CHAPTER VIII
BENTHIC INVERTEBRATES

RESULTS

In the Neyyar River (figs.46-50) st.V recorded the highest density of benthic invertebrates constituting 38.89% of the total and the minimum was encountered at st.IV (4.23%). The pre-monsoon recorded the highest mean density and the lowest was during the monsoon in almost all the sampling stations except at st.V. The minimum density at st.V was noted during post-monsoon period. The benthic invertebrates was mainly represented by nematodes, oligochaetes and dipteran larvae.

The faunal density at st. I (Table.70) fluctuated from 504 to 66530.m⁻² (December and February). The pre-monsoon recorded the maximum density (89775.m⁻²) and the minimum was during the monsoon (6845.m⁻²). Nematodes, oligochaetes and chironomus larvae were the dominant forms. Nematodes and oligochaetes recorded the maximum during February while chironomus larvae recorded the maximum during January (Table. 70). The other taxa such as copepods, water mites and ostracods were present only for a limited period. Insect larvae other than diptera showed sparse representation.

The density of benthic invertebrates at st.II ranged from 101 to 33317. m⁻² (December and January) and
contributed 9.35% of the whole sampling stations. The bulk of the population during January was constituted by chironomus sp. The highest density was recorded during the pre-monsoon (56165 m\(^{-2}\)) and the lowest during the monsoon period (10256 m\(^{-2}\)). Chironomus larvae and Oligochaetes were the predominant forms recorded. Oligochaetes were most abundant during February and March. Nematoda was the next dominant form which was represented ten months. Cladocera and ostracoda were present only during the pre-monsoon period. Mollusca represented once and that was during January. A total depletion of insecta other than chironomid larvae and odonate nymph was noted during post-monsoon period. Water mites appeared sparingly (table. 71).

The benthic invertebrates at st. III (Table. 72) ranged from 1867 to 115966 m\(^{-2}\) (May and March). The peak density during March was due to the highest occurrence of oligochaetes, ostracods, copepods, odonates, hemipterans and chironomus larvae. Seasonal mean showed the maximum during the pre-monsoon (232158 m\(^{-2}\)) and the minimum during the monsoon period (74888 m\(^{-2}\)). St. III recorded the second highest density constituting 37.1% of the total. The benthic fauna mainly composed of nematodes, oligochaetes, copepods, ostracods and insect larvae. Among insect larvae Chinonanus sp. was predominant and was represented in eleven months of the period. Insect larvae such as Ephemeraptera, Odonata and Hemiptera were recorded the maximal density during pre-
monsoon while water mites showed the maximum occurrence during post-monsoon period. Mollusca was present only during August (Table. 72).

The faunal density at st. IV varied from 604 to 7030 m$^{-2}$ (September and February). The mean density showed that the highest was recorded during pre-monsoon and the lowest during the monsoon period. (Table. 73). Nematods, oligochaetes and chironomus larvae formed the bulk of the faunal density. However, the abundance of insect larvae was less at st. IV (Table. 73) when compared to st. III. Nematodes recorded the maximum during January, oligochaetes during August and Chironomus sp. during February. Copepoda was the next dominant taxa represented in seven months. Hydracarina was present only during two months (September and October).

At st. V the density of benthic fauna ranged from 705 to 107297 m$^{-2}$ (July and March). The bulk of the density during March was constituted by oligochaetes and nematodes (Table. 74). The mean density showed that the maximum was recorded during the pre-monsoon and minimum during post-monsoon period (255648 m$^{-2}$ and 47795 m$^{-2}$). Nematodes and oligochaetes were the predominant forms and their densities were high during March. Among the five stations st. V observed a reduction in the abundance of insect larvae (Table. 74). Amphipods, isopods and tanaidaceans formed the bulk during the post-monsoon period along with nematodes and
oligochaetes. Both mollusca and water mites appeared in three samples each.

Correlation coefficients of benthic invertebrate density with nine hydrographical parameters are given in Table 80. Correlation coefficient values showed that the density of benthic invertebrates exhibited a positive relation with water temperature, phosphate, nitrate and silicate in almost all the stations, irrespective of few exceptions. Among the other parameters, hardness and rainfall showed a inverse relationship with benthic invertebrate density in all the sampling stations. Except at st. 2, all other stations showed positive correlation with water temperature. Dissolved oxygen content of the medium had a negative correlation at the first three stations and a positive relation was observed at the last two stations. The influence of water flow on benthic fauna was negative in both st. III and IV. Alkalinity of the medium exhibited a negative correlation at st. II and V, and positive correlation was noted at st. I, III and IV. The influence of hardness noted was below significant levels in all the stations. A positive correlation could be between phosphate content and the density of benthic invertebrates at station II to IV. Phosphate content showed a positive correlation at 5% level in st. III. Both st. I and V showed the lower values of negative correlation with phosphate. (Tabia, 200)
RESULTS OF STATISTICAL ANALYSIS

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above 1% level at st. II; 5% level at st. III and 10% level at st. IV with benthic invertebrates. Except at st. V, silicate content showed positive correlation with benthic fauna. The influence of rainfall on benthic invertebrates density was negative (Table. 80).

The dissimilarity index of benthic invertebrates between five stations are given in Table. 81. The Euclidean Distance exhibited the maximum between st. III and IV (0.69) and the second maxima was noted between st. II and III (0.68). Highest mean dissimilarity between st. II and III during post-monsoon and the lowest was also noted during the same season between st. I and IV (0.05).

