DISCUSSION
The ecological conditions of both lotic and lentic waters are greatly affected by inflow of nutrients and other pollutants from their catchment and surrounding areas. The latter include chiefly release of agricultural and domestic wastes from the human habitation. Kashmir lakes are no exception and many of them, especially those situated in close proximity to human settlements, are showing visible signs of advancement in their trophic level. Some of these, like Khushalsar, Anchar, Brari Nambal have already become polluted to a great degree and others like Dal, Nageen, Manasbal are in a state of transition towards eutrophication. The lakes of Manasbal and Nageen are two famous water bodies in the valley which because of their scenic beauty and relatively clean waters attract large number of tourists. Both the lakes have been receiving large quantities of agricultural runoff and domestic sewage over the years and are under the stress of exploitation & increasing biotic impact. These have affected both the quality of water and the structure and productivity of biotic communities inhabiting these lakes.

Recently it has been demonstrated that biotic communities can provide better means of assessment of the
water quality than originally conceived (Gannon & Stemberger 1978, Barzin & Pejler 1989). Certain living organisms are tolerant to adverse environmental conditions and serve the purpose of monitoring the environmental pollution as they serve as bio-indicators, and are capable of measuring the actual response of organisms or populations to the changes in environmental quality. The aim of present investigation was to study the distributional pattern and relative abundance of different planktonic groups and taxa in Manasbal and Nageen lakes and evaluate the trophic level of these waters based on these.

A definite clue regarding the typical organisms in a water course is given by the survey and analysis of various types of waters and by correlating their physical and chemical characteristics with existing flora and fauna. In view of this and along with the study of plankton communities, data on the physico-chemical environment of the lakes were also collected. In the following pages seasonal changes in different abiotic features are discussed first, followed by occurrence, distributional pattern & relative abundance of different planktonic groups.

Water temperature is one of the most important limnological parameters that plays a prominent role in
regulating nearly all other physical & chemical characteristics of the water as well as the biological productivity (Wetzel, 1980). Surface waters being directly in contact with the atmosphere, the thermal structure of lakes is straight away influenced by solar radiation. In both these lakes the water temperature range and fluctuation showed a similar pattern with surface water being almost always warmer than the bottom layers. While in case of Manasbal water temperature throughout the column never fall below 4°C, in Nageen lake, which is relatively shallower, the surface got frozen during January 1987. However, freezing of lake surface in both Nageen and Manasbal is a very rare phenomenon and occurs only during very severe winters when the atmospheric temperature falls well below -10°C. The present data together with the findings of Qadri & Yousuf (1978) reveal the warm monomictic nature of Manasbal lake. Inspite of the fact that appreciable temperature gradient persists during summer in Nageen lake and the lake experience warm monomictic conditions in its thermal behaviour, it cannot be included in that category as its depth is less than 8m, a pre-requisite for the permanent establishment of thermal stratification. Manasbal lake thus witnesses a more or less uniform thermal structure from surface to bottom without any stratification. Consequently the distributional pattern from surface to bottom is not very much effected.
Stratification resulting in the differentiation of epilimnion, hypolimnion and metalimnion mainly due to temperature gradient provides an almost physical barrier for the free movement of planktonic organisms that are stenothermal. Although the truly eurythermal organisms may not be influenced so much, yet the temperature induced changes in other biological parameters like O₂ may act as limiting factors.

Such a phenomenon is clearly witnessed in the case of Manasbal where three well differentiated zones of epilimnion, hypolimnion and metalimnion or thermocline are seen during the months of June and July with a single mixing or turnover once during the months of December-January when the uniform thermal conditions are seen throughout the lake depth providing a uniform environment for the organisms.

The water transparency, which is closely associated with the penetration of photo-energy and therefore pivotal to all the energy relationships in aquatic habitats, has been also used as an index of lake eutrophication (Yoshimura, 1933; Rawson 1960 and Pechlaner 1968). The transparency values in Manasbal fluctuated from 0.1m to 1.6m in the littoral zone and from 3m to 5m in the limnetic zone. In case of Nageen
lake the range was 0.1m to 2.0m and 2m to 4m in two zones respectively. A comparison of the data regarding the depth at the collection sites in the two lakes makes it quite apparent that Nageen lake seems to be more transparent. In this lake the seochi disc was visible generally in 60% of the water column. However, both the lakes show low seochi values which may be due to its increased suspended matter in the water.

