CHAPTER - II
PLANKTON

The seasonal variation in the numerical abundance of phyto and zooplankters are given in Figs. 12-17.

A. PHYTOPLANKTON
RESULTS

The density of phytoplankton at station I (Table. 19 Fig 12) ranged from 1000 to 22932 m\(^{-3}\) (November and May) and the major taxa were Cyanophyceae, Bacillariophyceae, Dinophyceae and Chlorophyceae, among which the dinophycean members were only sparsely represented. Chlorophyceae (green algae) dominated the phytoplankton community at station I forming 58.86% followed by Bacillariophyceae (diatoms) 26.88%. Cyanophyceae (blue green algae) consisted of 13.45% and Dinophyceae 0.81%. The density of phytoplankton was at its maximum during the pre-monsoon season (43801 m\(^{-3}\)) and the minima were recorded in the post-monsoon period (32065 m\(^{-3}\)). As depicted in the figure three monthly peaks of the density of phytoplankton was noted, one in May (22932 m\(^{-3}\)), one in June (18300 m\(^{-3}\)) and another one in January (19734 m\(^{-3}\)). It can be observed that the peaks during May and June consisted mainly of the species...
Spirogyra where as Chlorophyceae and Bacillariophyceae were dominated during January.

Cynophyceae (blue green algae) showed maxima during February (3241 m⁻³), Baccillariophyceae (diatoms) during January (9600 m⁻³) and Chlorophyceae (green algae) showed two peaks, one in May (17066 m⁻³) and another in June (18000 m⁻³). The density of blue green algae was at its maximum during the pre-monsoon season (8073 m⁻³) and the minimum were noted during the post-monsoon period (2600 m⁻³). Diatoms showed maxima during the pre-monsoon period (10047 m⁻³) and the minima during the monsoon season (6699 m⁻³). Green algae showed monsoonal peak (26499 m⁻³) and a fall during the post-monsoon period (15865 m⁻³). In chlorophyceae, Spirogyra and Microspora were the dominant species encountered where the former represented in seven samples and the latter in five samples. Navicula was the dominating species of diatom which represented in seven samples. In blue-green algae, Phormidium was the dominating form which represented six sampling stations. The density of Spirogyra sp. was high in June (18000 m⁻³) and was low during October. Microspora showed maximum during January (2667 m⁻³) and minima during December (333 m⁻³). The density of Navicula sp. was high during January (5333 m⁻³) and low during June (300 m⁻³). Phormidium sp. showed maxima in May (1600 m⁻³) and the minima during the month of July and December (1000 m⁻³).
At station II (Table. 20), Bacillariophyceae dominated the phytoplankton comprising of 46.72%. The other taxa such as Cynophyceae, Dinophyceae and Chlorophyceae shared the rest of the population and the annual percentages were 25.78%, 0.98% and 26.52% respectively. The numerical density (Figure. 13) was in the range of 2616 to 40900 m\(^{-3}\) (October and May). Dinophyceae represented by Ceratium sp. appeared only during July. The density of phytoplankton was at its maximum during the pre-monsoon season (98933 m\(^{-3}\)) and the minima were recorded in the post-monsoon period (27747 m\(^{-3}\)). As depicted in the figure two monthly peaks of the density of phytoplankton was noted, one in April (32800 m\(^{-3}\)) and another one in May (40900 m\(^{-3}\)).

Cynophyceae showed the maxima during the pre-monsoon period and the minima during the monsoon season. The density was high during January (11666 m\(^{-3}\)) and low during May (834 m\(^{-3}\)) (Table. 20). Among the blue green algae Phormidium ambiguam and P. truncicola were found during ten months and their density was high during January. Bacillariophyceae (diatoms) showed dominance at all the eight months except during September, November, December and January and the density reached the peak during May (69.03%). Relatively higher values were noted during the pre-monsoon and low values during the post-monsoon season. Among the diatoms, Navicula sp. and Diatoma sp. were the dominating species. Their number was high in May.
(Table 20). Cymbella sp. showed sparse representation. Chlorophycean members dominated during February, September, November and December constituting 38.63%, 50%, 59.78% and 53.66% respectively and the maximum density was observed during the pre-monsoon period (23866 m\(^{-3}\)). Chlorophyceae showed maxima during May (11833 m\(^{-3}\)) and minima during October (800 m\(^{-3}\)). Microspora sp. and Spirogyra sp. were the most abundant species of Chlorophyceae and was found during nine and ten months respectively. (Table 20). Closterium sp. represented six months and was abundant in May (7333 m\(^{-3}\)). Microspora sp. showed maxima during January and Spirogyra sp. during the month of April. Both species showed maximum density during the pre-monsoon period.

