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THE FOOD AND FEEDING HABITS OF SOME FRESHWATER CURSTACEAN ZOOPLANKTON

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ABSTRACT

The food and feeding habits of some freshwater zooplankton of this region were studied. The filter feeders, cladocera (*Ceriodaphnia cornuta*, *Daphnia carinata*, and *Moina micrura)* and calanoida (*Heliodiaptomus contortus* and *Heliodiaptomus viduus*) were found to be strictly herbivorous, feeding upon detritus, phytoplankton and bacteria. Cladoceran exhibited a tendency towards fine detritus particles and smaller phytoplankton species while calanoids fed mainly on coarse detritus and larger algal species. Cyclopoid exhibited a variety of feeding types. *Mesocyclops leuckarti* and *Thermocyclops hyalinus* were highly predacious, *Microcyclops varicans* fed equally on plant and animal matters and *Eucyclops rubescens* was strictly herbivorous. Some evidence of food selection was found in calanoida, cladocera and cyclopoida. Blue green algae were definitely avoided by all species.

INTRODUCTION

Though filteration is the main mode of feeding in planktonic crustacea, a variety of other feeding habits has also been observed. Great majority are herbivorous and obtain their energy for growth and reproduction from first trophic level. The calanoids and cladocerans are filter feeder, feeding upon suspended materials comprising both phytoplankton and detritus (Hutchinson 1967). The majority of cyclopoids and some cladocera belonging to Haplopoda are siezers, some are omnivorous or herbivorous while most others are carnivorous (Fryer 1957).

The feeding ecology of crustacean zooplankton has been the subject of considerably advanced and sofisticated researches during recent years. However, majority of the works deal with filteration rate of cladocera and calanoida, relationship between body size and the size of food particle and the role of food ingested in the energy transformation etc., mostly under experimental conditions (Richman 1958, Rigler 1961, McMohan 1965, Burns 1968, 1969, Schindler 1968, Arnold 1971, Buikema 1973, Kersting and Leeuw-Leegwater 1976 etc.). The basic works on the qualitative and quantitative composition of food, its variation with age, season and habitat and relative importance of different kinds of food in the diet, specially of non-filter feeders, are fewer. Most of the important works done on the

food selection of filter feeders are on marine copepods (Marshall and Orr 1962, Conover 1966, Mullin 1966). Generally the works on freshwater species are scattered and yield diverse information (Nauwerck 1963, Tappa 1965, Saunders 1969, Anderson 1970, McQueen 1970, Confer 1971), except that of Fryer's (1957) who dealt in length the food of feeding habits of cyclopoid copepods. In India no such work has been carried out. The objective of the present paper is to report the quantitative and qualitative composition of food of some important crustacean zooplankton of this region.

Materials and Method

Zooplankton samples were collected mainly from Dhakuria lake, Indian Museum Pond and Monohar Das Pond of Calcutta during 1975-79 period. Sampling was always done between 9 to 11 A.M. Gut contents analysis was carried out on live animals shortly after their collection. The technique of Fryer (1957) was followed with some modifications. Single specimen was put in a drop of water on a glass slide and covered with a cover glass. By manoeuvring the cover glass, the specimen was positioned on its side and carefully pressed. This caused the rupture of cephalothorax and extrusion of gut contents. Gut contents, which came out in the form of a compact mass, were further pressed and contents smeared across the field of vision. Though the technique was a tidious one, after considerable practice it gave satisfactory results. The number of guts having particular type of food has been expressed as percentage of total guts analysed of the particular species. The food of following species were analysed (i) *Ceriodaphnia cornuta* Sars, *Daphnia carinata* King, *Moina micrura* King, *Heliodiaptomus contortus* Gurney, *Heliodiaptomus viduus* (Gurney), *Mesocyclops leuckarti* (Claus), *Thermocyclops hyalinus* (Rehberg), *Microcyclops varicans* (Sars) and *Eucyclops rubescens* Brady. Copepods were divided into three classes, nauplii, copepodites and adults and cladocerans were divided into two classes, juveniles and adults.

