I. INTRODUCTION

Water is said as liquid of life and it is the essence of all living processes. Water is universal solvent as it dissolves more substances than any other liquid without undergoing any chemical change. Thus water, the unique component of nature has played an important role in the life from molecules to man, hence since the time unmemorable the great human civilization has originated, evolved and flourished around water resources. Water covers about 70% of the earth’s surface but only 2.7% of the total water is fresh water, of which 1% is ice free water in the rivers, lakes, atmosphere and as biological water. It has been estimated that only 0.00192% of the total water on the earth is available for human consumption (Trivedi 1998).

Numerous anthropogenic activities like disposal of sewage & industrial water, recreational activities, excesses fertilization of lands and use of pesticides has threatened environmental health of both surface and ground water. In addition to this, due to the uneven distribution of fresh water on earth, due to development thrust of man and due to difference in the per capita availability of water, the water has become scarce natural resources and national wealth. Water pollution now a day is considered not only in terms of publics’ health but also in terms of its conservation, aesthetics and preservation of natural beauty and resources. Water pollution has however threatened to reduce the quantity available in ponds, lakes, rivers and reservoirs due to disposal of sewage, industrial waste and due to other human activities (Trivedi and Chandrasekhar, 1999). Population explosion, industrialization, urbanization and development thrust of man have created these problems of water pollution. According to different surveys, 70 to 80 percent of the Indian water sources are polluted and different enteric diseases affect millions of the people every year. United Nations Organization report has indicated that mortality of world population lack reliable sources of drinking water. Hence, now day raw water from the water body is being analyzed for its utility like drinking, aquaculture, industrial and irrigation purpose.

India has rich fresh water resources in the form of rivers, lakes and rivulets. From all the resources in India, the total available fresh water is estimated to be 1900 billion cubic meters per year. About 80% of this water is
lost as surface run-off. The surface flow represents 97% of the available water. The water-spread area of reservoirs and tanks is about 3 million hectares; whereas lakes and ponds of India measures more than 1.5 million hectares. In India there are about 117000 small and large natural and manmade fresh water bodies (Ann. India, 1983). Every year there is an addition in the total water supply tanks, city water supply tanks, irrigation tanks, flood control reservoirs etc. Shrivastava et. al (1983) and Jain (1948) reported the approximate estimate of cultural water spread area as 2.3 million hectares in India.

Most of the small water bodies are located in the vicinity of temples and mosques like religious places. Most of the “Yatras” and “Melas” are celebrated near these lakes. The day-to-day maintenance of these reservoirs is neglected. These activities cause pollution of these holy water bodies. Water is precious and therefore it is duty of each and every individual on the earth to conserve all the available water.

It is due to negligence of man many ground water and surface water sources get contaminated. Ultimately the contamination of water lead to many hazards situations and many times it becomes harmful to the large community. The contaminated water is dangerous to aquatic flora and fauna and to the precious vegetation grown on such water.

The contaminated water bodies have been polluted largely due to contaminations of microbes, human and animal wastes with its pathogens collecting during its course-up reservoirs. Information on species diversity, richness evenness and dominance species evaluation on the biological component of the eco-system is essential to understand detrimental changes in environment or deterioration of water quality (Krishnamoorty and Subramaniam 1999). Biological contamination is a basic measure of community structure and organization and the most important parameter to understand the health status of the ecosystem. The biological diversity index gives us a measure of the way on which individuals in a community are distributed.

Some lakes die because of lack of oxygen. In a normal lake, the amount of dissolved oxygen in the water varies little with depth. In eutrophic lake oxygen count varies from sufficient at the surface to very low at the bottom. The population pressure and activities near lake like bathing and cloth washing
contribute substantially in reduction of the oxygen level of the lakes. The surface area run-off increases the volume of nitrates and phosphates flowing into the lake water, which stimulate weed growth.

Thus, the increasing pace of developmental activities and extensive use of water resources are subjecting the quality and hydrobiology of fresh water resources (Mishra and Trivedi, 1993). These activities not only influence the micro fauna of fresh water but also favor the development of variety of undesirable new fauna, rendering the water unfit for human consumption. This increase in the nutrient status is termed as “Eutrophication”, which makes the water body unfit for most of use.

Water is one of the prime necessities of life. We can hardly live for a few days without water. Generally water contains iron, calcium, Manganese, silica, fluoride, nitrite, phosphate, Sulphates and chlorides. When the quantity of these rises, then it affects the body systems and cause destructions of health. Arsenic salts can create cancer, cadmium affects kidney while Barium carbonate has bad effects on veins etc.

The study of freshwaters in all their aspects physical, chemical, geological and biological is termed as Limnology (Odom 1971). Or limnology is the study of freshwater or saline water, which are contained within continental boundaries (Goldman and Horn 1983). Limnology is also described as “Hydrobiology or aquatic biology”. According to Edgar-do-Baldi, a prominent Italian ecologist Limnology is the science dealing with internal action of processes and methods where by matter and energy are transformed within the lake or pond. Welch (1952) stated it as the science dealing with biological productivity of waters together with all the casual influences on the qualitative and quantitative features along with its actual potential aspects. Wetzel (1975) defined limnology as “Study of the functional relationship and productivity of freshwater biotic environmental factors.”

