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The Food and Feeding Habits of a Freshwater Prawn *Macrobrachium choprai*

D. ROY and S.R. SINGH

Department of Zoology
S.M.M. Town Post Graduate College
Ballia (U.P.) - 277001
India

Abstract

The food contents of adults and juveniles of *Macrobrachium choprai* were examined in relation to sex, size, maturity and season. Organic detritus supplemented by planktonic algae, crustacean larvae, molluscs and insects formed the major part of the food of adult individuals. Fish bones were occasionally observed in the gut of males only. This species, however, did not exhibit any preference for a particular animal or plant food item. Variation in food components in relation to size, sex or season was also insignificant. Juveniles exhibited absence of organic detritus and depended only on planktonic algae, crustacean and insect larvae.

Introduction

Macrobrachium choprai is an inhabitant of the middle and lower reaches of the river Ganga in India. Its fishery has declined to a great extent, and immediate attention is needed to evolve methods for propagation and culture on a commercial basis. Among various factors involved in aquaculture practices, quality and quantity of natural foods available in the medium play a significant role. It is believed that natural foods (algae, snails, worms, insect larvae, tadpoles, etc.) contribute significantly to the growth of prawns even in commercial operations (Fujimura and Okamoto 1970). A perusal of the literature available reveals that most of the contributions in this field are limited to studies of feeding behavior of Penaeid prawns, and that the non-penaeid forms have least been studied. In view of the potential of prawn culture in this area, and the importance of prawn fishery, the authors have carried out the present investigation.

Materials and Methods

Plankton and bottom soil samples were collected regularly at monthly intervals and analyzed according to the methods of Singh and Srivastava (1989; 1991).

Regular samples of *M. choprai* were collected over 2 years from catches at nearby areas of Buxar (25°34' N Lat. and 83°58' E Long.). Prawns did not appear in the catches from October to February probably owing to their migration into deeper zones of the river due to excessive cold (<20°C). Due to this, it was not possible to collect year-round data on the food and feeding habits of this species.

Animals were segregated according to size and sex. Maturity states of females were determined by the physical appearance of the gonads (Singh and Roy 1994). This made it possible to determine any food preferences in females at various stages of sexual maturity. However, such a pronounced distinction was not possible in males.

The animals were caught alive and cut open immediately. The extent of feed was determined by the degree of stomach distention and the amount of food contained in it. The cardian portion of the stomach was cut open and the entire contents carefully washed into a petridish and made to a known volume by adding 5% formaline. After shaking the mixture, a drop equivalent to 0.1 ml was examined under a microscope. The percentage of different components was determined by eye estimation. After examination, the sample was again mixed with the stock and the process repeated thrice.

The food items of adults and juveniles were determined separately and identified as far as possible. A total of 260 adults and 300 juveniles were examined during 2 consecutive years.

Results

Trophic Status of the Catch Area

The stretch of the Ganga River selected for the present study was observed to enjoy a rich plankton population and benthic fauna.

Plankton

Total plankton population consisting of both phyto and zooplankton reached its maximum in January (1,247 $u \cdot l^{-1}$), and minimum (236 $u \cdot l^{-1}$) in July.

Phytoplankton

Phytoplankton contributed as high as 93% to the annual plankton count and was mainly comprised of members of Chlorophyceae, Bacillariophyceae and Cyanobacteria. Some forms of Xanthophyceae, Chrysophyceace and Dinophyceae, though present, were scanty in number and poor in forms. The phytoplankters exhibited a distinct preference for winter, recording 57.63% of yearly total production, followed by monsoon (21.59%) and summer (20.78%) (Table 1, Fig. 1).

Table 1. Seasonal variations in abundance of phyto- and zooplankton.