Results

Details of gut having different kind of foods expressed in terms of percentage have been presented in Figs. 1 (cladocera), 2 (calanoida) and 3 (cyclopoida). Among cladocera most stereotype feedings have been observed in all the species, both in adults and juveniles, as far as the quality of the food is concerned. The gut contents of 210 specimens of *C. cornuta*, 175 specimens of *D. carinata* and 110 specimens of *M. mincrura* were analysed. The food composed of fine detritus, phytoplankton and bacteria. Fine detritus (below 50μ in size) was the most important food constituting more than 40μ in all the species and their juveniles. However, its contribution was slightly more in juveniles. The coarse detritus (above 50μ) was found only in few guts. Among phytoplankton, which were no less important than detritus, the smaller and unicellur algae formed the bulk of the plant matter. The occurrence of filamentous green algae, blue green algae and larger diatoms were rare. Bacteria were always very insignificant comprising merely 8-10% and never occurred alone in any gut. No animal remain could be detected but some guts were always having indeterminate mush which might have been composed of

masarated vegetable matter. Not much significant difference was noticed in phytoplankton composition of adults and juveniles.

The calanoids were always found to subsit on similar kind of food, detritus, phytoplankton and bacteria but the composition varied greatly from that of cladocera. The gut contents of 135 specimens of *H. contortus* and 115 specimens of *H. viduus* were analysed. In calanoids, coarse detritus were found to occur in abundance. However, there was a