The numerical density of the algae at station III ranged from 1983 to 48631 m\(^{-3}\) (October and May) (Figure 14, Table 21). As represented in the figure two peaks of phytoplankton were observed, one in March (38500 m\(^{-3}\)) and another one May (48631 m\(^{-3}\)). The algal community exhibited more or less uniform distribution of the representative population of the three major taxa. Cyanophyceae and Bacillariophyceae showed more or less similar proportion (37.48% and 36.65%) whereas Chlorophyceae was less abundant than the other taxa (25.87%). The density of phytoplankton was at its maximum during the pre-monsoon season (121299m\(^{-3}\)) and the minima were observed in the post monsoon period (26185 m\(^{-3}\)). In the seasonal occurrence, a predominance of
cyanophycean species was noted during April (68.92%), but during October the diatom population was exuberant constituting 85.73%.

The density of Cyanophyceae was high in March (16000 m$^{-3}$) and absent during October. Blue green algae showed the maxima during the pre-monsoon period (47600 m$^{-3}$) and the minima during the post-monsoon season (9834 m$^{-3}$). Blue green algae were dominated during April, June and January constituting 68.93%, 66.67% and 47.62% respectively. Among Cyanophyceae, Lyngbya sp. and Oscillatoria sp. were the dominating taxa. The density of Lyngbya sp. was high during April and of Oscillatoria sp. was low during March. Phormidium truncicola represented seven months and the monthly maxima was observed during May (10100 m$^{-3}$).

The total density of phytoplankton at station IV varied from 1500 to 39668 m$^{-3}$. The diatom population outnumbered the cyanophycean, dinophycean and chlorophycean populations and it contributed as much as 66.32% of the annual density. Cyanophyceae contributed 15.24%, Dinophyceae was 0.24% and Chlorophyceae, 18.2%. The numerical density of diatom was more during the post-monsoon months when it was indomitable, with the share of 80.0%, 70.54%, 100% and 91.3%. Phytoplankton showed maxima during pre-monsoon season (62887 m$^{-3}$) and minima during the post-monsoon period (28267 m$^{-3}$). As depicted in the figure (15) three monthly peaks of the density of phytoplankton was
noted, one in March (39668 m\(^{-3}\)), one in June (20400 m\(^{-3}\)) and another one in January (23367 m\(^{-3}\)). It can be observed that the peaks during March and January consisted mainly of diatoms and Chlorophyceae were contributed major share during June.

The density of blue green algae was high during March (6235 m\(^{-3}\)) (Table. 22) and was not present during the first three post-monsoon months. Cyanophyceae showed dominance only during May (48.25%). Phormidium truncicola was the most abundant species represented in six months. The density of P. truncicola was high during March (3400m\(^{-3}\)). Maximum density of blue green algae was observed during pre-monsoon period (13165 m\(^{-3}\)). Bacillariophyceae showed dominance at all the nine months except during May, June and September. Diatoms showed a peak density during March (31732 m\(^{-3}\)) and the seasonal peak during pre-monsoon period (44458 m\(^{-3}\)). Navicula sp. was the prominent species (36.77%) in Bacillariophyceae. It represented nine months and showed peak density during January (16000 m\(^{-3}\)). Chlorophyceae was dominant during June and September and their percentage composition was 58.82% and 41.69% respectively. The density was maximum during monsoon period (18000 m\(^{-3}\)) and minimum during post-monsoon season (2184 m\(^{-3}\)). Among the Chlorophyceae, Spirogyra sp. was the most dominant form which represented seven months and showed maxima during June (9500 m\(^{-3}\)). Ceratium sp. was the only
dinophycean and was showed sparse representation during July.