Season	Contribution to phytoplankton (%)	Contribution to zooplankton (%)	Contribution to total plankton(%)
Summer	20.78	36.39	21.80
Monsoon	21.59	31.33	22.29
Winter	57.63	32.28	55.91

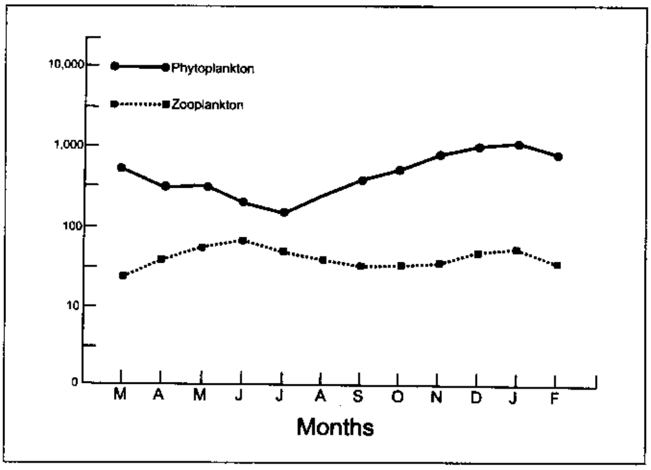


Fig. 1. Seasonal fluctuation in numerical abundance of phyto and zooplankton (on logarithmic scale).

Chlorophyceae

Chlorophyceae contribued 47.5% to the total annual production of phytoplankton with a yearly average of 3,364 u·l^{-1} (Table 2). It was represented by 17 genera, important among them were *Mougeotia, Actinastrum, Scenedesmus, Hydrodictyon, Chara* and *Spirogyra* (Table 3).

Bacillariophyceae

With a yearly average of 3,128 u·l^{-1}, Bacillariophyceae accounted for 30% of the total annual production of phytoplankton and was represented by 16 genera. The important forms observed were the species of *Synedra, Fragilaria, Diatoma, Gomphonema, Navicula* and *Nitzschia*.

Table 2. Percentage contribution of planktonic groups.

Planktonic groups	Yearly average (unit·l^{-1})	Contribution to total phyto/zooplankton (%)
Phytoplankton		
Chlorophyceae	3,364	47.5
Bacillariophyceae	2,128	30.0
Cyanobacteria	1,589	22.5
Zooplankton		
Rotifera	213	40.0
Copepoda	266	50.0
Cladocera	38	7.0
Protozoa	17	3.0

Cyanobacteria

Cyanobacteria recorded a yearly average of 1,589 $u \cdot l^{-1}$ and contributed 22.5% to total annual phytoplankton crop. The principal genera encountered were *Microcystis, Coelosphaerium* and *Gleocapsa.*

Zooplankton

Zooplankton exhibited a depressed population (only 7% of the total annual plankton population). Summer contributed the maximum share to the total zooplankton population (36.39%) followed by the winter and monsoon seasons (32.28% and 31.33%, respectively) (Table 1, Fig. 1). The zooplankton population was formed chiefly by members of Rotifera, copepoda, cladocera and Protozoa recording yearly averages of 213, 266, 38 and 17 $u \cdot l^{-1}$, respectively (Table 2). The principal zooplanktonic forms encountered in the river were the species of *Brachionus, Keratella, Filinia* and *Rattulus* among rotifers; *Nauplius, Cyclop* and *Diaptomus* among copepods; *Bosmina, Ceriodaphnia, Siola* and *Chidorus* among cladocerans, and *Diffugia, Stentor* and *Vorticella* among protozoans (Table 3).

Table 3. List of plankters encountered in Ganga River.