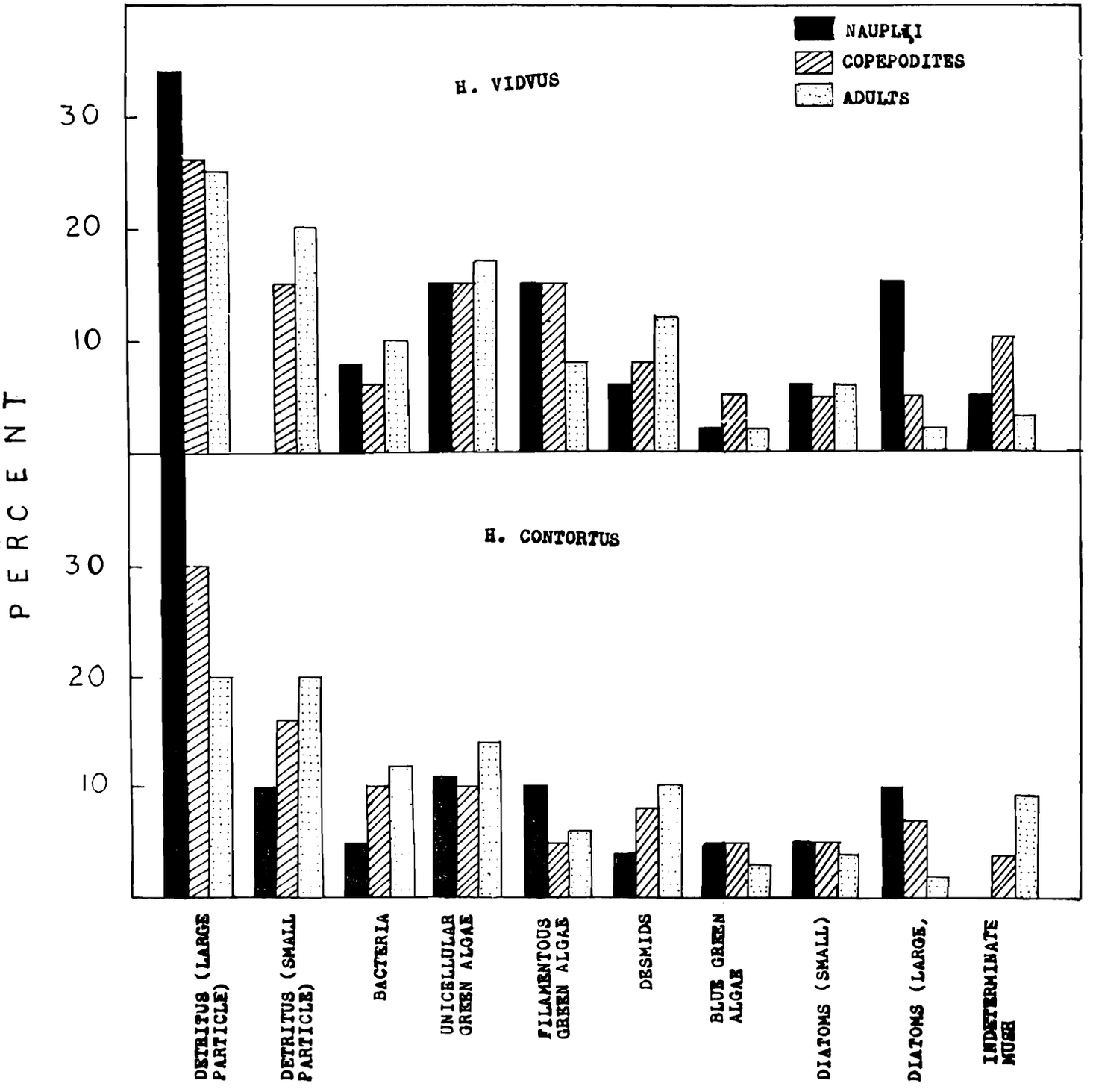

Fig. 1. The food of Cladocera expressed as percent of guts having different types of food.

tendency of changing over from fine detritus to coarse detritus with increasing age in both species (Fig. 2). Similarly, among phytoplankton, filamentous algae and larger diatoms were more common than the other algae. Bacteria did not constitute significant proportion in calanoids too.

The most varied feeding habits were observed in cyclopoda. Gut contents of 165 specimens of *M. leuckarti* 130 specimens of *T. hyalinus*, 95 specimens of *M. varicans* and 80 specimens of *E. rubescens* were analysed. *M. leuckarti* and *T. hyalinus* appear to be carnivorous species containing

