fecal ones. Fokmare *et al.* (2002) studied the bacteriological status of drinking water in Akola city of Maharashtra and recorded higher amount of bacteria in ground water (untreated) than in tap water (treated). Bhadra *et al.* (2003) investigated the density of heterotrophic, total and fecal coloform and fecal streptococcai bacteria in the river Torsa, North Bengal and found highest and lowest total and fecal coliform count respectively in the month of March and January. Isobe *et al.* (2004) studied the effect of environmental factors on the relationship between concentration of coprostanol and fecal indicator bacteria in tropical (Mekong Delta, Vietnam) and temperate (Tokyo, Japan) freshwaters. Karagul *et al.*(2005) investigated the fecal coliform load in Buyuk Melen river basin (Duzce, Turkey) and found highest fecal coliform in spring which could be due to increase in water temperature and suspended sediment at that period. The actinomycetes population of Rankala and Kalamba lakes of Maharashtra was studied by Jadhav and Desmukh (2006). Usha *et al.* (2006) counted the bacterial density of water of Perumal Lake, Tamilnadu and recorded highest plate count during the rainy seasons. Ksoll *et al.* (2007) studied the presence and sources of fecal coliform Bacteria in Epilithic periphyton communities of Lake Superior. They found that fecal coliform densities increased upto 4 orders of magnitude in early summer, reached peaks by late July, and decreased during autumn.

Radha Krishnan *et al.* (2007) analysed bacterial parameters like standard plate count, total coliform count, fecal coliform count and fecal streptococci count of drinking, borewell and sewage water in three different places of Sivakasi. Omezuruike *et al.* (2008) studied the

microbiological and physico chemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos State, Nigeria.

Though a vast number of limnological investigations have been done throughout India, limnological works of the water bodies of Darjeeling Hills is very scanty. Preliminary work on the physico-chemical parameters of the water of Mirik Lake was done by Jha and Barat (2003). There has been no work on a holistic approach to understand the Mirik Lake ecosystem, which is influenced considerably by the surrounding life forms.