The interaction between several physical, chemical and biological parameters, the aquatic environment results in determining acid-alkali relationship and therefore establishing suitable living conditions in terms of pH index, which thus provides a very dependable factor for knowing the trophic conditions of the aquatic habitats. According to Ruttner (1953) pH values in the alkaline range are generally maintained by eutrophic lakes. The pH values of both the lakes under study were always in the alkaline range (7-10.5 units in Manasbal, 7.5 - 11 units in Nageen), values above 9 units have been attributed to extreme divergence from the equilibrium because of high photosynthetic activity or presence of carbonates of sodium and Magnesium (Hutchinson, 1967). The present data substantiates that values above 9 units generally during late spring and summer months, as this seems directly to be outcome of increased photosynthetic activity by
macrophytic population. The littoral zone in both the lakes which contains relatively higher populations of macrophytes, generally showed higher pH values than the limnetic zone. The relatively low values during the cold season also support this view as during this period the macrophytes either die completely or remain under dormancy and thus a reduced pH, however on alkaline side.

Total alkalinity of water has been used as a rough index of lake productivity and also for classifying water bodies as soft and hard water (Moyle 1945, 1956). In the present lakes the total alkalinity showed a considerable fluctuation during the course of study. In case of Manasbal it ranged from 30 mg l$^{-1}$ to 230 mg l$^{-1}$ and in case of Nagpan 30 mg l$^{-1}$ to 300 mg l$^{-1}$. Waters having total alkalinity up to 40 mg l$^{-1}$ are designated as soft, those with 40-90 mg l$^{-1}$ as medium hard and those having values above 90 mg l$^{-1}$ as typical hard waters (Moyle, 1945). The present data reveal that in respect of total alkalinity conditions the lakes under study pass through all the three categories at different times of the year - during late summer water of the lake Manasbal was medium hard whereas for the rest of the year it was typical hard water, values
40 mg l\(^{-1}\) were recorded only once at site III (July 1987). Similarly total alkalinity in Nageen lake remained above 90 mg l\(^{-1}\) for most of the year but sometimes water at site II and III conformed to medium hard type values 40 mg l\(^{-1}\) were recorded only once at site III in October 1987. When the alkalinity values at different sampling sites and at different depths were compared it was found that shallow, macrophyte - infested areas of both the lakes contained relatively low values, similarly bottom water maintained higher values than the surface water. This appears due to the fact that in shallower zones higher photosynthetic activity results in utilization of higher quantities of bi-carbonates resulting in the precipitation of carbonates and ultimately lowering of total alkalinity values. Similarly surface waters also record higher photosynthetic activity than the bottom waters thereby showing low total alkalinity as compared to bottom waters thereby showing low total alkalinity as compared to bottom layers where considerable quantities of bicarbonates are constantly added due to decomposition process.