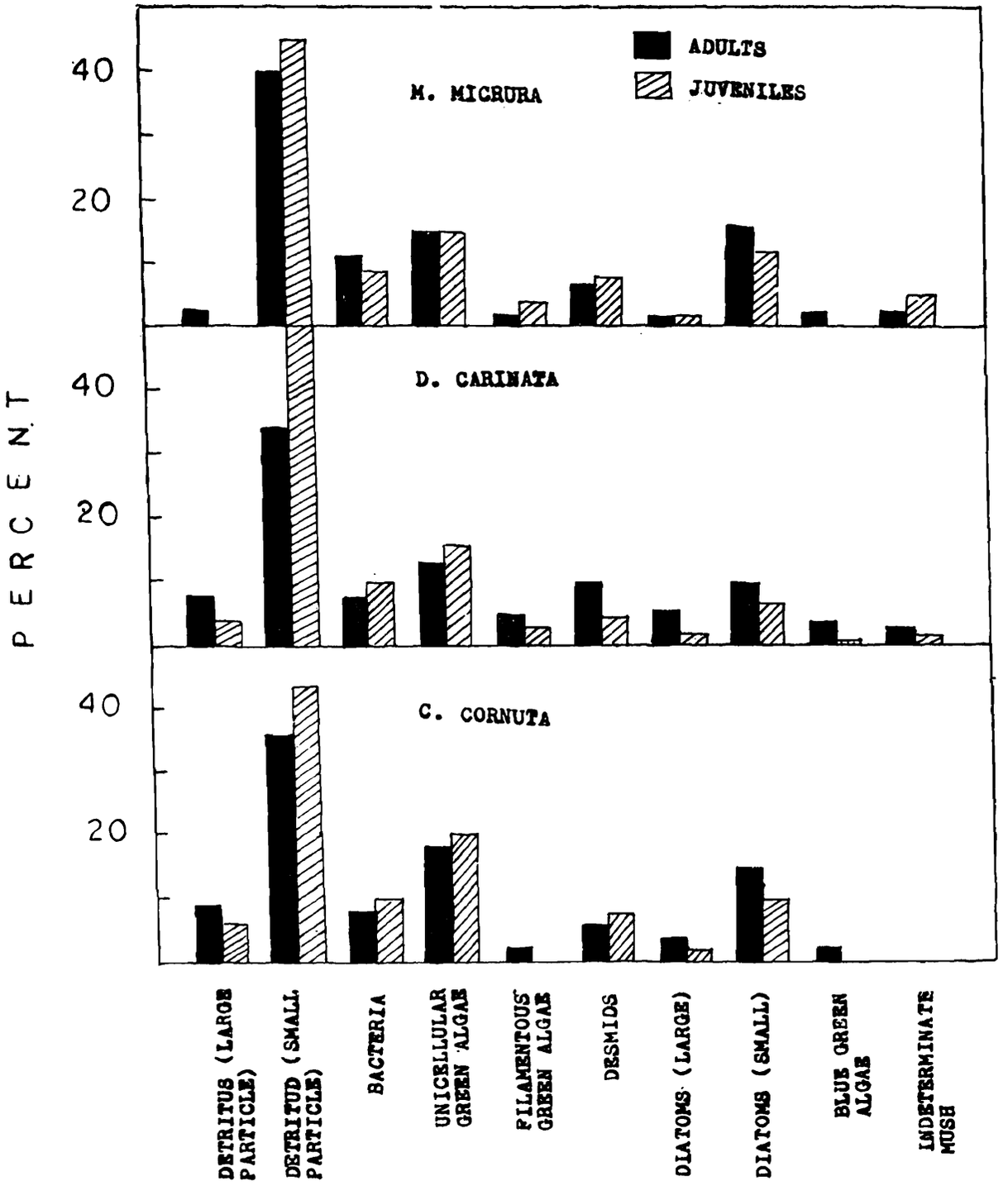

Fig. 2. The food of Calanoida expressed as percent of guts having different types of food.