Although limnological observation has a long history, they only evolved into distinct discipline during last two centuries. For the first definition of limnology one will owe to Forel (1892), a Swiss Professor, who has been called the father of limnology His pioneer investigations were focused on Le Leman (Lake Geneva). He published three volumes on Lake Geneva in 1892, 1895 and 1904. In the first 40 years of the 19th century Birge and Juday worked

About 1500 year ago development had proceeded so far that an Aryan civilization in the Dry zone of Srilanka relied on extensive exploitation of the stream of the low lands. The construction of system of reservoirs or lake and channels started in the second century A. D. and reached a high technical level in the fourth century. Gradually much of low land of Srilanka was placed under well-planned scheme of water utilization. In India also damming streams in ancient times were mainly used for irrigation and drinking water supply.

Man’s impact on nature is growing exponentially under the pressure of ever-larger technical projects. The stream and rivers are part of those natural systems, which produce easily exploitable energy much appreciated for being clean and easy to handle compared to other forms and less disastrous to the ecosystem.

Therefore, the exploitation of streams will go on increasing in spite of the fact that greater part of the world, majoritily, the economically exploitable running waters are already regulated or under construction for small and large scale irrigation project.

According to Water Frame Work Directive (WFD), some characteristics suggested for different type of lakes are, for each lake type reference conditions must be established, as far as possible, undisturbed conditions and including biological as well as hydro morphological and physico-chemical baselines. The purpose is to identify reference biological communities against which other communities will be compared (Heinonen et al. 2001).

WFD gives standard definition for the classification of lakes into different ecological quality classes, such as high, good and moderate status. The ecological status of lake is based on its level of deviation from the reference biological population (which corresponds to high status) and includes phytoplankton, Macrophytes, phytobenthos, benthic invertebrate and fish data.
Man has tried to cope up with this scenario and has rapidly advanced its efforts to counteract this Malady. In past few decades natural and polluted waters have been studied in detail all over the world and considerable data are now available on most kind of pollutants and their effects on ecosystem as well as on organisms. A large number of parameters signifying the quality of waters in various uses have been proposed. A regular monitoring of some of them not only prevents the hazards but also checks the water resources from going further polluted.

Several researches from abroad have made contribution on hydrobiology on large natural lake and man made reservoirs of North America, Canada and Europe in temperate climatic conditions.


The primary productivity of the phytoplankton is one of the most important sources of energy input in aquatic ecosystem. This productivity is greatly dependent on the nutrient status of the aquatic body in relation with other physico chemical parameters. The process that contribute to Primary

In order to utilize a freshwater body it is very important to study the biotic and abiotic factor influencing the biological productivity of said water body. Research in this field is no doubt of indirect assistance but it will serve as a guideline to maximize the use of the productivity of water.

Such investigation estimate the productivity of any water body involves mapping the shape and depth of the water body observation on the physical factor like temperature, turbidity, transparency, color of water. Chemical factor like $P^H$, Dissolved oxygen, free carbon dioxide, hardness of water. In Biological investigation, study of micro and macro flora and fauna always provides the clear picture of the ecological relationship existing in water body.

Direct correlations have been established between the planktonic crop and fish production because planktonic biomass indirectly related to the fish production. Among the planktonic communities, zooplankton occupies the key position in the food chain of Lake. Therefore, interactions between zoo and phytoplankton are a central topic in plankton ecology. Zooplanktons are the microscopic free-swimming animalcule components of an aquatic ecosystem, which are primary consumers of phytoplanktons. Zooplanktons provide the main food item of fishes and can be used as indicators of the tropic phase of water body (Mathew, 1975, Verma and Datta Munshi, 1987). Zooplanktons play and integral role in transferring energy to the consumers, hence they form the next higher tropic level in the energy flow after phytoplanktons. Therefore, in view of importance in studies related to their distribution zooplanktons have attracted the attention of several workers throughout the world.

The diversity of the zooplanktons in reservoirs is controlled by several physico-chemical factors of water. The pattern of algal distribution and its density is the main biological factor affecting the diversity of the zooplanktons. Temperature, dissolved oxygen (DO) and organic matter are the important factors which control the growth of zooplankton (Hanaazato and Yasuno 1985, Bhati and Rana 1987, Takamura et. Al 1989). Several researches have used the different zooplankton groups to evaluate the tropic status and pollution potential of the freshwater bodies all over the world. Zooplanktons are also used as biological indicators of eutrophication.

Phytoplankton plays a very important role in regulating the dynamics of the aquatic food web and become a driving force in shaping the community structure of zooplankton (Xie et.al 1998).

