SUMMARY
Limnological studies have laid way and received a lot of attention throughout the world. Its importance has been well established by scientists in the development process of a nation. A review of the progress made by developed countries or so called advanced nation, falling in the temperate belt, indicates the importance of the availability of limnological data. Water, the basic element needed for the existence of life is not only an important but also a limiting factor as far as development of any nation is concerned. Its availability and proper utilisation enhances development and non availability, scarcity or wasteful utilisation limits the pace of development. Unfortunately the existing water resources throughout the world are becoming polluted day by day and if immediate remedial measures are not adopted the situation might become worse. Even at the moment the situation is alarming and in certain cases resulted in major problems such as pollution of drinking water, disposal of untreated affluents from industries in to the water bodies, and reckless sewage disposal. Limnological studies have to a large extent helped in solving these problem. Limnological studies of water bodies have been undertaken extensively in the developed countries in the temperate belt. Invaluable and extensive data is now available related to lakes, rivers and ponds. However very little limnological data is available about
the water resources in tropical countries which, too are facing water pollution related problems. Hence it is the need of the time to collect similar data in tropical countries too. The present study of three water bodies viz. Military Engineering lake, Ratona tank and Dubey pond is a modest step in this direction. These water bodies were selected to study the following aspects:

- to generate morphometric informations and to trace their possible relationships with the biotic and abiotic factors of the water body.

- to work out the temporal and spatial variations of some important physico-chemical properties and the relationships among themselves in each water body.

- to observe the temporal and spatial variations of major planktonic groups and study their relationship with the environment.

- to study the primary production and trophic status of the water bodies.

- to suggest the possible ways and means for conservation and management of these water bodies.

Sagar district occupies almost a central position on the map of India (23°10' to 24°27' N and 87°40' to 79°21' E) at an average elevation ranging from 457.2 to 533.4 mts above the mean sea level at the junction of two geologically different rock formations, the Deccan tatarrean basalt and the Vindhyan sandstone.
The climatic feature of the Sagar is generally pleasant and salubrious. Summer season extends from March to June, rainy season from July to October and the winter season from November to February. The air temperature ranging from 12.1°C in December to 40.3°C in June and the rain fall reaches the highest point of 456.72 mm in August.

The Military Engineering lake was constructed in 1978. The lake is located at 20°50' N and 70°45' E, at about 517 m above to mean sea level. The Military Engineering lake is small (7143.75 m²), shallow and rain fed water body. It is generally used for fish cultivation and boating by military personnels.

Ratona tank is a large water stretch (170,500 m²) built up by impounding a tributary of Dhasan river. The tank is located at 23°49' N and 70°40' E at an elevation of 480 m above mean sea level. The Ratona tank is mainly used for irrigation but it also supplies water to hatcheries which are situated at the lower level of the tank.

Dutey pond is a rain fed water body and occupies an area of 15,000 m². The pond is situated at 23°50' N and 70°45' E. The pond was previously used for domestic and fishery purposes and had a large area but due to heavy silting and eutrophication process it has been reduced to a small pond over the years. People now use this pond for bathing, washing the clothes and wollowing the cattles etc.
The present investigation of the above mentioned water bodies were carried out from March 1987 to February 1988. There were selected two stations in each water body, a littoral and a limnetic. Both being visited once in a month for field work. A number of physico-chemical parameters like air and water temperature, Secchi transparency, conductivity, total dissolved solids, pH, alkalinity, carbon dioxide, dissolved oxygen, BOD, COD, chloride, hardness, sodium, potassium, ammonia, nitrate, phosphate, reactive silica etc.

The biological parameters like phytoplankton, zooplankton, phytoplankton productivity were worked out.

Following observations were derived after analysing the data carefully.

- Out of all the study sites the Military Engineering lake is perennial while the Matona tank and Dubey pond are seasonal which were dried up in May and June months.

- Water level varied greatly over the annual cycle because of seasonal changes in rainfall and air temperature which regulates the evaporation and evapotranspiration.