The cell counts of phytoplankton at station V fluctuated from 1667 to 36266 m$^{-3}$. The annual density was shared by the three major taxa such as Cyanophyceae (13.83%), Bacillariophyceae (47.23%) and Chlorophyceae (38.94%). The diatom population peaked the density (Table 23) though the margin was not wide. The density of phytoplankton was at its maximum during the pre-monsoon season (54598 m$^{-3}$) and the minima were noted during the monsoon period (33466 m$^{-3}$). Two monthly peaks in the total density was observed, one in February and another one in August (Figure. 16).

The density of Cyanophyceae was at its maximum during the pre-monsoon season (12566 m$^{-3}$) and the minimum was noted during the post-monsoon period (1433 m$^{-3}$), where as maximum monthly peak (Table. 23) was during February and was absent during December and January. Blue green algae was dominant during May and July (81.25% and 59.99%). Phormidium truncicola was the dominant species and which showed peak density during May (3150 m$^{-3}$). Bacillariophyceae showed maxima during post-monsoon (27067 m$^{-3}$) and minima during the pre-monsoon period (11398 m$^{-3}$). The numerical density was high during August (Table. 23) and was absent during the months of May, June and July. Diatoms were dominant during April, August, October, November and January.
and their percentage composition was 71.18%, 86.90%, 66.04%, 76.81% and 100% respectively. *Navicula* sp. was the dominant species and which represented eight months. Green algae showed maxima during the pre-monsoon period (30634 m⁻³) and minima during monsoon season (7150 m⁻³). Where as the monthly increase was observed during February (Table. 23). *Chlorophyceae* was the dominant taxa during February, March, June, September and December and the percentage composition was 70.59%, 47.06%, 62.49%, 52.17% and 68.42% respectively. *Spirogyra* sp. was the most dominant species and which represented nine months. The peak density was noted during February (18133 m⁻³).

At station VI the density of phytoplankton fluctuated between 2609 m⁻³ and 50700 m⁻³. *Bacillariophyceae* followed a similar type of dominance (Table. 24) and it contributed 47.38% of the annual density. The rest was shared by *Cyanophyceae* (23.04%) and *Chlorophyceae* (29.58%). The cell count of phytoplankton was at its maximum during the pre-monsoon season (74201 m⁻³) and the minima were recorded in the post-monsoon period. *Cyanophyceae* and *Chlorophyceae* contributed the major shares in the pre-monsoon peak of the phytoplankton (Table 24). Phytoplankton showed two monthly peaks, one in March (30401 m⁻³) and another one in August (50700 m⁻³).

Blue green algae showed the maxima during pre-monsoon season (28934 m⁻³) and the minima during post-
monsoon period (3667 m⁻³). Cyanophyceae was predominantly represented during March, April, May and June and their percentage composition was 42%, 38.89%, 61.76% and 56.52% respectively. The monthly peak was observed during March (12767 m⁻³) and was absent during October and December. Phormidium ambiguum was the most abundant species which showed a monthly peak during May (Table 24). The density of diatom was maximum during the monsoon season (45099 m⁻³) and minimum during post-monsoon period (15750 m⁻³). The major constituent of the monsoonal peak was Diatoma sp. and the quantity of which was 20583 m⁻³ during August. Cyanophyceae was the dominant group during January, February, August and November and their percentage composition was 43.24%, 57.59%, 88.39% and 50% respectively. The dominant groups of Cyanophyceae were Phormidium ambiguum, Oscillatoria neglecta and Lyngbya aerugineoaeerulea (Table 24) Chlorophyceae showed seasonal peak during pre-monsoon (25234 m⁻³) and the monthly hike was noted during March (12501 m⁻³). Green Algal dominance was observed during July, September, October and December and constituted 78.31%, 74.68%, 64.28% and 58.34% respectively. Spirogyra sp. was the most abundant member of the taxa and was represented throughout the year in the phytoplankton.
RESULTS OF STATISTICAL ANALYSIS