Eutrophication is a global phenomenon of associated with nutrient enrichment of aquatic ecosystems. In natural course it is slow process of lake ageing which ultimately lead to succession. However, man is responsible for accelerating the process many folds endangering the very survival of water bodies all over the world. The Nutrients like Nitrates, Phosphates, Sulphate, Chloride and silicates are contributed to the process of eutrophication. In developing countries sewage pollution from rapid urbanization is a major environmental issue today. The lack of proper sewage treatment and disposal
are the two factors responsible for gross pollution of ecosystems, particularly in urban environment.

Nutrient enrichment directly affects the water quality and lead to a number of consequences indicative of imbalance in the ecosystem.

The first and most visible symptom of nutrient enrichment is prolific growth of algal communities (Primary Producers) producing mono or polyspecific blooms. The main groups of hypertrophic phytoplankton are cyanobacteria, chlorophyceae, cryptophyceae, and Euglenophyceae. Comparatively diatoms attain biomass lower than the preceding groups. Other groups like desinids occur in an oligotrophic system. Dianoflagellates, chrysophyceae and xanthophyceae are either absent or present in very low number in hypertrophic lakes.

Blue green algal blooming is a global phenomenon and a lot of efforts at theoretical and practical levels are going on the evolving effective strategies for its control. Environmentally the algal blooms are highly detrimental to ecosystem; they adversely affect water quality, disrupt nutrient and energy cycles, alter trophic states, reduce biodiversity and are responsible for fish kills. Thus, water forming algal blooms is totally useless for aquaculture, and use in domestic, industrial and irrigation sectors; theoretically algal targeting the measures at life histories, environmental requirements and ecological responses of the problematic species can control blooms.

Aquatic weeds referred to, as Macrophytes constitute an important component of an aquatic ecosystem. They provide support, shelter and oxygen to other organism and play an important role in biological production. Their diversity and biomass influence primary productivity and complexities of trophic states (Singh, 1991, Verghese 1992).


Normally well-balanced ecosystem maintains fairly constant biogeochemical and energy cycles, trophic states and biodiversity. However, in balance as a result of pollution more tolerant fast breeding and hardy one replace one set of sensitive species. Biodiversity is markedly reduced and succession sets in. Fishes occupy high position in the food chain, Moderate
cooler Climate, high degree of precipitation and tropical ecosystem in lake sustain significant piscine fauna.

The principal objectives of the present Study are-
1) Evaluate the quality of surface water during different seasons of the year.
2) Detection of any sign of deterioration in water quality.
3) Identification in the chemical and biological aspects.
4) Establishing pattern in variation of water quality, if there are any.
5) Recognize microbial pollution if any.
6) Establish pattern if any in over all conservation of ecosystem.
II. REVIEW OF LITERATURE

The limnology suggests complete knowledge of fresh water area including its Physico chemical and biological aspects (Knight 1970). While pollution is a change in the environment, which become gradually worse (Prakash and Rawat 1979) and acting as the important limiting factor (Odum 1971).

If Indian surface water is concerned, scientists turned to limnology at very late i.e. 19th century. In India, hydrobiological conditions of lakes and pond were initially pioneered by Prasad (1916) Prythi (1933). The studies covered the different aspects of lotic and lentic water impoundments with ecological variation, water quality controls fisheries problem and sewage water utilization. It was followed by Ganapati and Chacko (1951), Ganapati (1951), Ganapati and Sreenivasan (1968, 1970, 1974, 1976) on the south Indian almost all the fresh water reservoirs.

Our improved social development faces a unique crisis in the form of environmental pollution. Various sources such as industrialization urbanization are polluting it. Addition of domestic and human wastes is functioning toxically for the growth of flora and fauna of the waterways.


Moitra and Bhoumik (1968) have reported the three groups of zooplanktons rotifers, cladocerans and copepods as dominating groups in a freshwater fish pond in Kalyani West Bengal. Nayar (1968) observed ecology of rotifer populations of two ponds at Pilani, Rajasthan. Kaul (1971) studied the production and ecology of some macrophytes of Kashmir lakes Kant and Kachroo (1975) reported the diurnal changes in the temperature and pH of water as well as diurnal movements of plankton in Dal lake Srinagar. Qadri and Yousuf (1978, 1979) have described the seasonal hydro biological conditions of many freshwater bodies. Seasonal variations in the density of rotifer population and physico-chemical parameters of Matyatal Panna (M.P.) have been studied by Nayak et.al (1982). Rao et.al (1987, 1988, 1989) studied various aspects of the Gandhisagar reservoir.

The work of Douglas (1965), Arora et.al (1965) Dhaneshwar et.al (1965), Richard (1966), and Bhowmic et al (1985) on the storage and the ecology of lentic and lotic water are also important.
In recent years, several scientists have investigated the present status of various lakes throughout the world in the focus of conservation, important among them are Loriya et al. (1998), Tittel et al. (1998), Izaquirre et al. (1998), Nages et al. (1998), Makarewicz et al. (1998), Anthony Ricciard and Rasmussen (1999), Duigan et al. (1999), Donachie et al. (1999), Larson et al. (1999), investigated some of the physical and chemical characteristics of 58 lakes in alpine, sub alpine and forest vegetation zones between 1989 to 1993.