Phytoplankton	Cyanobacteria
Chlorophyceae	*Microcystis* spp
Mougeotia spp	*Coelosphaerium* sp
Zygnema sp	*Aphanocapsa* sp
Spirogyra spp	*Merisomopedia* sp
Closteridium sp	*Gleocapsa* sp
Actinestrum sp	*Formidium* sp
Genicularia spp	**Zooplankton**
Ankistrodesmus sp	Rotifera
Coelastrum sp	*Brachionus* spp
Netrium sp	*Karatella* spp
Pediastrum spp	*Filinia* sp
Pandorina sp	*Polyarthra* sp
Volvox spp	*Pompholyx* sp
Cosmarium sp	*Microcodon* sp
Scenedesmus sp	*Trichocera* sp
Kirchnriella sp	*Pedalion* sp
Staurastrum sp	*Rattulus* sp
Chara spp	*Philodina* sp
Bacillariophyceae	Copepoda
Synedra spp	*Cyclops* sp
Fragilaria spp	*Nauplius* sp
Diatoma spp	*Diaptomus* sp
Gomphonema sp	Cladocera
Navicula sp	*Bosmina* sp
Nitzschia spp	*Daphnia* sp
Phaeosphaeria sp	*Ceriodaphnia* sp
Meridion sp	*Siola* sp
Cymbella sp	*Chydorus* sp
Amphora sp	*Moina* sp
Pleurosigma sp	*Alona* sp
Melosira sp	Protozoa
Gyrosigma sp	*Diffugia* sp
Terpsinoe sp	*Stentor* sp
	Vorticella sp

Benthic Fauna

Benthic fauna recorded a peak value (87.36 individuals·m^{-2}) in March, whereas the lowest (44 individuals·m^{-2}) was recorded in October (Fig. 2). It included both macro- (10.3%) and meobenthic (89.7%) populations. The macrobenthos were composed of various forms of Gastropoda and Bivalvia, whereas members of dipterans, amphipods, annelids, copepods and ostracods formed the bulk of the meobenthic population. Dipterans and amphipods formed the major bulk, contributing 38.68% and 35.39%, respectively, to the total benthic population. *Chironomous* larvae among dipterans and *Gammarus* spp. among amphipods were the significant benthic forms. Other important genera encountered during the study were *Viviparous* among gastropods, *Corbicula* among bivalves and *Tubifex* among annelids (Table 4).

Table 4. Bottom fauna encountered in Ganga River.

Macrobenthos		
	Gastropoda	
		Viviparous bengalensis
		V. subpurpurens
		Indoplanorbis exustus
		Gillia altilis
		Pleurocera acuta
	Bivalvia	
		Goniobasis linescens
		Ellipsaria lineolata
		Lampsilis spp
		Pisidium spp
		Medionidus spp
		Corbicula spp
		Perrysia sp
		Musculium sp
Meobenthos		
	Diptera	
		Chironomous larvae
		Pseudochironomous
		Pentaneura sp
		Philorus pupa
	Amphipoda	
		Pontoporeia spp
		Gammarus spp
	Annelida	
		Tubifex tubifex
		Dero digitata
		Difurcota sp
	Copepoda	
		Bryocamptus sp
		Paracyclops
	Ostracoda	
		Cypricircus sp

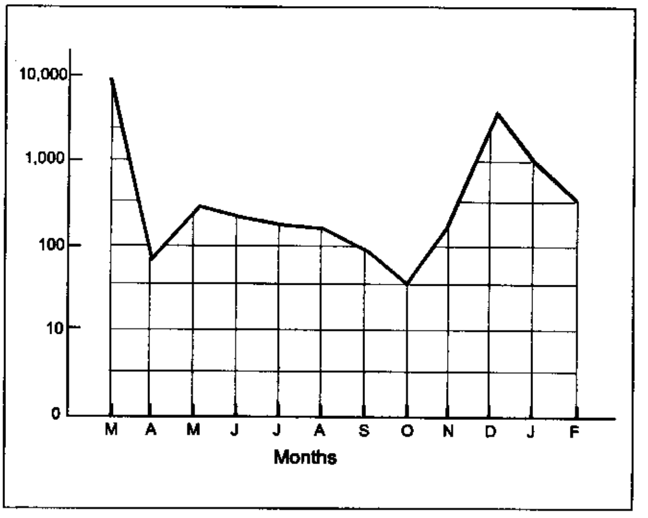


Fig. 2. Seasonal fluctuation in numerical abundance of benthic fauna (on logarithmic scale).