Dissolved oxygen is one of the most important and critical factors for aquatic life and the pattern of its spatial and temporal distribution in the lakes is basic
to the understanding of the occurrence and the abundance of the aquatic organisms (Wetzel 1983). In oligotrophic lakes dissolved oxygen values are generally close to saturation point of the gas in water and any deviations are attributable to the process of eutrophication (Hutchinson, 1957). A perusal of the data regarding oxygen concentration in Manasbal and Nageen reveals that the saturation of the gas shows very significant variations from unsaturated conditions to supersaturated condition. In case of Manasbal lake the values fluctuated from 1.6 mg l$^{-1}$ to 14.4 mg l$^{-1}$ and 18.3% to 176.9% saturation. In case of Nageen lake, the range was from 0.32 mg l$^{-1}$ to 12.0 mg l$^{-1}$ and 6.1% to 164.7% saturation. Horizontally oxygen concentration showed significant differences between located in the shallower zone and those located in the deeper zone. In both the lakes the oxygen concentration recorded an irregular seasonal pattern and the fluctuations were mainly influenced by rates of photosynthesis and decomposition. In the open water zone fluctuations in the concentration were also influenced by the thermal structure of the water body. This is very clearly revealed in Manasbal lake where the oxygen concentration fluctuates in close relationship with thermal stratification (Qadri & Yousuf 1978).
Contamination of inland waters from domestic sewage can be monitored by the assessment of chloride concentration as the higher quantities of the anion imply that the water body is receiving the organic water (Gola, 1975). Chloride concentration in both the lakes showed a similar range although the pattern of fluctuations differed, not only between the two water bodies but also between the various zones of the same water body. In case of Manasbal lake the chloride concentration varied from 8 mg l\(^{-1}\) to 68 mg l\(^{-1}\), whereas in case of Nageen lake it varied from 10 mg l\(^{-1}\) to 75 mg l\(^{-1}\), Singh (1960), Munawar and Munawar (1970) and Parveen (1986) have recorded higher quantities of chloride during summer. No definite pattern was recorded in the seasonal fluctuations at different sites. However, relatively higher concentration were recorded during warmer period. Generally higher concentration of the anion were found in the surface layers. A comparison of the present data with the 1970-71 data of Zutshi and Vass (1978) and Kaul (1977) in case of Nageen lake and with the 1970-71 data of Kaul (1977) and Vass (1977) and 1976-78 data of Yousuf & Qadri (1981) in case of Manasbal lake reveals that the chloride concentration in both the lakes has significantly increased over the past two decades.
O'Nabey and Ke (1967) attribute increase in chloride content in lakes to industrial wastes, road silting and municipal sewage. In the present lakes the increase in the chloride content seems to be directly related with the increase in the human population in the catchment areas of the two lakes.

Hardness of water is mainly contributed by calcium and magnesium. Calcium and Magnesium hardness in Manasbal lake fluctuated from 32 mg l$^{-1}$ to 164 mg l$^{-1}$ whereas in case of Nageen lake it showed a range of 32 mg l$^{-1}$ to 186 mg l$^{-1}$. As per the classification of Glof (1974) both the lakes come under the hard water category; the degree of hardness fluctuated irregularly from month to month. Horizontal distribution of hardness also shows variations in both the lakes. Parveen (1988) has recorded a positive relationship between hardness and alkalinity in Dal lake. However, present data do not reveal any such relationship. It seems that not only carbonates & bicarbonates of calcium and magnesium but also their sulphates and chlorides contribute to the hardness of water in the present lakes. Generally the bottom water was harder than the surface water.
Nitrogen is one of the fundamental constituents of nutrients - proteins and nucleic acid and hence its concentrations in fresh waters control the overall biological production. Plants use generally nitrogen in nitrate form but some plants can utilize ammonical nitrogen as well. Nitrate nitrogen usually occurs in small quantities in fresh water, however, contamination by industrial, agricultural and domestic wastes may increase its concentration and lead to pollution of lakes (Walmsley et al. 1976). The previous hydrological data of Kashmir lakes reveal considerable variations in the concentration of NO$_3$-N. For example Kaul (1977) found the range of 0.09 mg l$^{-1}$ to 0.6 mg l$^{-1}$ in Dal, Nageen, Manasbal and Anchar during 1970-72, Mir (1977) recorded an average concentration of 0.15 mg l$^{-1}$ in Dal during 1974-76, whereas Yousuf & Qadri 1981 recorded a range of 0.115 - 1.03 mg l$^{-1}$ in Manasbal lake during 1976-78. During the present study the concentration of NO$_3$-N fluctuated from traces to 0.243 mg l$^{-1}$ in Manasbal and from traces to 0.192 mg l$^{-1}$ in Nageen lake. Higher quantities were generally recorded during winter and as soon as the growing season commenced, the late winter to early spring, the concentration of NO$_3$-N decreased considerably in the water, particularly in the surface layers.
Concentration of NH$_4$-N in surface waters is very variable (Kaul 1977, Zutshi et al. 1978) and values above 1 mg l$^{-1}$ are generally attributed to entry of domestic sewage and extremely high rates of decomposition within water bodies. In the present lakes the concentration of NH$_4$-N fluctuated from 0.01 - 4.67 mg l$^{-1}$ in Manasbal and from nondetectable level to 4.43 mg l$^{-1}$ in Nageen. For most part of the year the range was well below 1 mg l$^{-1}$ and it was only during March, April and June, 1987 that exceedingly high quantities (up to 4.67 mg l$^{-1}$) were recorded. The significantly high quantities of NH$_4$-N seems to be related to unusually high rainfall in the catchment which brought in high quantities of allochothonous material into the lakes.