Noges et al. (1998) investigated the plankton seasonal dynamics and its controlling factors in shallow polymictic eutrophic lake Vortsjäerv Estonia. Oriya et al. (1998) investigated the changes in chemical and biological characteristic of the environment at a newly constructed reservoir Sapporo (Japan) for over eight years from the beginning of water within two years, phytoplankton composition in three years and zooplankton composition of four years.

Zalidis et al. (1997) studied 291 Greek wetlands and reported that various anthropogenic activities like construction of irrigation activities; diversion of watercourses over pumping, agricultural and municipal pollution affected the water quality.

Sommaruga and Robarts (1997) roughly studied the autotrophic and heterotrophic Pico plankton in heterotrophic ecosystem and reported that hypertrophic aquatic ecosystems are biologically important as they represent an environment where homeostatic mechanism are strongly reduced and extreme oscillation occur in physical and chemical parameters as well as in the growth of many planktonic organisms.

Vijverberg and Boersma (1997) observed that the biomass of the large bodied cladocerans increase with increasing chlorophyll content. Wetzel (1975), Mar Galef (1984) documented vertical distribution of zooplanktons and is great ecological complexity since it is related to various environmental, physical and chemical factors such as light, transparency and dissolved oxygen concentrations. It is also related to biological factors the most important of which being the search for food and fight from possible predators.

Hino et al. (1988) categories the Akan Panke lake in an oligotrophic lake which they were surveyed the limnological characteristics and vertical distribution of phytoplankton. Bini et al. (1997) by using statistical tools, were reported the spatial variation of zooplanktonic groups (cladocerans, rotifers,
nauplius and adult Copepods in the Boro reservoir. The variation in the density of cladocerans and nauplius and adults of copepods was structured along the geographic space in the form of gradients, which implied the rejection of the hypothesis of spatial homogeneity.

The temporary pond in military area of south Germany was studied by Maier et.al (1998) as a physical, chemical conditions and crustacean communities. The pond was turbid, without higher aquatic plant but contained unique crustacean community with endangered species such as Branchipus schaefferi, the copepods, Cyclops crucifer and Metacyclops minutus and the cladocerans Moina brachiata and Macrothrix hirsuticornis. Branchipus was only present in ponds which dried out where drying occurred. Day-night fluctuation of temperature was up to 15°C in summer.


The cladocerans from 13 Northern German Lakes of different tropic levels were analyzed using the bosminid and chydorid remains in the superficial sediment as an integrated sample of the total lake fauna by Hofmann (1996), Adarian (1987). They examined the interactions between calanoid and cyclopoid copepods in the 11 years field study of an eutrophic lake in Germany.
Bandu Amarasinghe et.al (1997) was carried out the production biology of copepods and cladocerans in three Lowland reservoirs of south East Sri Lanka and its comparison to other tropical freshwater bodies.

Effect of altitude and physical heterogeneity (temperature PH and surface area) a crustacean zooplankton in fishless subartic ponds was investigated by Raut (1998). Humans are Known or suspected to be major agents of dispersal for many aquatic invasive species Johnstone et.al 1985, carlton and Geller 1993, Schneider et.al 1998, Buchan and Padilla 1999, Willimanson etal (1999) have also argued a paradigm that includes coloured dissolved organic carbon (CDOC) as well nutrients are useful in predicting and understanding the response of lake ecosystem to multiple stressors.

Arnott et.al (1998) assessed crustacean zooplankton richness in eight Canadian Shield lakes as different temporal and spatial scales using three months of estimation cumulative, asymptotic and chaos index.

Hydrobiological investigation on some fresh water ponds in relation to pisciculture has been made by Baruah et.al (1998). The analysis of water quality of ponds revealed temperature range of 17-22.5°C. PH 6.6-8.5 dissolved oxygen level 1.2-8.3 mg/L, CO₂ 3.3 13-9 mg/L hardness 7.22 78.3 mg/L, turbidity 1.1 to 100.00 NTU, alkalinity 36.1 – 166.7 mg/L, hardness 7.22–78.3 mg/L and conductivity 39.9-285.5 µ mhos/cm. Thirteen species of zooplankton were observed belonging to protozoa, rotifera and crustacea, Eleven microzoobenthic invertebrate fauna were recorded belonging to annelida, arthropoda and mollusca and numerous larvae belonging to chironomus, plecoptera, odonata and coleopteran were recorded.

The works on limnological aspects of Indian water are those of Bhatia (1930, 1936) Arora (1931), Edomondson and Hutchinson (1934), Ganapati (1940). Later on it could attract the attention of many biologists such as Gonzalves and Joshi (1946), Quadri and Baqui (1956), Chakraborty et.al (1959) Naidu (1962, 1966), Sreenivasan (1964, 1965, 1971), Nayer (1965a 1970), Vashist (1968, 1982), Vollenweider et.al (1974), Heyman (1983) They classified the lakes on the basis of oxygen concentration and primary production value. Neumann (1927) defined and classified the ponds and lakes on the basis of geographical nutrient content, physical factors and age. Recently the work on limnological aspects of Indian waters are those of

Limnological studies on two ecologically different water bodies at Dumka (Bihar) with special reference to their chemistry and Primary productivity for a period of one year during different seasons were carried out by Kumar et.al (1996). The study showed that the primary productivity of the water bodies depended mainly upon the intensity and quality of light, the carbon supply, and the availability of nutrients as well as the biomass. The primary productivity was found to be more in sewage-fed water body due to presence of adequate nutrients and carbon dioxide. The presence of high rates of primary productivity further indicated that the eutrophication had been at a faster rate in singhra pokhar pond which received domestic sewage. The Barabandh pond where there was only bathing and washing of cloths activities were predominant.


