REVIEW OF LITERATURE

A lot of analytical work has been carried out on natural water bodies, both freshwater and marine water, throughout the globe and as such a voluminous literature is available on the subject. In view of the objective of the present research, a critical survey of literature was carried out to gather information on various relevant aspects such as physicochemical features of water and sediment, denitrifying bacteria and phosphate solubilizing bacteria from aquatic environments especially ponds., bioaccumulation.

Aquatic ecosystems are very productive ecosystems which help in the regulation of biological cycles, maintenance of water quality, nutrient movement and support of food chains. In addition they provide refuge for endangered species of plants and animals and economic benefits such as fish breeding (Mini et al., 2003).

Considerable information are available on the role of physio-chemical character of Indian freshwater bodies (Prasad et al., 1985; Bhatt et al., 1999; Shanthi et al., 2003; Khan et al., 2007; and Rajasulochana et al., 2008). Parameters such as temperature, pH, dissolved oxygen, alkalinity, carbondioxide, macro and micro nutrients and few heavy metals are also involved in the assessment of water quality. Khare et al. (2007) studied the water quality of natural water and he reported that pond water could be substituted for the purpose of drinking by proper treatments. In several cases pond water remains coloured due to the presence of organic matter, mixing of effluents and iron compounds (Reshma and Prakasam, 2007). In general, water quality index is used to assess the quality of water in the aquatic ecosystem.
Ayyappan and Gupta (1981) made a study on the perennial pond and pointed out a significant correlation between plankton communities and physico-chemical parameters. In and around Kashmir area, Yousuf and Shah (1988) made a study on Limnology. The water quality of Thiruvannamalai lake, Tamilnadu was assessed by Ramakrishna et al. (1991). Seasonal dynamics of physico-chemical parameters in a high attitude freshwater pond in Tamilnadu was studied by Rao et al. (1993). There are several reports on the environmental factors which affect the water quality (Singh, 1995; Jain et al., 1996 and Kumar, 1997). Ecological significance and biological characteristic features of freshwater bodies in Mysore were highlighted by Bhatt et al. (1999). Jha and Barat (2003) studied the hydrobiological characters of Minik lake at Darjeeling. Seasonal variation of different nutrients in the Sullur pond at Coimbatore, Tamil Nadu was studied by Dhanalakshmi et al. (2008). She found high temperature and dark brownish green colour of the water during the month of October 2002. The dissolved oxygen concentration of the water determines the water quality and domestic waste mixing in ponds, streams and river systems reduces the oxygen control. The different parameters of water quality around Jaipur were studied by Srivastava et al. (2003). Water quality index was reported from a wetland of degraded area by Chaulya et al. (2002). The biological oxygen demand and dissolved oxygen content of a fresh water lake Bodhan, Andra was reported by Solanki et al. (2007). The dumping of waste into the streams, ponds and river systems accumulated enormously, causing pollution and damaging the aquatic ecosystem was observed by Murugesan et al. (2003)

The role of sediment in assessing the water quality of fresh water ecosystem is an important factor. It was reported that the bottom soil depends upon the pond age
(Boyd, 1995). The sediment characteristic features of a freshwater body at Mangalore were reported by Trivedi and Gupta (1999). Seasonal variation in physico-chemical features of bottom soil of Lacustrine habitats of Jammu was reported by Anand and Sharma (2000). The availability of metals and concentration of heavy metals in the sediment were studied by Campbell and Tessier (1991) and Shanthi et al. (2003). The qualities of sediment and pollution caused by them were highlighted by Mohanraj et al. (2000).

The concentration of nutrient sources in the sediment and their impacts were reported from Varuna river system by Agarwal et al. (2000). The phosphate concentration in the bottom sediment was analysed by Sodergaard et al. (2003) and Hupfer et al. (2004). The role of soil sediment in determining the productivity of pond is well documented by Adhikari (2003). Sun Yao et al. (1997) reported that the contact layer between pond mud surface and water is the major source of nutrition. In any aquatic body primary productivity gives information relating to the amount of energy available to support the bioactivity of the system. Primary productivity of ponds is adversely affected by anthropogenic activities which serve as an important tool and a biological phenomenon in studying the effect. Productivity of the lake depends on the plankton biomass. Environmental conditions, different concentrations of nutrients and dissolved matters in the water bodies affect the diversity and the physicochemical properties of water (Kumar, 1997). Several studies were carried out on seasonal variation and productivity of various aquatic ecosystems (Pandey et al., Pond aquaculture, ecology of fresh waters, seasonal variations and physico-chemical characteristics of mixed water were studied out by Mason (1991). A good management practice is essential for all aquatic ecosystems. Within the past decade,
there has been considerable interest in the relevance of limnological information in the productivity, development and management of aquatic environments (Vereshkumar and Hosmani, 2006; Tiwari and Shukla, 2007).

