Water is an essential requirement to all life processes. It is a part of life itself since the protoplasm of most of the living cells contain about 80% of water, which participates either directly or indirectly in all metabolic reactions. The amount of water on the earth is about $1.4 \times 10^9$ Km$^3$ (1 Km$^3 = 10^9$ m$^3$) which covers about 70% of the earth's surface. The quantity of freshwater on the earth is estimated to be $29 \times 10^6$ Km$^3$ which is about 2-2.5% of that salt water. This quantity of freshwater, if uniformly spread out, will give a layer about 50 m thick (Golterman, 1975). Of this 50m about 49.5m is present as glaciers and polar ice. Of the remaining 0.5m, 50% is in rivers and as ground water, while 50% is in lakes (12500-150000 Km$^3$).

Inland freshwater bodies are variously used to satisfy the human needs such as domestic use, industrial consumption, agriculture, recreation, transport and as a cheap source for input of domestic and industrial sewage. The growth of human population is in an exponential phase and the meagre supply of freshwater on the earth cannot cope with increased stress. This finite freshwater resource can be increased only slightly via desalinization, which involves a tremendous energy cost.
and is not feasible at the present phase of energy crisis. Man is a real component of these ecosystems, and his effect on them will increase markedly until stabilization of demophoric growth is achieved. A well known effect of human impact upon aquatic ecosystems is eutrophication which is associated with increased productivity, structural simplification of biotic components and a reduction in the ability of the metabolism of the organism to adapt growth response to imposed changes. The main factor responsible for the eutrophication is the accelerated rate of the input of nutrients into the aquatic bodies from the various sources like agricultural fertilizers, sewage, detergents and industrial wastes by human activities (Cultural eutrophication).

Therefore, the conservation and management of the freshwater bodies is very necessary for rational exploitation of these natural resources. The basic understanding of any system is very essential prior to the formulation of strategies for its conservation and management. Limnology (Greek prefix "Limn" meaning 'marsh'), the science of freshwater systems deal with various aspects of hydrobiology, hydrochemistry, hydrophysics and geology. In other words, limnology is the science which deals with the reciprocal relationships between organisms and their environments in inland waters.

Though man's attention usually has been focused on the
open water of lakes and rivers for his commercial harvest of food; however, of late it has been found out that the weedy shoreline, swamps and marshes may be the sites of greatest primary productivity. Photosynthetic fixation of carbon in inland aquatic ecosystems may occur by various communities. The phytoplankton represent the algal community of the open water; macrophytes are all macroscopic chlorophyll bearing plants that are submerged or emergent, rooted or floating; and periphyton the community of plants, other than macrophytes, that grows on submerged substrates.

The relative importance of these three groups of primary producers in individual aquatic ecosystem is highly variable and largely unknown. In very large and deep lakes phytoplankton are undoubtedly the major primary producers. However, in the shallow shoreline area of deep lakes and especially in shallow lakes, swamps, marshes and running water ecosystems the contribution by periphyton and macrophytes certainly becomes more important if not dominant (Allen, 1971). Chemosynthetic fixation of carbon may be significant in a few rather specialized ecosystems like meromictic lakes or reservoirs (Sorokin, 1966).

Though the study of freshwater life, like the marine one, had been started during the time of Aristotle (384-322 BC)
but no significant contributions of a strictly limnological nature appeared till early nineteenth century. In later half of nineteenth century and early twentieth century real biological work in lake investigations was started and credit for this goes to Professor F.A. Forel (1841-1912) who published about 116 papers on limnological aspects during the period 1888 to 1909 (Chumley, 1910). The concept that the lake is a 'microcosm' (a little world within itself) was developed for the first time in 1887 by Forbes and later on Forel recognized this and designated these studies as limnology. Progress in the limnological studies since 1910, particularly since 1918, has been quite rapid. During this period limnology became more completely an integrated and coherent branch of science.

Earlier studies were mainly restricted to the biological characteristics of the lakes. Thienemann (1925), and Birge and Juday (1926) suggested that only quasi-quantitative estimation of biota is not enough, and stressed the need of simultaneous studies of physico-chemical factors and geomorphology of lakes. Thermal stratification, pH, dissolved oxygen, carbon dioxide, nitrate and phosphate were recognized as important factors. Hutchinson (1941) provided the 'concept of lake ecosystem' and Lindeman (1942) emphasised the significance of the productivity studies of the lakes and introduced for the first time the concept of
nergy flow. Fundamentals laid down by Thienemann (1915, 1954), Welch (1952), Ruttner (1953) and Hutchinson (1957) are still the guidelines for today's worker's.