Phosphorus is a key metabolic nutrient and its supply often controls the biological productivity in natural waters. It is also regarded as key element in the eutrophication process (Vollenweider 1972). In fact, Hutchinson (1957) and Lee (1970) have indicated that most natural waters respond to additions of phosphorus with greater plant production. Total phosphorus concentration in Manasbal lake during the present study fluctuated from 'undetectable levels to 0.3 mg l$^{-1}$. Whereas in case of Nageen lake the range of fluctuation was much greater (0.003 to 2.02 mg l$^{-1}$). Nageen lake showed generally higher concentration of
this nutrient. No regular pattern was observed in the monthly fluctuations. Bottom contained generally higher quantities of Phosphorus than the surface layers.

The presence of an organism in a given body of water depends on a number of complex, spatial and temporal interactions among environmental factors affecting growth rate, behavioural characteristic of the alga and the activities of the other organisms (Parveen 1988). The term phytoplankton is used for the large group of planktonic plants that live in surface water. The vast majority of phytoplankton are algae which belong to nearly all major taxonomic groups.

The taxonomic composition of phytoplankton communities and the abundance and relative dominance of different species and different algae groups present undergo continuous change in close association with the environmental conditions (Smayda 1980). In general enrichment of nutrients is closely followed by change in the taxonomic composition and the abundance of different groups. During the present investigation a total of 108 taxa of phytoplankton were recorded in Manasarbal lake. Of these 46 belonged to Chlorophyceae,
48 to Bacillariophyceae, one to Chrysophyceae, 2 to Dinophyceae, 4 to Euglenophyceae and 7 to Cyanophyceae. In case of Nageen lake the total number of taxa was 113 out of which 44 belonged to Bacillariophyceae, 57 to Chlorophyceae, 7 to Cyanophyceae one to Chrysophyceae, 2 to Dinophyceae and 2 to Euglenophyceae.

Khan (1978) recorded unimodal behaviour of phytoplankton population in Naranbagh lake, a eutrophic water body. However, according to Hutchinson (1967) the unimodal behaviour is characteristic of large deep cold and unproductive lakes only and several peaks can be obtained by the phytoplankton in productive lakes. In case of Manasbal lake a bimodal pattern with the first, major, peak population in spring and the second comparatively smaller in summer. In case of Nageen lake also two peaks were recorded the first, comparatively smaller one, during spring and the second in summer, least population was recorded during winter.

Effects of eutrophication can be traced by the study of phytoplankton production in waters (Vollenweider 1974 and Zutshi 1981). According to Prescott (1939) the phytoplankton assemblages present in a water body reflect its trophic level. According to Prescott (1939) and Rawson (1956) oligotrophic lakes
are characterized by Chlorophycean flora with a conspicuous deemid element. On the other hand increase in the abundance of Cyanophyceae has been related with eutrophication and that of euglenoid with pollution (Mitchell & Marshall 1974). Phytoplankton population of Manasbal lake was dominated by Bacillariophyceae and Chlorophyceae stood at number two with regard to population in shallow as well as deep areas (Table I). Zutehi and Wanganeo (1984) also recorded the dominant nature of Bacillariophyceae in this lake. In case of Nageen lake Chlorophyceae was the dominant group, being closely followed by Bacillariophyceae. Mir and Rachroo (1982) based on the data of 1974-76 reported diatoms to be the most dominant phytoplankton of these two lakes. During the present study Chlorophyceae was found to be forming the dominant component of the phytoplankton in the peripheral areas of the Nageen lake. In the open areas diatoms formed the dominant group (Table I). Qualitatively as well the same pattern was recorded. In Manasbal 48 diatom taxa and 46 green algae taxa were recorded whereas in Nageen lake 57 green algae and 44 diatom taxa were found. According to Hutchinson (1967) diatoms are the most important members of the fresh water plankton, being nearly always present in considerate numbers.
Khan (1978) reported two peaks of diatoms, one during spring and the other in summer, in two eutrophic lakes of Kashmir, Trigam and Naranbagh. Wani (1983) also recorded bimodal behaviour of diatoms. Mir (1977) recorded only a summer peak in Dal lake. Several workers have found diatom communities to be influenced by changes in the temperature and light (Patrick, 1969, 71 and Munawar, 1974). During the present investigation, although the least population of diatoms was recorded during the coldest season, the influence of temperature and/or light on the seasonal dynamics of diatom flora was not significant. Out of 48 taxa found in Manasbal 13 were of significance with regard to the total population density. As per Hustedt's (1956) classification of diatoms with respect to temperature tolerance the diatom flora of both the lakes can be designated as belonging to cold water to temperate forms as the water temperature never exceeds 30°C in the lakes.