The density of phytoplankton during the twelve month period at six sampling stations were compared to find out the correlation values with water temperature, dissolved oxygen content, alkalinity, hardness, waterflow, phosphate, nitrate, silicate, rainfall, BOD and total dissolved solids (TDS) and the results are given in Table 33. Phytoplankton community showed a positive correlation with water temperature and the values were significant at 5% level at station II and 10% level at station III. A similar trend of positive correlation with dissolved oxygen was observed in the first five sampling stations. Phytoplankton and alkalinity showed positive correlation in majority of the stations except at station V. At stations II and III there existed significant levels of positive correlation and was a 10% at station II and 1% level at station III. Hardness showed positive impact at the first three sampling stations and lesser degree of negative impact at the last three sampling stations with the phytoplankton. In the first two stations significant levels of correlation was noted and the values were at 10% and 5% levels respectively. Flow of water showed negative correlation with phytoplankton at the first three stations and at station VI and the values were positive at station IV and V. Phosphate content showed positive correlation with phytoplankton in majority of the
sampling stations. Positive correlation at 10% level at stations II and III were the only significant values observed among the stations. Positive correlation was noted between nitrate content and phytoplankton at station II, IV, V and VI. The correlation values at station IV and VI showed higher levels of significance. Influence of silicate content on phytoplankton was negative in almost all the sampling stations except a low value of positive correlation at station II. The impact of rainfall with phytoplankton was positive at station II and IV and showed negative correlation at the rest. The positive correlation between BOD and phytoplankton was at 10% and 5% levels of significance at station II and III respectively. Total dissolved solids showed positive correlation at 2% and 5% level at station II and III respectively. TDS showed negative correlation at station IV and V and was not significant.

The dissimilarity index values of phytoplankton population between stations during the twelve months period, and the annual mean are given in the Table. 34. Highest degree of dissimilarity of Euclidian distance was noted between station III and V whereas the highest similarity was noted in two combinations one between stations I and II and the other between station I and IV (Table. 34). Post-monsoonal peak of dissimilarity (0.88) was noted between station IV and V and highest similarity was observed between station II and VI (0.12) during post-monsoon period. The
fluctuations in the values of dissimilarity index between station I and II ranged from 0.004 to 0.94 (August and April). The index value between station I and III varied between 0.01 and 0.95 (October and March) and the dissimilarity is maximum during pre-monsoon period (0.51) and maximum similarity existed during post-monsoon period (0.13). A peak dissimilarity was observed (1.00) during March between station I and IV. The dissimilarity was high during pre-monsoon (0.35) and low during monsoon period (0.23). Phytoplankton showed maximum dissimilarity during post-monsoon period (0.79) and the similarity was higher during pre-monsoon season (0.34). The index value ranged from 0.07 to 1.00 (January and August) between station I and station VI. The minima and maxima between station II and station III of the index value ranged from 0.02 to 0.89 (October and December). The combination between station II and station IV showed minima during February and maxima during April. Highest dissimilarity between station II and V was noted during October and highest similarity during March. The comparison between the values of station II and station VI showed maxima during August (0.995) and minima during January (0.05). Comparatively wide range was observed between the seasonal averages, viz, 0.75 during monsoon period and 0.12 during the post-monsoon period. The seasonal maxima was noted during monsoon period. A similar trend between station III and station V of highest dissimilarity
during May and July and similarity during June and August (Table. 34). Seasonal average was moderately higher during the pre-monsoon period. The dissimilarity between station III and station VI showed maxima during September (0.99) and the peak seasonal value showed during the monsoon period (0.77). Highest similarity between station IV and station VI was noted during September (0.003) and the seasonal value showed maximum during pre-monsoon (0.19). The dissimilarity index value of phytoplankton between station V and VI ranged from 0.03 to 0.89 (June and October). The value showed maximum dissimilarity during post-monsoon period.

The species diversity indices of Shannon Wiener (H), evenness index (J) of Pielou and dominance index of Margalef (Ma) are given in Table. 35 (a,b,c,d). The coefficient of variation was very high (Table. 35 d) in the first station because of the ranges of diversity indices were wide. The diversity pattern at station I was distinct from that of the other sites except at station IV. The increase in the H is equivalent to the increase of the evenness index. The species distribution in station I during October showed the highest value of evenness index (Table. 35b) and moderately higher value of diversity index. The peak value of H in station I noted during February with higher value of evenness index. The range of variation of Margalef index was very high at station III and the peak value was observed during March (6.32) which attributed to
the higher value of $H$. Seasonal averages of Shannon-Wiener index values were maximum at station III, IV, V and VI during post-monsoon period and were the minimum at station II, III, IV and VI during post-monsoon period. At station I the seasonal mean average was higher during post-monsoon and lower during monsoon period whereas at station II maxima was noted during monsoon period. The minimum seasonal average was observed during monsoon period at station V. The annual average values were maximum at station III and minimum at station V (Table. 35d).