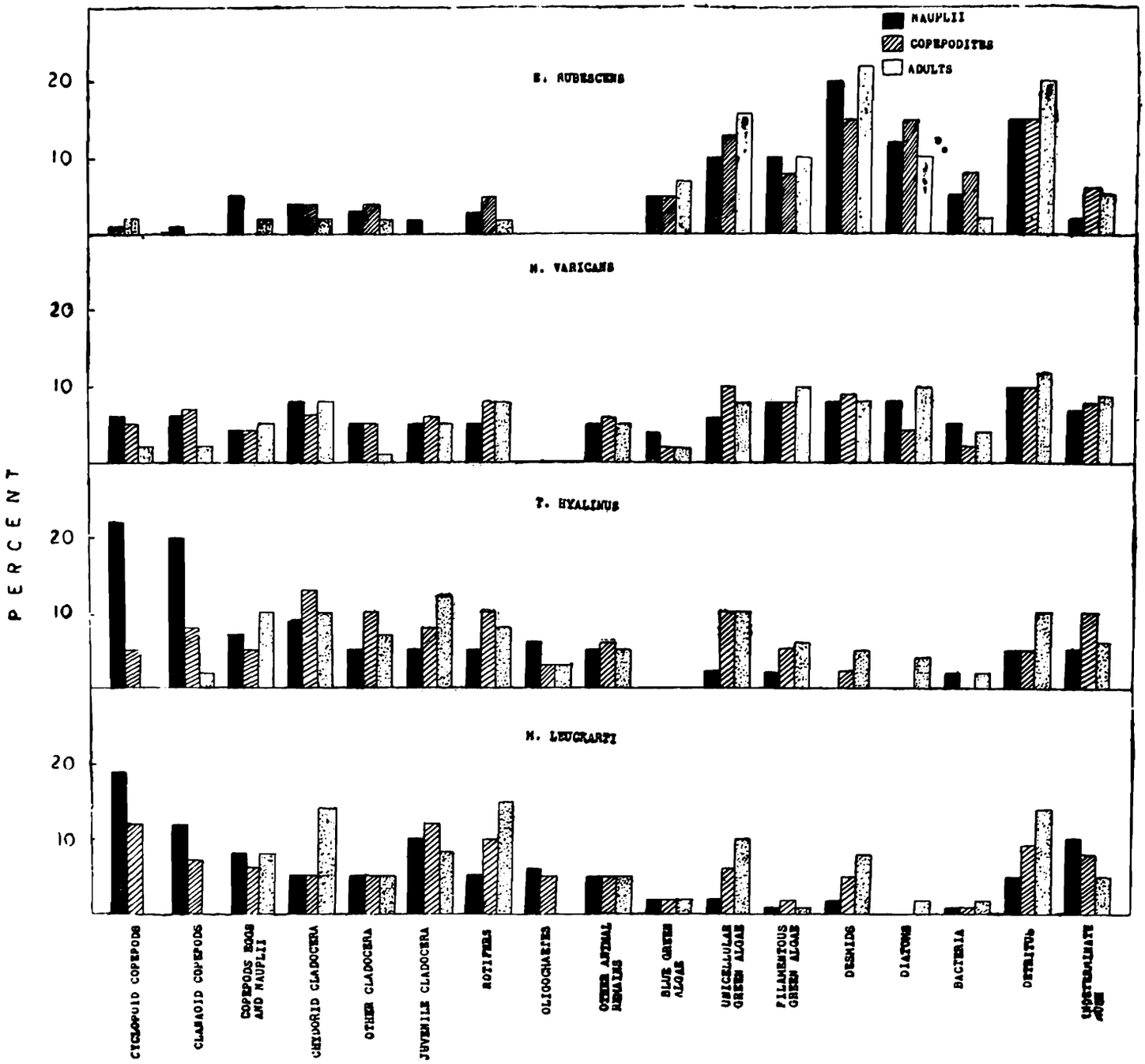

Fig. 3. The food of Cyclopoida expressed as percent of guts having different types of food.

more than 75% of animal matter. Cyclopoid copepods, calanoid copepods, their eggs, nauplii and copepodites, cladocerans, rotifers and oligochaetes etc., formed the bulk of the diet of two species. Plant matter and detritus were always in negligible quantities and most of the algae were within the prey species ingested. However it is interesting to note that the contribution of phytoplankton and detritus was more in immature stages than adults of the two species. Taking into consideration the feeding habits of the species it may be said that the indeterminate mush belongs mostly to animals remain. *M. varicans* appears to be omnivorous where both animal and plant matters were found to contribute almost equally (Fig. 3). The fourth species *E. rubescens* appear to be mainly herbivorous where phytoplankton and detritus constituted the bulk of the food. Animal matter was always in negligible quantities.

Discussion

From the food spectrum of cladocera and calanoida, it is clear that all the species of both groups are strictly herbivorous, feeding mainly on detritus and phytoplankton. Similar observations have been reported by Tappa (1965) who observed that detritus constituted about 50% of the food of Daphnids and Nauwerck (1963) who found in case of *Eudiaptomus graciloides* that it could not subsist on phytoplankton alone and the detritus was the main component of the diet. The low percentage of bacteria in the diet revealed that it plays very negligible role in the diet of all the herbivorous species as also observed by Saunders (1969). Cyclopoids exhibited a variety of feeding. Two most common species of the region, *T. hyalinus* and *M. leuckarti* are highly predacious, feeding upon cyclopoid and calanoid copepods and their developmental stages, cladocera and rotifers and even oligochaetes which are much larger than the feeding animal itself. Canabalism has also been observed in *M. leuckarti*. Fryer (1957) also reported that carnivorous cyclopoids feed upon prey larger than their own size. As far as occurrence of some algae in the guts of these two species are concerned, the conclusion of Fryer (1957) seems to be valid that some of these may be ingested along with the prey animal which has inturn eaten the algae. This phenomenon was also observed in laboratory. Specimens of *M. leuckarti* were kept in pond water from which all rotifers and crustaceans were filtered out by No. 25 cloth and it contained only phytoplankton. Periodic observations showed that the guts of animals remained empty even after 48 hours. In contrary to present results where cladoceran formed the sizeable portion of the diet of carnivorous species, Confer (1971) observed that *Mesocyclops edax* does not feed upon cladocera.