The growing interest of scientists and invention and development of techniques in limnology led to the well planned and long term research in different countries of the temperate regions. Secchi (1856) devised Secchi disc to note light penetration in water. Winkler (1888) proposed the technique to measure the dissolved oxygen content of water. Welch (1935) emphasized for the measurement of water temperature and calculation of heat budgets. Further he proposed a classification of lakes on the basis of thermal characteristics. Gaarder and Gran (1927) introduced the light and dark bottle technique for the measurement of productivity of waters. The development of $^{14}$C technique is more useful in measuring small changes in productivity (Steemann-Nielsen, 1952). Macrophytic production on the basis of biomass changes during their growth period was suggested by Westlake (1963, 1965). More rapid and accurate techniques have been developed with the advent of new scientific inventions. The use of advanced space technology and laser fluorescence system in limnological studies has been recently adapted by a few workers in America and Canada. Strong et al. (1974) have described "Chemical Whitening" due to
calcium carbonate precipitation in lake Michigan by utilizing the data from the NOAA-2 and ERTS-1 satellites. Strong (1978) has discussed the "chemical whitening" and chlorophyll distribution in the great lakes as viewed by Landsat. Reid (1978) demonstrated the working of 'Geostationary Operational Environmental Satellite' (GOES) system and collection of hydrometric, hydrometeorological and water quality data like water temperature, pH, dissolved oxygen, conductivity and turbidity.

It is important to note that most of the available limnological information pertains to the temperate regions. However, since 1930 the tropical waters also gained due scientific attention and some of the important contributions are those by Ruttner (1931) in Java, Sumatra and Bali; Talling (1957, 1963, 1965a, b, 1966a, b, 1969, 1970), Talling and Talling (1965), Viner (1969), Moriarty et al. (1973), Biswas (1966, 1969a, b, 1972, 1973) and Blake (1977) on African and East African lakes; Berman et al. (1972), Berman and Pollingher (1974), and Pollingher (1978, 1981) on lakes of Israel; Lewis (1974, 1978) on lake Lanao in Philippines. Important contributions on Indian freshwaters are those of Ganapatii (1940, 1943, 1955, 1957, 1960, 1962, 1970, a, b, 1972), Ganapatii and Chacko (1951), Singh (1955), Das and Shrivastava (1956, a, b, 1959), George (1961, 1962, 1966), Sreenivasan (1963,

The tropical waterbodies which differ from temperate ones, have been less worked out and only little information is available on them. The tropical aquatic system have five characteristic features (Belsare, 1982) which include (i) the wide range of fluctuation in water level during the course of a year on account of dam design, evaporation and draw off, the concomitant result of the change in water quality and quantity; (ii) small variation in the intensity of solar irradiance during the year, resulting in a relatively high mean temperature which is modified by a combination of latitude and attitude, the temperature never falls to physiologically inhibitory level in most of these water bodies, (iii) small differences between the temperatures of surface and bottom waters; (iv) release of active convection currents due to variations in density, which affect the warm hypolimnion and cause turn over in the lake without the necessity of any wind action and (v) variation in
temperature not being confined to a certain season. Therefore, in tropical aquatic ecosystems the seasonal studies alone generally are unable to give clear picture particularly of the functional aspects of aquatic bodies. And hence to understand the relationship between organisms and their environment the seasonal diel studies are very essential; however, these type of studies are very few in comparison to those of temperate regions. Whatsoever work on diel studies is available from tropical water bodies it is either performed for a very short duration or limited to some physico-chemical parameters.


The work on diurnal studies performed by most of these workers are generally related to physico-chemical properties and zooplankton, but studies on phytoplankton biomass and their production were very few and mostly for a short duration.
In view of this the present work was carried out to know the depth-wise diel behaviour of phytoplankton crop and their productivity in relation to physico-chemical characteristics and zooplankton populations at three water bodies in and around Sagar from July 1982 to June 1983.

The brief outline of the work done during the present study is as under:

i. General survey of all the sites under investigation has been made as regard to history and geology, geographical situation and local climatic conditions.

ii. Study of temporal and spatial variation of various physico-chemical properties of water at different water bodies.

iii. Study of temporal and spatial variation of phytoplankton and zooplankton populations.

iv. Study of temporal and spatial variation of phytoplankton productivity.

v. To work out the possible relationships among abiotic and biotic factors and productivity.