The relationship between bacteria and the water environment has received the attention of researchers, studies have been undertaken to determine the relationship between the aerobic heterotrophic bacteria or total bacteria and the water environment (Guo et al. 1988; Fang et al. 1989; Zhang et al. 1989; Liu et al. 1992)) The distribution of nitrifying bacteria in different niches of ponds depends upon the substrate concentration, pH, water stress and other environmental parameters were observed by Belser and Schmidt, 1978. Temperature (Berounsky and Nixon, 1993), light (Horrigan and Springer, 1990), oxygen (Usui et al., 2001), ammonia (Magalhaes et al., 2005) and sulphide (Joye and Hollibaugh, 1995) are reported to affect the rates of nitrification in different ecosystems. The effect of seasonal variations in abundance of nitrifying bacteria in relation to change in temperature, dissolved oxygen, pH and concentration of ammonia as well as nitrite in the surface and bottom water of fish ponds are reported by Vibhakumara et al., 2011). There are reports of aerobic denitrifying species isolated from canals, ponds, soils, and activated sludge that can simultaneously utilize oxygen and nitrate as electron acceptors. These include Paracoccus (Lukow and Diekmann, 1997), Pseudomonas (Kesser et al., 2003), Bacillus (Kim et al., 2005), Alcaligenes (Robertson and Kuenen, 1983) etc.A strain with the highest activities was identified according to its morphological, physiological and biochemical properties and phylogenetic analysis of its 16S rRNA sequence by Yang et al., 2011. Wan et al. (2011) isolated a novel denitrifying Pseudomonas sp. strain yy7 that had a nitrite removal rate of 99.7%. Genetic and physiological
characterization of denitrifying bacteria from brackishwater shrimp culture ponds of India by Nagarajan et al., 2014. It has been reported that the population of phosphate solubilizing bacteria was considerable in sediment and soil, including both aerobic and anaerobic strains, such as Pseudomonas, Bacillus, Rhizobium, Burkholderia, Achromobacter, Agrobacterium, Micrococcus, etc., and new strains are constantly being discovered (Yichao Qian, 2010).

Abbas Rezaee1 et al. (2008) purpose of this study was to investigate the immobilization of denitrifying bacteria on microbial cellulose (MC) for biological denitrification. Kathleen Champion et al. (1999) to identify the denitrifying strain EbN1 utilizes either ethylbenzene or toluene as the sole source of organic carbon under strictly anoxic conditions. Andersson et al. (2009) were to investigate the potential of biofilm-mediated bioaugmentation for enhanced denitrification in the presence of a natural wastewater flora. The diversity of the denitrifying bacterial populations in Daejeon Sewage Treatment Plant was examined using a culture-dependent approach Lim et al. (2005). Venterink et al. (2006) to analyses various flood plain communities may differ in their relative abilities to influence water quality through nutrient retention and denitrification. Jun et al. (2000) to analyses of pond water and mud samples show that nitrifying bacteria (including ammonifying bacteria, nitrite bacteria, nitrobacteria and denitrifying bacteria) are in general closely correlated with various physicochemical factors; ammonifying bacteria are mainly correlated with dissolved oxygen; denitrifying bacteria are inversely correlated with phosphorus; nitrite bacteria are closely correlated with nitrites, nitrobacteria are inversely correlated with ammoniac nitrogen.
Doraipandian and Thangasamy, 2010 study to envisage the comparative analysis on the ecological nature of ponds with varying utilization and management. Recently, some researchers designed PCR primer specific for gene encoding denitrifying enzymes to detect only denitrifying bacteria and analyze their microbial community, which are primer sets specific for functional genes concerning denitrification, namely, \( \text{nirK, nirS} \) (Braker et al., 1998; Hallin and Lindgran, 1999) and \( \text{nosZ} \) (Scala et al. 2000). Mireles et al. (2007) An analysis of the molecular diversity of N2 fixers and denitrifiers associated with mangrove roots was performed using terminal restriction length polymorphism (T-RFLP) of \( \text{nifH} \) (N2 fixation) and \( \text{nirS} \) and \( \text{nirK} \) (denitrification), and the compositions and structures of these communities among three sites were compared. Aruleba and Agbei. 2010. most important characteristics observed for delineating the ponds to their suitability classes are pH, organic carbon, clay content, permeability, bulk density, soil texture, phosphorus and nitrogen content etc. Ward et al. (2009) Denitrification as the dominant nitrogen loss process in the Arabian Sea. Jayakumar et al. (2009) Denitrifying bacterial community composition changes associated with stages of denitrification in oxygen minimum zones. Song et al. (2009). Molecular methods to detect and monitor of uncultured dissimilatory arsenate respiring bacteria (DARB) in sediments.

storage tank at Hiras Minar, Sheikhpura. Shivappa et al. (2000) noted the ecological characteristics of water from Savaloanga tank in Shimoga.


Biological denitrification has proved to be one of the most feasible, advanced, selective, and cost effective processes for removing nitrate by dissimilatory reduction (Song *et al.*, 2005), which transforms it into nitrogen gas using biodegradable carbon compounds as the energy source (Ovez *et al.*, 2006). Biological denitrification has been performed using immobilized cells (Narayan *et al.*, 2007; Zumft *et al.*, 1997). Since then, many studies of denitrification using immobilized cells have been undertaken (Lee *et al.*, 2005).

Recent studies have shown that the *nosZ* gene has the highest level of congruence with taxonomic classification based on 16S rRNA, compared with other denitrification genes (Davidson *et al.*, 2004; Jonus *et al.*, 2004). Yiwen and Haiwei (2011) isolate and characterize a novel aerobic nitrification and heterotrophic denitrification bacteria from anaerobic treatment system. Aerobic denitrification abilities were isolated too Su *et al.* (2001); Ahmed, (2005). Denitrifiers can survive in aerobic condition, reflooding caused serious osmotic stress Schimel *et al.* (2007).