Occurrence of various rotifers in different lakes is well studied by several authors Galkivskaya 1998, Holst et.al 1998, Ventelae et.al 1998, snell and Serra 1998.

In India the major contributions in the rotifer study are those of George (1961), Arora (1962), (1963a), (1963b), Dhanapathi (1973, 1974a, 1974b,

Sampathkumar (1991) reported eight taxa of rotifer in freshwater fishponds in Tuticorin, south Tamilnadu - new record of India.

Rotifers are generally been considered to indicate tropic status of the water body (Pegler 1957, Radwan 1976, Arora 1961, 1966). Rotifers are well known for Cosmopolitanism Ammeren 1964, Green 1967, Patil 1976, and Patil et.al 1985, Patil 2002. The abundance of Brachionus species in tropical rotifer has been pointed by Green (1972), Chengalath et.al (1974), Peyler (1977b) and Fernando (1980 a,b) Sharma and Michael (1980) and at present some of the new species described from India appear to be pantropical. (Dhanapathi 2000).

The abundant occurrence of Rotifers is related to abiotic factors such as temperature pH, dissolved oxygen, alkalinity, chloride etc. High temperature, less nutrients and low oxygen content of water favors the growth of rotifer as observed by Arora (1966). Dhanapathi (1997). Yousuf and Quadri attributed it to temperature, which is the main factor for appearance of rotifers. Davis (1955) stated that pH is the important parameter in controlling the rotifer populations. Balkhi et.al (1984) pointed out that temperature and dissolved oxygen have their influence on the abundance of species composition of Rotifers in Anchor Lake. Compbell (1941) attributed it to three factor like dissolved oxygen, CO₂ and pH in fresh water. When the alkalinity and temperature is high the abundance of rotifer stated by Byars (1960) Rotifer responses to increased acidity was studied by frost et.al (1978). Many species decreased in abundance under reduced pH conditions but other rotifers increased at the same time such that there was ultimately an increase with acidification in total rotifer biomass and quite conspicuously, in the proportion that rotifers comprised of total zooplankton biomass.

The species of Rotifer Keratella valga appear to be indicative of Mesotrophic environment (Leenta Vaar 1980). Pajler (1957) stated that this species is distributed in Northern region and related it to low temperature.
Segres et al. (1998) was investigated diversity and zoogeography of rotifer in a food plain lake of the Lehilo river. Bolivia Devetter (1998) was evaluated the influence of 46 different environmental factors on the rotifer assemblage in an artificial lake. This study showed that the rotifers in the reservoir were controlled by biotic and abiotic factors.

Sarma and Mannel (1998) were surveyed rotifers in small pond from central Mexico. They recorded a total of 78 species with 20 new records for Mexico; Pallard et al. (1998) studied the effects of turbidity and biotic factors on the rotifers and cladoceran community in an Ohio reservoir (USA). They reexamined patterns of rotifer and cladoceran abundance and population dynamics along a turbidity gradient over a period of 4 years in Ohio reservoir. The result suggested that there was no effect of turbidity on rotifer abundance further they suggested that inter annual variation in Daphnia abundance could be variation in fish biomass.

Joman-wilms et al. (1999) studied population dynamics of planktonic rotifers in relation to their potential food predators in lake Loosdrecht, Netherlands.

Vijverberg and Boersma (1997) further investigated that small bodied species become increasingly abundant and dominant over large bodied species with increasing eutrophication by studying long term dynamics of small bodied and large bodied cladocerans in the shallow lake. However the investigation could not be proved due to negative relation between hydro biological conditions and abundance of fish with chlorophyll content.

Aquatic weeds are widely distributed in tropical and subtropical aquatic ecosystems. Macrophytes may be emergent, submerged, and free floating or rooted with floating leaves. The majority of water bodies, particularly shallow water bodies are partly or wholly covered by one or more macrophytes Varshney and (Zoska 1973). Rooted macrophytes can also absorbed nutrients from sediments through their root system (Bristow and which 1975, Bristow 1975, Huchnoson 1975). These macrophytes play an important role in energy input, nutrient budget and recycling of nutrients in the water bodies (Howard-Williams and Junk 1977, Mickle and Wetzel 1978, Rana and Nirmal Kumar 1988) Hutchinson 1978, Rana and Nirmal Kumar 1988) Hutchinson (1975)
reported the absorption of nutrients from water medium through their leaves or shoots.