- The air and water temperature showed a similar pattern of changes in all the three water bodies throughout the study period. Water temperature showed a significant negative correlation with Secchi transparency in all the three water bodies. This was due to the dense algae growth which restricts the light penetration. It shows that
Phytoplankton productivity depends on the temperature. A significant positive correlation between water temperature and pH was also observed in all water bodies which was due to complex behaviour of phytoplankton productivity. Water temperature showed a negative correlation with conductivity in the Military Engineering lake which indicates that the lake is poor in cations and anions.

- Pool transparency was inversely correlated with calcium in all the three water bodies. It was due to the increased concentration of chlorides of calcium which reduce the light penetration. A significant inverse correlation between pool transparency and bicarbonate alkalinity was observed in the Ratona tank and Dubey pond. This shows the high uptake of carbon dioxide during intense photosynthesis.

- The conductivity was found to be maximum in Dubey pond and minimum in Military Engineering lake. Conductivity showed a positive correlation with sodium and potassium only in Dubey pond. This indicates the higher concentrations of anions in the Dubey pond.

- Among the three water bodies the maximum value of TDS was observed during summer season only in Ratona tank while minimum values were noticed during rainy season in all the three water bodies.

- The maximum and minimum seasonal values of pH were recorded in all the three water bodies during summer and winter season respectively. A direct significant correlation
with carbonate alkalinity was observed in the Military Engineering lake and Dubey pond and with bicarbonate alkalinity in the case of Dubey pond. Due to the high uptake of carbon dioxide the alkalinity of water had increased considerably.

- Throughout the study period, free carbon dioxide was totally absent in Military Engineering lake and Ratona tank while it was present in Dubey pond during January and February. A negative correlation of free carbon dioxide with water temperature was observed. It may be due to the complete utilization of carbon dioxide by algae at high temperature.

- Due to the absence of free carbon dioxide the concentration of carbonate and bicarbonate alkalinity had increased. It was observed that the concentration of total carbon dioxide was maximum during summer season.

- Carbonate and bicarbonate showed a positive correlation with calcium because the calcium ions are usually associated with carbonate and bicarbonate ions. Carbonate alkalinity was negatively correlated with sodium in the Military Engineering lake and Ratona tank. It may be due to the utilization of sodium in high concentration by blue green algae. A positive correlation between carbonate alkalinity and chloride in Dubey pond and bicarbonate with chloride in the Ratona tank indicates that the Dubey pond has a high content of organic matter in comparison to the Ratona tank while the Military Engineering lake is relatively poorest.
- Dissolved oxygen showed a negative correlation with water temperature. It was due to the high solubility of the oxygen in water low temperature. A negative correlation between dissolved oxygen and ammonia in the Military Engineering lake showed the high population of blue green algae. It was because of utilization of ammonia in large quantity by blue green algae. Significant negative correlation of dissolved oxygen with reactive silica in the Military Engineering lake also showed the high population of diatoms.

- BOD and phosphorus were found to be positively correlated in the Ratona tank shows that in the Ratona tank, the most biodegradable substances are phosphorus compounds.

- Among the three water bodies the maximum value of COD was observed in April in the Dubey pond while the minimum value was noted in July in Military Engineering lake. A negative correlation between COD and dissolved oxygen in Dubey pond indicates the occurrence of organic matter in higher concentration.

- Amongst the three water bodies the maximum concentration of chloride was observed in the Dubey pond. The high chloride concentration indicates the strength of organic pollution.

- The maximum values of calcium hardness, magnesium hardness and total hardness were observed in the Dubey pond. It is due to the wallowing of cattle as well as use of the pond water for washing and bathing purposes.
- The maximum and minimum values of sodium and potassium explains the low and high photosynthetic activity of the blue green algae.

- Ammonia was found negatively correlated with Secchi transparency and dissolved oxygen in the Military Engineering lake which shows the abundance of algae and high productive nature of the lake in comparison to the other two water bodies.

- The maximum and minimum values of nitrate can be explained on the basis of decomposition rate of nitrogenous compounds at high and low temperature. A significant correlation was observed between nitrate and Secchi transparency in all the three water bodies. This shows the abundance phytoplankton growth due to the high uptake of nitrate, resulting in low light penetration.