The seasonal mean of evenness index values showed maxima at station I, II and III during post-monsoon period and the minimum at station II, III, IV, V and VI during pre-monsoon period. At station V and VI the maximum evenness was noticed during the monsoon period. At station I, a similar trend of minimum evenness values were observed during the pre-monsoon and monsoon periods.

At the last four sampling stations Margalef index showed seasonal dominance during pre-monsoon period and the minimum was observed at station II, III and IV during post-monsoon period. The seasonal mean was high during monsoon at station II and during post-monsoon period at station I. Margalef index values were minimum during pre-monsoon at station I and minimum values at station V & VI noticed during the monsoon period (Table. 35c). The annual mean values were higher at station III and low at station I.
DISCUSSION

The phytoplankton density in the Kallada River exhibited an increasing trend from station I to station III and at station IV and V it dropped down and the rise was noted again at station VI. The concept of heterotrophy to autotrophy (Vannote et al., 1980) from high order to lower stream is evident with the density of phytoplankton. Among the six representative stations, the third station exhibited the highest phytoplankton density (20.83%) and the minimum density was recorded at station I (12.45%). The density of phytoplankton showed a decreasing trend from pre-monsoon to post-monsoon period in almost all stations except at station V where it was minimum during monsoon period. The variation in the percentage composition on the numerical abundance was less at station I when compared to the rest of the stations. Though the pre-monsoon period recorded the highest density of phytoplankton (38.51%) the fluctuations between seasons was less prominent except at station II and III where it was distinctive with the highest percentages (58.17% and 63.73%) during the pre-monsoon and the highest density of phytoplankton had been reported from Mahandi River (Philipose, 1959) during February and May, but in the Hoogly River it was recorded during winter, (Roy, 1955). In the River Ganges the phytoplankton maxima occurred both in winter and summer (Pahwa and Mehrotra, 1966). High peaks of
algal development had been reported from the River Moosi (Venkateswarlu, 1969).

In the Kallada River Bacillariophyceae formed the bulk of the algal population (45.2%) in all the stations and the Chlorophyceae stood next (33%). Similar condition of diatom domination in the River Jamuna (Chakrabarty et. al., 1959); the River Ganges (Lakshminarayana, 1965; Pahwa and Mehrotra, 1966), in the Mississippi River (Richard, 1931), the River Moosi (loc. cit.), the torrential waters in the Indian uplands of the Garhwal region (Nautilyal Prakash, 1985) and in the Venezuelan rivers (loc. cit.) have been documented. However, station I was characterised by low diatom richness this may probably a result of nutrient limitation, less calcium and chemical enrichment. Similar observations were made by Chessman (1986) in the mountainous torrential areas of an Australian River system with least human disturbances.

Significant positive correlations between the phytoplankton density and water temperature, alkalinity, total hardness, phosphate, nitrate, B.O.D. and total dissolved solids. Such a similar positive relationship has been reported by Chessman (1986). The increase in the density of phytoplankton at station II and III were reflected in the correlation values. Relatively significant levels of correlation exhibited in these sampling stations indicated the direct relationship with temperature.
Rainfall and waterflow tends to have inverse relationship with phytoplankton at Kallada River. This may be due to the influx of turbid water with relatively high flow rate to the system which is unfavourable for phytoplankton production. The density of phytoplankton decreased either during the south-west monsoon or during the north-east monsoon period and the maximal density was mostly noted during the pre-monsoon period. Welch (1952), Roy (1955) and Legare (1957) observed that the adverse effect of turbidity on plankton production is due to the ‘blanketing effect’ of suspended materials interfering with the photosynthetic activity of the phytoplankton. The reduction of phytoplankton population with increase of flow rate has been reported by Swale (1964). This is presumably because the plankton population are swept away faster than they can reproduce.