Daily net production in submerged macrophytes is low in comparison to emergent and free-floating species (Sinha 1969, Sinha and Sahai 1973). Macrophytes are pollution indicators of water bodies (Shashikant 1978) Kaul et.al 1987. All plants require light for growth and hence it is considered to be an important factor in controlling the abundance and occurrence of particular macrophytic species. Spence and Chrystal (1970) emphasized that sharp zonation of macrophytes may be due to light effect. The dependence of tropical potamogeton on light for germination observed by Spence et.al (1971) the importance of nutrients of the surrounding medium and macrophytic growth and productivity has been discussed by Hutchinson (1975).

Few studies have also been initiated on the structure and morphometry of the Macrophytes and the occurrence of different species of insects on them. Chitton (1990) concluded from these studies that submerged macrophytes like Myriophyllum and ceratophylum having dissected leaves supported greater number of biomass of invertebrates than plants with simple leaves (Vallisneria). The roughness of the plant surface can also be an important factor according to Velde and Brock (1991)

Light is the ultimate energy source for photosynthesizing organism. However light energy can be useful if absorbed in excess of photosynthetic utilization and may lead to photo inhibition (Osmond 1994). photo inhibition reduces photosynthetic efficiency and may reduce plant growth (Organ and Syositrom 1990. Wener et.al 2001). Witt (2002) tested photo inhibition phenomenon among freshwater macrophytes and concluded that high degree of photo inhibition was not a common phenomenon among submerged aquatic macrophytes. However due to the higher sensitivity to light by aquatic algae and mosses, Photo inhibition may affect the relative abundance of plant species in the surface waters by excluding the light sensitive plant group.

Patil et.al (2002) was studied aquatic weed of Ujani wetland. It was dominant aquatic weeds in this wetland some were Marshy amphibious, some rooted submerging and few were free floating.

Ramkrishna and Siddiqui (2002) were studied macrophytic vegetation in Kabar lake Bihar. The aquatic macrophytic vegetation in the lake falls nearly
in shallow water submerged species, floating leaf forms, amphibious marsh forms moist meadow forms and dry meadow forms.

Rahta, Naik and Padhi (2003) were studied epiphytic algal diversity associated with different aquatic macrophytes of freshwater ponds in and around Berhampur University campus Orissa. They were reported the strong potential epiphytic association in spite of the unfavorable ecological conditions. Raut and Pejaver (2003) were reported the biodiversity of some macrophyte infested lakes from Thane city, Maharashtra. They were show of abundance of three different species of macrophytes in three different lakes Lemna, Pista, and Eichhornia. Total 35 species of Phytoplankton were observed 19 were common to uninfested and infested lake but 16 species were in infested lake and 12 in uninfested lakes.
III. MATERIAL AND METHOD

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3.3 Physicochemical and Biological Analyses
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3:3:9 Alkalinity
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3:3:16 Biological studies.
3:1 Preface: -

The human settlement, its growth and industrial activities generate lot of wastewater. This wastewater finds its way into nearby low-lying area. The wastewater some time percolates through surface into ground water and pollutes it. All this highly polluted water ultimately pollutes nearly fresh water resources like lakes, rivers, ponds, wells etc. Proper sampling and analysis methodologies can correctly determine the strength of pollution of such water bodies. Hence analysis of physico-chemical and biological features of Mhaswad tank, Mhaswad was undertaken for present investigation.

3.2 Materials: -

3.2.1 Sampling Sites: -

1) Sampling station A:

The sampling station A is Hingani village. It is located on the East-north side of the water reservoir.

2) Sampling Station B:

The sampling station B is Devapur. It is on West-north side on left bank of the water reservoir. This site is 4 kms away from dam.

3) Sampling Station C:

The sampling station C is Palsawade. It is on West-South side on right bank of the water reservoir.

4) Sampling Station D:

The sampling station D is centre of tank.

3.2.2 Sampling schedule & Procedure –

A) Sampling to study Physico-chemical characters

Surface water sample were collected directly in two-liter capacity plastic containers from both water bodies by gently wading the container in the upper layer of the water. The analysis of water
temperature, dissolved oxygen, dissolved CO₂ was made on site, as they are liable to change during transport to the laboratory. For the analysis of other parameters the samples were brought into laboratory and stored in refrigerator till the completion of analysis. The analysis was completed with in 72 hours after collection of water. For dissolved oxygen analysis sample were collected in 300 ml capacity B.O.D. bottles and oxygen was fixed on site & brought to laboratory for further analysis.

B) **Sampling for Bacteriological Analysis (M.P.N.) And BOD**

For M.P.N. study sample was collected in 100ml capacity sterilized bottles and brought in the laboratory. MPN & BOD test were carried out immediately after reaching the laboratory.

C) **Sampling for Zoo plankton study**-

The zooplanktons were collected with the help of zooplankton net. Initially about 50 liters of water sample is filtered and concentrated to 50ml. This concentrated 50ml samples were preserved in 4% formalin. These samples were used for microscopic analysis.