During the present investigation Bacillariophyceae recorded the main peak during summer. Two more, comparatively smaller, peaks were recorded during winter and spring in this water body. The most dominant taxa of Bacillariophyceae recorded in Nageen lake included
Synedra ulna, Cymbella lanceolata, Comphonema olivaceum, Fragilaria capucina, F. crotonensis, Amphora ovalis, Bactonia, Cocconeis placentula and Rhopalodia gibba.

In case of Manasbal lake the main Bacillariophycean peak was recorded during spring. Two more peaks were observed in this lake during autumn and winter but both of them were less important than the first peak. The dominant taxa in this lake included Synedra ulna, Cymbella ventricosa, C. citrula, Comphonema olivaceum, Fragilaria crotonensis, F. capucina, Amphora acuticosa, Nedinum affinis, Diatoms elongatum and Cocconeis placentula. Synedra ulna has been observed to prefer eutrophic waters (Lowe, 1972). Williams (1969) reported that Fragilaria shows up if sewage enters the lake. According to Dickman (1975) Cymbella ventricosa, Synedra ulna, Fragilaria capucina, Diatoms elongatum, Comphonema olivaceum, Cocconeis placentula and Navicula cuspidata are species which are commonly found in organically polluted waters. Vollenweider (1968) considers Fragilaria crotonensis to indicate eutrophy. Most of these taxa were found in the present lakes which clearly indicates the advanced trophic level of these water bodies.
Although the green algae contain a great number of morphologically diverse organisms in fresh water lakes the planktonic species belong mainly to volvocales, chlorococcales and zygnematales (Hutchinson, 1967). In the present lakes also these three groups of green algae were the main contributors, particularly chlorococcales and zygnematales. In case of Manasbal lake chlorococcales was represented by 22 taxa and zygnematales by 21 taxa, whereas in case of Nageen lake 30 taxa belonged to Chlorococcales and 23 to Zyg nematales. Chlorophycean plankton was better represented in Nageen lake where the group formed the most dominant component of the phytoplankton population. Parveen (1988) has also reported the dominant nature of Chlorophyceae in Nageen lake. In case of Manasbal lake Chlorophyceae formed the second most important phytoplankton group. Chlorophycean plankton has been reported to record different types of annual population cycle in different water bodies. For example, William (1969) reported an autumn peak in Swedish lakes but Castellin & Reynold (1977) Parveen (1988) Kant & Kachroo (1977) and Wanjaneo (1980) reported single summer peak. On the other hand Khan (1978) recorded two peaks of Chlorophyceae in Naranbagh and Trigam lakes of Kashmir.
In the present water bodies although the monthly fluctuations did not show much regularity, a bimodal behaviour, with two distinct peaks in summer and autumn, was recorded. The dominant Chlorophycean taxa in the Manasbal included *Ankistrodesmus falcatus*, *Pandorina* sp., *Staurastrum* sp., *Pediastrum* *duplex*, *Scenedesmus diarmorphus*, *Cosmarium granatum*, *C. monomazum*, *C. reniforme* and *Coelastrum*. Whereas in Nageen *Tetradon*, *Budorina*, *Coelastrum*, *Scenedesmus*, *Selenastrum*, *Chlorella*, *Cosmarium*, *Pediastrum* and *Ankistrodesmus* were the main dominant forms.