Gut Contents

In general the food items in the stomachs were composed of blue green algae, green algae, diatoms, fragments of other algal forms, fragments of insects and crustaceans, molluscs, decomposed organic matter, etc. A brief description of the principal food items is given in Figs. 3 and 4.

Blue Green Algae

Blue green algal forms were observed throughout the study in both sexes and in all size groups. *Microcystis, Coelosphaerium, Oscillatoria* and *Gloeocapsa* were the principal genera observed.

Green Algae

Green algae were consumed around the year in both sexes of all age groups. The principal genera encountered were *Hydrodictyon, Mougeotia, Desmidium, Ulothrix, Closteridium, Closterium, Stylosphaeridium, Microspora, Cladophora, Zygnema, Spyrogyra, Genicularia* and *Chara.*

Diatoms

Diatoms appeared in ingested food from April onward. They were preferred most by males of the size groups 14-18 cm and 18-22 cm (Table 5A), and females of the size group 18-22 cm (Table 5B). The principal forms observed were the species of *Synedra, Fragilaria, Diatoma, Gomphonema, Navicula* and *Nitzchia.*

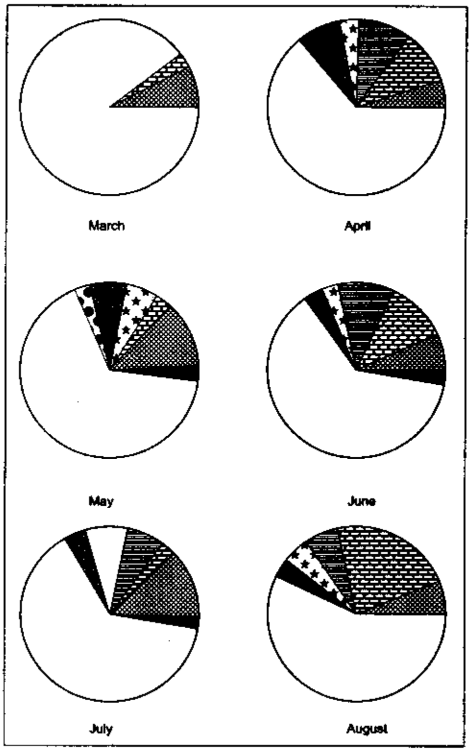
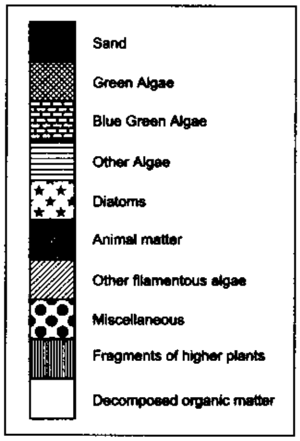


Fig. 3. Percentage composition of different food items found in gut contents of male prawns.



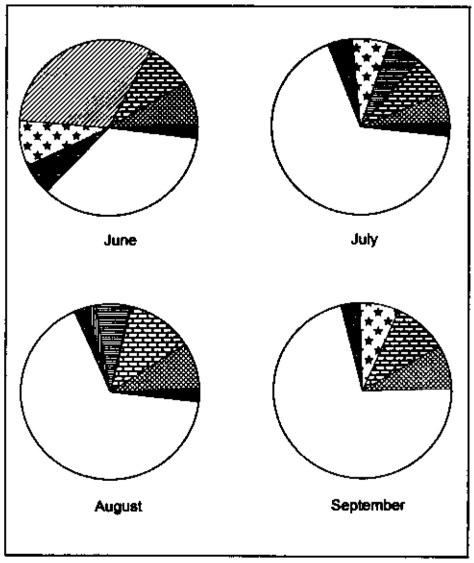


Fig. 4. Percentage composition of different food items found in gut contents of female prawns.

Other Algae

This included filamentous, unicellular and fragments of thalloid algae which could not be assigned a definite class owing to their occurrence in deformed state.