3.3 **Physico-Chemical and Biological analysis**-

Physico chemical and Biological analysis of water sample of selected four sites was carried out for different parameters as described in APHA (1989), Trivedi & Goel (1984) and Kodarkar (1992).

3.3.1 Temperature –

Temperature of the water was determined on site during sampling by inserting thermometer (0-100°C) in the water.

3.3.2 pH-

pH was measured with the help of field pH-meter Hanno model champ.

3.3.3 Transparency –

The transparency of water to light was measured using Secchi disc.

3.3.4 Total Dissolved Solids-

Presence of total dissolved solids in the sample water was estimated by evaporation dish at 103°C. The amount of total dissolved
solid was calculated by determining residue. The calculation was carried out by with the following formula –

\[ \text{Total Dissolved solids (mg/lit.)} = \frac{\text{Wt. of residue} \times 1000}{\text{ml. of Sample}} \]

3.3.5 Conductivity –
Conductivity was measured by conductometer in \( \mu \text{mhos/cm} \).

3.3.6 Dissolved oxygen (D.O.)

The dissolved oxygen was determined by Azide modification of Winkler’s Idometric method (APHA 1989). The sample was collected in 300ml capacity ground stoppered glass B.O.D. bottles without any bubbling. Then 2 ml of each saturated manganese sulphate & alkaline iodide Azide solution were added. Adding 2ml of conc. \( \text{H}_2\text{SO}_4 \) in sample water dissolved the precipitate and the liberated iodine was titrated against standard Sodium Thiosulphate (0.025N) solution using starch as an indicator. The calculation was carried out with the help of following formula.

\[ \text{D.O}(\text{mg/lit}) = \frac{0.1 \times \text{ml. Titrant} \times 1000}{100} \]

1ml of Hypo =0.1 mg of DO

3.3.7 Dissolved carbon dioxide

The dissolved carbon dioxide was calculated by titrating the water sample against 0.44 N NaOH and resultant change in pH from acid to neutrality to alkalinity was detected by phenolphthalein. The calculation was carried out with the following formula.

\[ \text{DCo}_2 (\text{mg/lit}) = \frac{\text{ml of titrant} \times \text{Normality of titrant} \times 44 \times 1000}{\text{ml of sample}} \]
3.3.8 **Alkalinity** - It was measured by titrating the sample with 0.1 N H$_2$SO$_4$ using methyl orange as an indicator. The alkalinity was calculated by following formula:

$$\text{ml of acid required} \times \text{normality} \times 1000$$

Total alkalinity (as CaCO$_3$) = \[ \text{ml of sample} \]

3.3.9 **Chlorides**

Chlorides were determined by Argentometric method using silver nitrate as titrant and Potassium Chromate (k$_2$CrO$_4$) as indicator. The end point was permanent brick red ppt. The chloride contents in water sample were calculated by using following formula

$$\frac{(\text{ml X N}) \text{of A}_3\text{NO}_3 \times 35.5 \times 1000}{\text{ml of sample}}$$

Chloride mg/ltr. = \[ \text{ml of sample} \]

3.3.10 **Sulphates** –

Sulphate estimation was carried out by turbidometric method (APHA-1989). After developing the turbidity by addition of barium chloride crystals to the acidified water samples, the optical density was measured at 420 mm on spectrophotometer. With the help of standard graphs the value of sulphates in the sample was determined.

3.3.11 **Hardness**

Hardness of water was determined by EDTA method as described in APHA (1989). The PH of the sample was increased to 10 with help of ammonium with the buffer solution. Erichrome Black T indicator was added in this alkaline water sample, which forms a wine red complex of calcium and magnesium. The solution was titrated with std. EDTA solution. The EDTA breaks the complex and forms blue colored company. The end point was permanent blue color. The amount of EDTA solution required was noted. The hardness of water sample was calculated by using following formula.

$$\frac{\text{ml of ETDA} \times 1000}{\text{ml of sample}}$$

Hardness (as CaCO$_3$ mg/ltr) = \[ \text{ml of sample} \]
3.3.12 Biological Oxygen Demand (BOD)

B.O.D. of water sample was determined by the methods described in APHA (1989). Four sample bottles were prepared for each sample, two containing diluted sample and remaining two containing dilution water (Blank). First day Dissolved Oxygen was determined from one bottle & sample of one bottle of blank by Winkler Azide method (APHA, 1989). The remaining bottles were incubated at 20°C for five days. After incubation period, the dissolved oxygen of these water samples was determined. The BOD was calculated as follows.

\[
\text{B.O.D. mg/lit} = \left( S_1 - S_5 \right) - \left( B_1 - B_5 \right) \times \text{dilution factor}
\]

Where
- \( S_1 \) = D.O. of sample on first day
- \( S_5 \) = D.O. of sample after 5 day’s incubation
- \( B_1 \) = D.O. of blank water on first day
- \( B_5 \) = D.O. of blank water after 5 day’s incubation.