A number of green algal genera like *Pediastrum*, *Scenedesmus*, *Tetradon*, *Coelastrum*, *Selenastrum*, *Cormarium* etc., have been reported to be abundant in eutrophic waters (Hutchinson 1967). All these genera were found in the present lakes and formed major part of the green algal plankton. *Volvoxales*, *Ulotrichales* and *Oedogonales* contributed very little to the Chlorophycean plankton in the present lakes, *ulotrichales* and *Oedogonales* being totally absent in the phytoplankton of Nageen and Manasbal respectively. *Volvoales* with *Chlamydomonas* as the dominant component has been reported to be the chief component if phytoplankton from the polluted areas of Dal lake
Yousuf and Parveen (1990). In the present lakes Volvocales did not contribute much to the green algal plankton and further the group was dominated by Pandorina instead of Chlamydomonas, the latter being completely absent.

Griffes (1923), Zafar (1964) and Munawar (1970) attributed higher percentage of Chlorococcales to higher oxygen concentration in water. The present observations are in conformity with these findings. The hydrogen-ion concentration in the present lakes also seems to favour the population of Chlorococcales. Vanoye (1934) attributes the paucity of desmids in Belgium waters to eutrophication. However, the present data show that the two lakes reveal a significant desmid population inspite of advanced trophic nature. It seems that some of the desmid species can withstand certain degree of eutrophication (Parveen 1988).

When the Chlorophycean data of the two study lakes are compared and Nygaard's Chlorophycean index applied to the data it becomes clear that Nageen lake with the index value of 1.37 is at a higher trophic level than the Manasbal lake.
The dynamics of blue green algae in the fresh water plankton has been discussed by a number of workers (Fritsch 1907, Prescott 1939, Ganapathi 1940, Singh 1960; Zafar 1967; Venkateshwarlu 1970; Munawar 1974, Khan & Seemayya 1982). Most of these workers have related the appearance of blue greens with the eutrophication process. The blue green algae ranked third in respect of population density in Manasbal as well as Nageen lake. In both the lakes the group was represented by seven taxa of which *Merismopedia punctata*, *M. elegans* and *Microcystis aeruginosa* were the main contributors to the total blue green algae population. According to Rawson (1956) eutrophic lakes are characterized by *Anabena* & *Microcystis*. Sawyer (1966) has considered *Microcystis* as an indicator of eutrophy. Khan (1982) reported *Oscillitoria* from polluted areas of Dal lake, similarly Parveen (1988) and Yousuf & Parveen (1990) reported the dominance of *Oscillitoria* in polluted waters. In the present lakes although *Oscillitoria* was present it occurred very rarely and its contribution to the Cyanophycean plankton was insignificant. Instead *Merismopedia* sps. and *Microcystis aeruginosa* were the main contributors. Thereby indicating that the lakes have advanced towards eutrophy but are not polluted.
Gonzalves & Joshi (1946) and Hutchinson (1957) correlated the dominance of Cyanophyceae with higher temperature of water. The present data also indicate that the temperature of water has a positive relationship with Cyanophyceae. Rao (1953) has noted that oxygen deficiency favours the blue greens. However, the present data are contradictory to this view as generally the water having low oxygen concentration contained low blue-green populations. It seems that the Cyanophycean plankton in itself contributes to and therefore influences the oxygen concentration in water.

Generally blue-greens have been reported to acquire peak density during the warmer period e.g. Cole (1978); Khan (1978); Wanganeo (1980); and Khan & Seenayya (1983) reported predominance of the group during summer and Kant and Kachroo (1973,74); Wani (1983) reported the peak during autumn. During the present study the group recorded peak density in Manasbal during spring-summer and in Nageen lake summer-autumn. As per Nygaard's Cyanophycean index two lakes are having similar trophic status.