The monthly variations of dissimilarity index between five stations are given in Table. 81. The index value ranged from 0 to 0.79 (November and January), and the mean values showed less variation between seasons. However, the maximum was observed during the pre-monsoon. The highest dissimilarity index value between st. I and III was noted during November (1.0) and lowest during May (0.09) (Table. 81). Euclidean Distance between st. I and IV varied from 0.001 to 1.00 (September and May) and the mean value exhibited maximum during the pre-monsoon period (0.41). Highest ED between st. I and V was noted during August (1.00) and the lowest during November (0.01). Three peak values of ED has been noted between st. II and III, one during October (1.0), one during November (0.999) and
another one during January (1.0). Seasonal mean between st. II and III showed the highest during post-monsoon and the lowest during monsoon period. The index value between st. II and IV ranged from 0.002 to 0.97 (September and January) and the mean showed less seasonal variations, however, the minimum (0.13) was noted during pre-monsoon. Euclidean distance between st. II and V was the highest during December (1.00) and lowest during November (0.01). The mean values showed less seasonal variation. The density of benthic invertebrates between st. III and V showed high dissimilarity during July (1.0) and low during March (0.01) and the seasonal mean showed that it was highest during post-monsoon and lowest during pre-monsoon (0.38). The ED between st. IV and V ranged from 0.008 to 1.00 (November and February, June and September). Generally, both st. III and V exhibited highest dissimilarity with the other stations (Table 8).
DISCUSSION

Benthic invertebrates.

The benthic invertebrate density in the Neyyar River exhibited an irregular pattern. The numerical density recorded was comparatively lesser in st.II (reservoir) and in the upper reaches of the reservoir (st.1). However, the population density of benthic invertebrates in Neyyar river was higher than those from Kallada River. The impoundment in the river had a greater impact on the abundance of benthic invertebrates. The reduction in the density at st.II may partly due to the deoxygenated conditions of the fairly matured reservoir. Such reduction or lowering of benthic biomass in the standing waters has been reported from the Bung Borapet Reservoir in Thailand (Junk, 1975); Lake George (Greenwood, 1976) and in the Varzea lakes from Amazonia (Reiss, 1977). Considerable increase in the benthic faunal density was noted at st.III. Both algae and other water vegetation are abundant in this canal and this may be responsible for the increase in the numerical density and taxa. The reason for this may be the provision of additional niches and large supply of food. Moreover, the vegetation provide refugia for the benthic invertebrates where the water velocity was considerably high. Similar increase of benthic invertebrates by the impact of algae and other vegetation by providing current refugia and food has been
observed by Spence and Hynes (1971) in similar regulated streams. According to Ward and Stanford (1979) macrobenthic diversity is generally reduced in impoundments compared with that of the stream above the reservoir, unregulated tributaries, or locations farther downstream. This fact is akin to the abundance and distribution of benthic invertebrates recorded from different regions of the Neyyar River. The peak density at st.V might be due to greater food availability and the increase of fine sediments. Minshall et al. (1983) pointed out such a greater food availability in the enriched river with biological processing no longer being completed in the water column. Periodical influence of rainfall and water flow might be attributed to the lesser abundance of the benthic invertebrates at st.IV.

The dominance of oligochaetes, nematodes and chironomus was observed in almost all the sampling stations in the present study. However, considerable reduction in the density of insect larvae exhibited at st.V indicated the marine influence. The occurrence of greater salinity tolerant forms like amphipods, isopods and tanaidaceans during post-monsoon period contributed greater proportion to the numerical density at the river mouth station. Benke and Meyer (1988) in their studies at black water river in the South eastern U.S.A. reported the similar kind of dominance of oligochaetes and chironomids in the sediments. Similarly
decrease of insect forms and relative increase of oligochaetes and other types feeding mainly on detritus downstream has been reported in Gombak stream (Bishop, 1973). In the reservoir station (station II) the density of chironomus was noted low when compared to the downstream station III, which was probably due to the reduction of oxygen content in the sediments of the reservoir. Similar decrease in the biomass of chironomus was observed in the Volta Lake, Ghana (Peter, 1972).

The benthic invertebrates showed peak occurrence during the pre-monsoon in all the stations of the river and may be due to the stable physical conditions accompanied by increased nutrient content and other ions in the medium. Statistical analysis gives further evidence to this fact that in almost all the stations phosphate, nitrate and silicate contents exhibited positive relationship with benthic invertebrate density. Correlation of the population densities of total benthic invertebrates against various parameters indicated that total load of phosphate and nitrate levels were strongly associated with high total population densities (Dudgeon, 1984). The lower density during monsoon attributed to the influence of rainfall indicated by inverse correlation. The rain "flushed out" causing declines in nutrient levels, sedimentary organics and deposit feeders (Dudgeon, 1983.a).
The density of benthic invertebrates showed close ED between st. I and IV, II and IV and I and II. The abundance and composition of benthic invertebrates up to a certain extent in the upstream stations may resulted in low dissimilarity between st. I and II. The occurrence of major forms such as nematodes, oligochaetes and chironomids in those regions marked similarity indicated that the sites with similar composition of the fauna occupy nearby positions and therefore, the ED became close (Jongman et al. 1987). The ED between st. III and IV (0.69) and between st. III and II was noted wide indicated highest dissimilarity. Moreover among the five stations st. III exhibited highest dissimilarity with other stations attributed to the diverse physical and chemical conditions of the site which provide diversity and peak occurrence next to st. V. Similarly st. V showed high dissimilarity with almost all the other stations. Considerable difference in the composition of fauna has been observed in the river mouth. The occurrence of certain high salinity tolerant forms like amphipods, isopods and tanaidaceans and the lesser abundance of insect larvae itself enough for such dissimilarity with other sites. In general both species composition and numerical abundance of benthic invertebrates have deterministic role on ED.