The low dissimilarity index between station I and II indicated the similar nature. These stations are located in mountainous, forested areas and least disturbed by human activity. Among the six sampling stations station V exhibited maximum dissimilarity with other stations indicated considerable amount of human activity on the system. This station was experienced by low phytoplankton density and which may be due to the routine collection of sand and other human disturbances. The increase in the phytoplankton population density of the station III may be due to the impact of temperature, phosphate and B.O.D.
whereas at station V the influence of these factors were less significant. Such relationship of temperature and other factors on plankton density have been reported by Chakravarti et al., (1959) from Jamuna River.

The coefficient of variation of Shannon Wiener index \((H)\), evenness index \((J)\) and Margalef index \((d)\) was very high at station I and station IV. The factors attributed to the variations in the species diversity are the natural and man-made changes in the occurrence and frequencies of the different species of phytoplankton. In the two regions the fluctuations are mainly due to the natural and man made changes respectively. Relatively higher variation at station I also may be due to small sample size compared to the other five stations. The variation in diversity at all the stations is the result of the spatial variation in species which is called habitat diversity (Sanders, 1968). The peak value of \(H\) in station I during February can be explained on the basis that the incidence of species (no. of species -17) in the collection is more than that occurred during October and the evenness index too is higher though not maximum. Similar dependence of diversity index on the species richness has been reported for the phytal animal communities (Edgar 1983). The species distribution in station I during October showed the highest value of evenness index consequent on the uniform occurrence of all the five species in equal numerical density. This is
in accord with the principle of the evenness component of diversity (Pielou, 1966). For a given number of species, the diversity of a collection is at maximum when the individuals are distributed among the species as evenly as possible. Thus, in a community the evenness index will be at the maximum when the composition of species is equally abundant. The dominance of Spirogyra sp. during June at station I reduced the evenness value to a monthly minimum and the diversity value also reported minimum (no. of species-2). The relatively higher diversity index of Margalef during January at station I may be due to the sample size. This is in agreement with the view of Sanders (1968) that Margalef's index is influenced by sample size. The major portion of the sample size was contributed by Navicula sp., Microspora sp., Diatoma sp., Spirogyra sp. and Oscillatoria limnetica. The increase in the Shannon-Wiener index is tantamount to the index of Margalef and Pielou (evenness index). This agrees with the results of Sanders (loc. cit.) that Shannon - Wiener has the functional attribute of being influenced by both the number of species present and how evenly or unevenly the individuals are distributed among the constituent species.

The two index values (H and J) reported maximum during September at station II (no. of species-15). The evenness index was very low in this station during May and is due to the dominance of Navicula sp. and Diatoma sp. (no.
of species 16). The value of Margalef's index is also high during May and was highest during April. Both sample size and species richness influenced the dominance index during April (no. of species-19). In the last four stations similar trend has been observed in the monthly maxima of diversity indices of Shannon-Wiener and Margalef and were during March, April, February and March at station III, IV, V and VI respectively. Relatively higher diversity index of Margalef at station III and VI in the respective months is due to the impact of both species richness and sample size. While at station V it was due to the influence of sample size. Higher value of Margalef index at station IV during April is related only to the species richness. This conflicts with the view of Sanders (1968). In this station the Margalef index is sensitive to species richness.

The evenness index value at station III reported maximum during November due to the even distribution of the six representative species. The phytoplankton species in this station (no. of species-16) during May exhibited low values of evenness which is due to the dominance of *Navicula* sp., *Spirogyra* sp. and *Phormidium truncicola*. The value of Shannon Wiener diversity index also low during this month indicated its influence on evenness index. Comparatively higher value of $H$ reflected in the high even distribution of phytoplankton at station IV during April (no. of species-15). The evenness was reduced to minimum during January due to
the dominance of two species viz: Navicula sp. and Diatoma sp.. Species richness at station V is relatively poor (no. of species-2) during July which in turn lead to high degree of evenness. Among the 6 species represented during December in this station, the dominance of Navicula sp. and Spirogyra sp. inturn resulted the lowering of evenness to minimum. At station VI July reported maximum evenness index value due to the even distribution of the five representative species. The evenness reduced to minimum during May in this station with the increase of Phormidium ambiguum and spirogyra sp. (1000 m^-2) and the highest density (3183 m^-2) respectively.