Phytoplankton dominated by euglenophytes is characteristic of hard water lakes (Palmer 1962)
containing significant quantities of organic matter (Hutchinson, 1967). The euglenoid population in the present lakes was insignificant as compared to other lakes, both qualitatively and quantitatively. The group was represented by 4 taxa in Manasbal lake of which *Euglena acus* was the most dominant. In Nageen lake the group included only 2 taxa viz., *Euglena acus* and *Phacus makii* which were almost of equal importance. Kaul (1986) recorded summer peak of Euglenoids in surface waters in Anchar lake, whereas in bottom water she recorded the peak during spring-summer. Kant and Kachroo (1977) on the other hand reported 2 peaks in Dal lake during spring and autumn. In case of Manasbal the group recorded peaks in spring and autumn. In Nageen on the other hand peak population was recorded in spring-summer. According to Hutchinson (1967) and Venkateshwarlu (1976) *Euglena* and *Phacus* are characteristic of waters having significant quantities of organic matter. Since the quantum of organic matter in the present lakes was low the population of both these euglenoids was very low throughout the year.

Chrysophyceae was represented by a single species *Dinobryon* in the two lakes and contributed
only very small amount of phytoplankton biomass. The species occurred in the water bodies generally at a time when other groups were either gradually decreasing in their numbers or had acquired the least population. This is in conformity with Pearsall(1932); Hutchinson (1944) and Rodhe (1948).

Just like Euglenophyceae and Chrysophyceae the Dinophycean population in the lakes was very low and was contributed by 3 species only. Maximum density of the group was attained during late spring - early summer. Ceratium has been classified as a mesotrophic form (Rawson 1956), whereas Peridinium is considered as a eutrophic plankter (Sommerfield et al 1975). Presence of both Ceratium hirundinella & Peridinium pusillum in Manasbal lake are indication of the advanced trophic level of this water body. The rareness of Ceratium hirundinella and presence of Peridinium pusillum in Nageen lake indicate that this water body is relatively advanced in its trophic level than Manasbal.

Planktonic animals are of paramount importance in freshwaters because of their role in transferring the energy captured by planktonic plants to the other animals (Michaël 1985). Their community structure and seasonal abundance are shaped by the various environmental factors and the densities. There is sufficient evidence to show
that the population of the zooplankton takes a bimodal pattern. Yousuf (1989) in a review on the zooplankton population in North Indian waters points out that the two peaks of zooplankton population in the mountainous parts of the north India are attained during late winter - spring and in autumn. During the present study also the zooplankton community recorded bimodal pattern in both the lakes thereby confirming the earlier reports. However, when the seasonal cycle at different sites in the two lakes is compared the pattern of monthly fluctuations show variations. This is in conformity with the conclusions of Pennak (1946) who reports that zooplankton annual & seasonal cycles are highly variable in nature from lake to lake and from year to year within the same lake. Generally the shallower areas of the two lakes recorded higher zooplankton population than the open, relatively deeper areas. Similar observations have been made by Yousuf & Qadri (1980).

The species composition and abundance of zooplankton communities are altered by advancement in the trophic condition of water body with typically an increasing predominance first of Cyclopoidea and then of Rotifers and Cladocera (Patalas, 1975; Gannon, 1981; Chapman et al 1985 and Balkhi, 1988). In the present lakes the order of dominance with number of species was rotifer > Cladocera > Copepoda. Same trend was also noticed in the population density of the three zooplankton groups in these lakes.
The rotifers are the most important soft-bodied invertebrates in the fresh water plankton (Hutchinson, 1967). The ecology of planktonic rotifers has been extensively studied (Zankei and Ponyi, 1970; Gophen, 1972; Anderson et al, 1977; Elliot 1977; Yousuf & Qadri, 1981). During the present investigation 29 rotifer taxa were recorded from Manasbal lake, whereas in Nageen lake 32 taxa were recorded. As is true for all fresh waters the group was dominated in both the lakes by species belonging to order Ploima. Out of 29 taxa recorded in Manasbal 27 belonged to order Ploima and only 2 belonged to order Flosculariaceae. In Nageen lake order Ploima was represented by 29 taxa, whereas two species belonged to order Flosculariaceae. Here class Belloidia was also represented by one species.