Microcyclops varicans was found to be omnivorous as both animal and plant matters contributed almost equally. Such omnivorous feeding habits among cyclopoids is rare. The herbivorous feeding habit, as observed in *E. rubescens*, has also been reported for other *Euclops* species like *E. agilis*, *E. macruroibes* and *E. macrurus* by Fryer (1957). This shows that *Eucyclops* are mainly herbivorous. One thing is very interesting to note that both *M. varicans* and *E. rebescens* avoided blue green algae.

The literature regarding food preference of filter feeder cladocera and calanoida has

been very contradictory. Rigler (1971) reports that the cladoceran and some calanoids possess little ability of food selectivity and if any selection occurs in cladocera, it must be passive and in the form of bolus rejection. On the other hand Gliwicz (1968) has concluded that different species of cladocera and calanoida select different particle size. The selectivity phenomenon in calanoids has more definitely been demonstrated than cladocera. McQueen (1970) has shown that blue green algae is definitely rejected by *Diaptomus oregonensis*. Main (1962) as cited by Lane (1975) also reported that omnivorous *Epischura lacustris* avoids cladoceran and rotifers and consumes calanoid nauplii etc., and also has a denitie preference for larger species of phytoplankton. Though food selectivity in cladocera has not been definitely demonstrated but Richman (as cited by Lane, 1975) has substantiated this phenomenon. Generally the size of food particle ingested has been related to size of animal particularly size of filtering apparatus (Burns 1968, Egloff & Palmer 1971), thus during the life span of cladocera it may vary (Gulati 1979).

Levins (1968) and Lane (1975) have concluded that major mechanism for competitive coexistence of filter feeders is habitat selection not the resource allocation. From the present study though not very clear pattern is observed, evidences are there for the food preference by cladocera and calanoida. As far as the size of the detritus is concerned, it may be seen that cladoceran always preferred fine detritus and calanoids coarse particles as also reported by Hutchinson (1967). Similarly in case of algae, cladoceran showed certain preferences towards smaller forms while calanoids for larger forms. Blue green algae have definitely and equally heen avoided by all species as their percentage was always low like in *Diaptomus oregonensis* of McQueen (1970). The importance of blue green algae in the diet of aquatic animals has always been the subject of question. Fryer (1957) noted that many blue green algae and also green algae were found undigested in the rectum of *Acanthocyclops bisetosus*. Kersting (1979) observed that algal cells can pass the gut of *Daphnia magna* several times before completely digested. Similarly Vass and Hofstede (1962) also found that blue green algae pass undigested from the alimentary canal of the fish *Tilapia mossumbica*. Khan and Siddiqui (1973) have also observed similar phenomenon in the major carp *Labeo rohita* where not only blue green algae but certain green algae like *Scenedesmus* and *Ankistrodesmus* were found quite fresh in the hind gut. Detail report regarding the importance of certain algae in the diet of freshwater animals will be presented elsewhere.

Definite food selection has been observed in Siezers, the cyclopoida. Various species existing together mainly have different feeding habits. Some are carnivorous, some omnivorous and some herbivorous. In Dhakuria lake the high density of the carnivore species *M. leuckarti* was associated with the abundance of *M. varicans* and sometimes, *E. rubescens*, former omnivorous and later herbivorous. During the period of abundance of the other carnivorous species *T. hyalinus*, population of *M. leuckarti* was found to decrease but no effect was noticed on either *M. varicans* or *E. rubescens*. This revealed that resource allocation played some role in the competitive coexistence of various

cyclopoid species. However as many of the cyclopoid species show definite vertical migration (Khan 1981), it may be said that both these factors, habitat selection and resource allocation, act in coordination for alleviating competition. Further extensive studies are required in a variety of habitats to bring a clear picture of this important phenomenon of zooplankton dynamics.

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