The depletion of zooplankters was noted during March, April, August October, and January. The major components of the zooplanktonic elements were copepods and copepod naupili and the other taxa such as Cladocera and nematoda appeared scattering. The occurrence of insect larvae was in fair numbers and the algaes dominated the insects. At station II the zooplankton population showed the maximum occurrence among the different stations and the annual density was 10917 m^-2. A total depletion of zooplankton was noted during July, August and December. The incidence showed higher values during the pre-monsoon season (8234 m^-2) and the drop during July and August, resulted in the decline during the monsoon period (500 m^-2). The prominent members of zooplankton were naupili, copepods and copepod naupili. Other groups such as nematodes and hydromedusae were
B. ZOOPLANKTON

RESULTS

The density of zooplankton in the Kallada River during the period of the present study was generally poor at all the representative sampling sites. Among the different sampling stations, at station II recorded the highest (32.13%) and station VI the lowest (10.83%). The total zooplankton density at station I ranged from 0 to 2500 m$^{-3}$. The post-monsoon and the monsoon seasons recorded the lowest (1000 m$^{-3}$) and the highest density (3133 m$^{-3}$) respectively. The depletion of zooplankters was noted during March, April, August October and January. The major components of the zooplanktonic elements were copepods and copepod nauplii and the other taxa such as Cladocera and Nematoda appeared sparingly (Table. 19). The occurrence of insect larvae was in fair numbers and the dipterans dominated the insects. At station II the zooplankton population showed the maximum occurrence among the different stations and the annual density was 15917 m$^{-3}$. A total depletion of zooplankton was noted during July, August and December. The incidence showed higher values during the pre-monsoon season (8234 m$^{-3}$) and the drop during July and August resulted in the decline during the monsoon period (500 m$^{-3}$). The prominent members of zooplankton were rotifers, copepods and copepod nauplii. Other groups such as nematodes and hydracarines were
recorded only during September, October and November respectively (Table. 20). The zooplankton density at station III constituting 15.24% of the total obtained in all the sampling stations. Seasonal maxima was observed during pre-monsoon period (5000 m$^{-3}$) and minima during post-monsoon season (949 m$^{-3}$). Monthly peak of the zooplankton was noted during May (Table. 21). The predominant taxa were copepods and nematodes. Copepods were present in large numbers during May only. Ostracodes and Chironomus larvae were showed sparse representation. (Table. 21). The density of zooplankton at station IV ranged from 0 to 1500 m$^{-3}$ and the pre-monsoon and the post-monsoon seasons recorded the highest (1843 m$^{-3}$) and the lowest (300 m$^{-3}$) density. The annual density of zooplankton percentage was 11.39%. The total depletion of the zooplankton was noted during March, August, November, December and January and the predominant taxa were copepods and copepod nauplii. (Table. 22). The numerical density of zooplankton at station V varied from 0 to 3532 m$^{-3}$ and was constituting 19.37% of the total obtained in all the sampling stations. Seasonal peak was noted during pre-monsoon period (6648 m$^{-3}$). The principal components represented were copepods, nauplii and nematodes and the incidence of other taxa such as rotifers, cladocerans and ostracods was less than other mentioned (Table. 23). The total density of zooplankton at station VI ranged from 0 to 1400 m$^{-3}$. Very low density of zooplankton was noted
constituting only 10.83% of the total obtained in all the sampling stations. Zooplankton showed maxima during pre-monsoon season \((3566 \text{ m}^{-3})\) and minima during monsoon period \((633 \text{ m}^{-3})\). A total depletion was observed during June, August, October and December. The predominant forms were copepods and copepod nauplii (Table 24).
DISCUSSION

Density of zooplankton in Kallada River was generally poor at all the six sampling stations. This general trend in the comparatively less abundance of zooplankton in rivers can be justified on the basis of the reports from other tropical rivers (Sanchez et al., 1985) of Venezuela. According to Fernando (1980a) the diversity of the zooplankton does vary on a more local scale; for example, rivers and streams in Sri Lanka carried half the number of species of near by ponds and reservoirs. This is in agreement with the low density of zooplankters observed at Kallada during the present study. Welcomme (1979) and Odum (1959) were also in the view that the flowing water is unfavourable for zooplankton.