Generally the zooplankton community at any time is constituted by several, often five to eight, dominant species belonging to different groups and a number of rarer forms (Goldman and Horne 1983). The rotifers commonly found during the present study included Asplanchna priodonta, Brachionus angularis, B. bidentata, Keratella cochlearis, K. quadrata, Polyarthra vulgaris and Notholca acuminata, almost all of which are typical eutrophic forms (Hutchinson 1957, Pejler 1964, Chengath et al)
1973; Hakkari 1977 and Sladecek 1983). Yousuf and Qadri (1981) recorded Polyarthra, Synchaeta, Asplanchna, Monostyla and Keratella to be the perennial and eurythermal plankters and Brachionus, Filinia, Anuraeopsis and Nothalca as Stenothermal forms. Sladecek (1983) recorded perennial behaviour in case of Brachionus angularis, Keratella cochlearis and Polyarthra vulgaris. During the present investigation Branchionus Keratella, Monostyla and Polyarthra contributed the rotifer plankton throughout the period, whereas Anuraeopsis, Colurella and Nothalca showed seasonal behaviour.

Cladocera was the second largest group in the lakes under study both in respect of number of species recorded and the population abundance. The group was represented by 13 species in Manasbal lake and by 8 species in Nageen lake. In both the lakes Chydoridae was the best represented family having 9 species in Manasbal and 5 species in Nageen. In most of the aquatic systems in valley Chydorus sphaericus has been reported to be one of the dominant Cladocerans (Yousuf & Qadri 1981; Yousuf et al, 1983, Balkhi 1987). The present data are in conformity with these findings. In both the lakes Chydorus, Sphaericus was one of the main contributors of the Cladoceran plankton and
occurred throughout the year. In case of Manasbal lake other perennial forms included *Graptolebris testudinella* and *Ceriodaphnia reticulata*. In this lake *Daphnopsis brachurum* was a significant member of Cladoceran plankton during most parts of the year except during the coldest period. *Bosmina longirostris* was restricted in its occurrence to the cooler period i.e. January to April in both the lakes. *Camptocercus rectirostris* showed varied seasonal abundance in the two lakes. Whereas it was absent only during summer months in Manasbal lake. In case of Nageen lake it occurred only a few times during the whole study period. *Daphnia laevis* was rare in both the lakes.

Copelod plankton was represented by 6 species in Manasbal and 2 species in Nageen lake the group recorded the least population size in comparison with other two groups. When the copepod population and species composition of the two lakes is compared it becomes very clear that the Nageen lake is having a relatively higher trophic status than Manasbal lake. Whereas there are 6 copepod species present in Manasbal lake only 3 were recorded from Nageen lake and their seasonal abundance was also very low as compared to their counterparts in the Manasbal lake. Diaptomids, which are regarded to be characteristic feature of
oligotrophic & mesotrophic waters, are completely absent in Nageen.

According to Hutchinson (1967) species of Cyclops appear generally in cooler season in the north temperate zone, whereas those belonging to Mesocyclops are more abundant in summer. The present data are in agreement with Hutchinson's views. In both the lakes C. vicinus was more abundant during the winter period and avoided the warm waters of the summer. Mesocyclops leuckarti on the other hand avoided the cooler water.

According to Cyanophycean index both the lakes were found to be on similar trophic status with a value of 0.75 in both the lakes. While Chlorophycean index showed Nageen to be on higher trophic level than Manasbal with values of 1.1 and 1.37 in Manasbal & Nageen respectively. According to Euglenophycean index Manasbal (0.2) was slightly on higher status than Nageen lake (0.1).

The similarity index for both phyto & zooplankton of the two lakes - Manasbal & Nageen determined according to Marezewski & Steinhaus (1957) showed the qualitative
similarity with $S$ values as given below:

<table>
<thead>
<tr>
<th>Phytoplankton groups</th>
<th>$S$ values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacillariophyceae</td>
<td>55.9</td>
</tr>
<tr>
<td>Chlorophyceae</td>
<td>35.5</td>
</tr>
<tr>
<td>Cyanophyceae</td>
<td>75.0</td>
</tr>
<tr>
<td>Chrysophyceae</td>
<td>100.0</td>
</tr>
<tr>
<td>Dinophyceae</td>
<td>33.3</td>
</tr>
<tr>
<td>Euglenophyceae</td>
<td>66.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zooplankton groups</th>
<th>$S$ values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kotifera</td>
<td>46.3</td>
</tr>
<tr>
<td>Cladocera</td>
<td>16.7</td>
</tr>
<tr>
<td>Copepoda</td>
<td>33.3</td>
</tr>
</tbody>
</table>