3.3.13 Most Provable number of Coliform Organisms (M.P.N.)-

It was estimated by multiple tube fermentation technique described by APHA (1989). Using standard methods in subscribed bottles did the sampling. The samples were brought to the laboratory immediately after collection and were preceded immediately. The samples were inoculated in Mac Conkey’s broth having following composition

- Peptone  -0.5gm
- Meat-extract -0.5gm
- Lactose -1.0gm
- Na-Taurocholate -0.5gm
- Neutral red (1%) -07.ml
- pH -7.4

Three sets each with five tubes was prepared the first set comprised of 5 tubes each containing 10 ml of double strength medium. The second set of tubes each containing 5ml of MacConkeys medium & third set of 5 tubes having 5 ml broth in each tube.

Ten ml of water sample was inoculated aseptically in each tube of set 1. One ml of water sample was inoculated in each tube of set 2 and 0.1 ml of sample was inoculated each tube of set 3. All tubes were
incubated at 37°C for 48 hours. The tubes were examined for acid and
gas production after 48 hrs. The number of positive tubes (acid & gas)
from each tube were noted and computed on MacConkey's table given
in APHA (1989) for estimation of most probable total number of
Coliform organisms from sample per 100 ml.

3.3.14 *Biological Analysis*

Physical and chemical characteristics of water bodies affect the
abundance, species composition, stability, productivity and
physiological condition of aquatic organism. Biological method is used
for assessing water quality such as pollution but pollution has
traditionally been chemical oriented and biological aspect have in a
subsidiary position because of Number of complication in analysis and
interpretation, collection of biological data. Biologically analysis of
water includes collection, counting and identification of aquatic
organisms.

Biologically monitoring of water includes, Plankton Analysis;
The two hundred liters water samples were filtered through the net
number 25 bolting silk. The samples collected were concentrated to a
50 ml volume and preserved in 4% formalin. Each replicate of phyto
and zooplankton samples was identified under research microscope
using suitable keys, standard texts and monographs given by Pennak

**Macrophytes studies:**

Aquatic Macrophytes were collected with the help of string
from reservoir at the above-mentioned sites, kept in polythene bag and
brought immediately to the laboratory, where they were washed under
water. Plants were treated with 10% silver sulphate (in 90% ethanol) for
one minute to prevent fungal and bacterial infection. The plants were
dried with blotting paper and herbarium sheets were made. They were
identified with the help of published literature.
IV. STUDY AREA

PLATE NO. 1
Map of India
PLATE NO. 2
Map of India Showing Study Area
PLATE NO. 3
Map of Maharashtra Showing Study Area

PLATE NO. 4
Map of Mhaswad tank, Mhaswad
1. The Topographical setting of Mhaswad Water reservoir:

The proposed ecological work will involve hydro biological study of a huge fresh water body namely Mhaswad Water reservoir, at Mhaswad, Dist.Satara, Maharashtra, India. The River Man begins its course close to the Sitamai hill (a part of Sahyadri hills) and flows towards eastern side for about 10 kms up to Andhali where minor irrigation tank is constructed. From Andhali River Man runs towards eastern side for 35 kms to reach Mhaswad where Mhaswad Medium water tank is constructed in 1872 by Queen Victoria. Afterwards it runs towards eastern side for about 110 kms and merges with River Bhima at Sarkoli of Solapur district

The Mhaswad Medium Irrigation Project envisages construction of a composite Dam across river Man near village Mhaswad in Man Tahasil of Satara District. It is the largest earthen dam. The construction of Mhaswad Dam was completed in 1872.

The salient features of this Mhaswad Water reservoir are as follows –

1. River – Man
2. Location – Longitude – 74° - 53' - 0" E
   Latitude - 17° - 35' - 0" N
3. Catchments area – 1243.15 sq. kms
5. Water availability as per studies carried out by C.W.C. New Delhi – 3.07 tmc.
6. Planned utilization – 1.63 tmc.
7. Gross storage – 1.63 tmc
8. Live storage - 1.62 tmc
9. Dead storage - 0.063 tmc
10. Length of Dam - 2473 ft.
11. Type of Dam -- Centrally earth dam in the gorge with Masonry Dam on either flanks. Left flank Masonry dam accommodates left canal and char type spillway outlets whereas right bank masonry dam is for right canal.
13. Length of Spillway - 1090 ft.
15. Maximum height of Dam - 24 m
16. Controlling levels - 
   a) Top Bund Level
      Earth Dam - 595 m
   b) Full Reservoir level (F.R.L.) - 591 m
   c) Maximum Water Level (M.W.L.) - 593.35 m

2. Sampling Stations:

1) Sampling station A:

   The sampling station A is Hingani village. It is located on the East-north side of the water reservoir.

2) Sampling Station B:

   The sampling station B is Devapur. It is on West-north side on left bank of the water reservoir. This site is 4 kms away from dam.

3) Sampling Station C:
The sampling station C is Palsawade. It is on West-South side on right bank of the water reservoir.

4) **Sampling Station D:**

The sampling station D is centre of tank.

Plate No 5
Worker is busy with his experiments

Plate No 6
Worker is busy with his experiments
Plate No 7
SITE A

Plate No 8
SITE B