- The maximum quantity of orthophosphate was present in Dubey pond while it was minimum in the Military Engineering lake and Ratona tank, the total phosphorus was negatively correlated with Secchi transparency. It may be due to the high uptake of phosphorus by plankton resulted the dense algae growth of which reduced the light intensity.

- During the study period, the maximum concentration of reactive silica was observed in the Military Engineering lake while it was minimum in the Ratona tank. A significant positive correlation between reactive silica and pH was
found in the Military Engineering lake which shows that the reactive silica is the main component responsible for the increase in alkalinity except carbonate, bicarbonate and phosphate ions.

- The maximum number of planktons were observed in the Military Engineering lake while they were minimum in Ratona tank.

- 55, 18 and 39 genera of chlorophyceae were identified in the Military Engineering lake, Ratona tank and Dubey pond respectively.

- During the present study 27 genera from Military Engineering lake, 12 from Ratona tank and 10 genera from Dubey pond were found in the group of Bacillariophyceae.

- 24 genera in Military Engineering lake, 13 genera in Ratona tank and 9 genera in Dubey pond were identified in the group of cyanophyceae. During the investigation period the group Euglenophyceae was represented by only Euglena and phacus species in all the three water bodies.

- The other groups of phytoplankton encountered during study period were Dinophyceae, chrysophyceae and Xanthophyceae.

- The group Dinophyceae was represented by ceratium, Gonyaulax and peridinium in the Military Engineering lake and Dubey pond but Ceratium was absent in the Ratona tank.
- Dinobryon and Halobryon were the only genera identified in the group of Chrysophyceae in all the three water bodies.

- Xanthophyceae was represented by four genera, in which only a single genera tribonema were identified from Ratona tank and rest of the genera Ohiocytium and Tribonema were identified from Military Engineering lake.

- The abundance of Euglenophyceae in the Dubey pond indicate that this water body is more polluted in comparison to the other two water bodies because of the fact that Eulenophyceae is by nature the most pollution to tolerant genera of algae.

- The zooplankton in the Military Engineering lake contained 33 genera of protozoa, 17 genera of rotifera, 8 genera of cladocera, 4 genera of ostracoda and 3 genera of copepoda.

- In the Dubey pond, the zooplankton consisted of 15 genera of protozoa, 29 genera of rotifera, 7 genera of cladocera, 3 genera of ostracoda and copepoda.

- However, in the Ratona tank 13 genera of protorozoa, 30 genera of rotifera, 6 genera of cladocera, 3 genera of ostracoda and copepoda were observed.

- In the present study neither phytoplankton nor zooplankton showed a significant correlation with temperature at required level in any water body.

- Secchi transparency showed a positive correlation with total phytoplankton and total zooplankton in the Military Engineering lake and Ratona tank.
- Since the phytoplankton is a favorite food of zooplankton a positive relation was observed between them.

- The higher values of alkalinity may be associated with better production of phytoplankton in the water bodies.

- During the course of present investigation a positive correlation was observed between hardness and plankton population in the Military Engineering lake and Ratona tank.

- The group Bacillariophyceae was negatively correlated with silicate in the Military Engineering lake. It suggests an increased uptake of silicate during the development of diatoms.

- In Ratona tank and Dubey pond the primary productivity increased gradually from summer season to winter season, while in the case of Military Engineering lake the primary production was decreased with the progress of season from summer to rainy. But with the advent of winter season the primary production increased suddenly.

- A positive significant correlation was observed between GPP and bicarbonate alkalinity in the Military Engineering lake. This is an indicator of increased photosynthetic activity of the phytoplankton population in the water body. However in the Ratona tank and Dubey pond the GPP was insignificantly correlated with alkalinity. This discrepancy indicates that the Military Engineering lake is much more productive than the Dubey pond and Ratona tank.
- The GPP was found to be positively correlated with the most of the phytoplankton groups in all the three water bodies.

- It can be concluded that Dubey pond is highly eutrophic as compared to the Ratona tank and Military Engineering lake. The Military Engineering lake is the only water body which is free from pollution of any kind.