Animal Matter

Animal tissues appeared in the gut contents mostly from May onwards and were represented mainly by insects, crustaceans, molluscs and fish bones. It is presumed that the fish might have consumed some other animal forms, viz. radiolarians, foraminiferans, polychaetes, etc., which could not be identified because of their faster digestion. Insects were represented mainly by their legs or cuticular exoskeleton. Molluscs were represented occacionally by their shells only. Fish bones were observed, surprisingly, in the gut contents of all size groups of males only. It is possible that they might have been consumed along with detritus.

Table 5. Gut contents in relation to size of prawns.

	Food components (%)									
Size groups (cm)	Blue green algae	Green algae	Diatoms	Other algae	Insects	Crustaceans	Molluscs	Fishes	Pieces of higher plants	Decomposed organic matter	Sand
Male											
10-14	4.3	2.6	2.6	0.6	-	-	-	1	-	88.0	0.2
14.1-18	2.3	1.3	5.3	9.0	2.0	0.6	-	0.6	-	78	1.0
18.1-22	8.0	11.1	5.0	8.5	1.2	0.5	0.2	1.5	1	61.4	1.0
22.1-26	10.0	18.0	1.0	5.0	2.0	3.0	-	1.0	-	60.0	-
Female											
8-12	5.1	6.0	4.0	2.0	1.0	1.5	-	-	-	80.0	-
12.1-16	7.0	14.0	6.2	4.3	1.5	1.4	0.6	-	0.8	63.2	1.1
16.1-20	16.5	7.5	3.5	1.7	1.7	1.7	-	-	0.7	66.5	-

Table 6. Gut contents in relation to sexual maturity of females.

Gonadal state of ovary	Blue green algae	Green algae	Diatoms	Other algae	Insects	Crusta-ceans	Molluscs	Fishes	Pieces of higher plants	Decomposed organic matter	Sand
Immature	5.0	10.0	2.0	10.0	2.0	3.0	-	-	-	68.0	-
Mature	12.3	6.2	4.3	2.2	2.1	1.8	-	-	0.5	71.2	0.5
Spent	11.2	16.0	6.6	3.8	2.4	3.0	1.0	-	0.6	55.6	1.0

Decomposed Organic Matter

Decomposed organic matter was the most common food material in all size groups of both sexes. Maximum consumption was in March, but it contributed more than any food item all year round.

Sand

Sand was recorded since May onwards in meager percentage in the food components of both sexes.

Food Habits in Relation to Sexual Maturity (Females)

Females with immature ovaries consumed larger amounts of green and other filamentous algae indicating that immature prawns are not always bottomfeeders. Molluscs were present only in females with spent ovaries. Crustaceans were more abundant in females with immature and spent ovaries. Decomposed organic matter was highest in animals with mature ovaries, while sand was present only in animals with mature and spent ovaries (Table 6).

Feeding Intensity

Prawns showing full, three-fourths full and half-full stomachs were taken to have fed actively; while quarter-full, food in traces and empty stomachs were considered as poorly fed. Results are depicted in Figs. 5 and 6.

Feeding Habits of Juveniles

Most juveniles below 25 mm were found with empty stomachs or with traces of food. However, feeding intensity showed an increasing trend in size groups of juveniles above 25 cm (Table 7).

Blue green algae and diatoms were the food components in all size groups of juveniles. Animal matter included larval forms of Crustacea and Insecta. Some food was observed in semi-digested or digested form. Decomposed organic matter and sand, however, were absent from the consumed food.

Discussion

Prawns in general are reported to be omnivorous depending on both animal and plant matter. While in *Penaeus indicus*, the bulk of food material is reported to be formed by crustaceans and vegetable matter (Gopalkrishnan 1952), in *Macrobrachium dobsoni*, it is mainly composed of small animals and diatoms along with mud and sand (Menon 1951). George (1976) observed that in small individuals of *M. monoceros*, the gut contents contained more mud and detritus compared to larger animals, and that they exhibited selective feeding in different size groups.

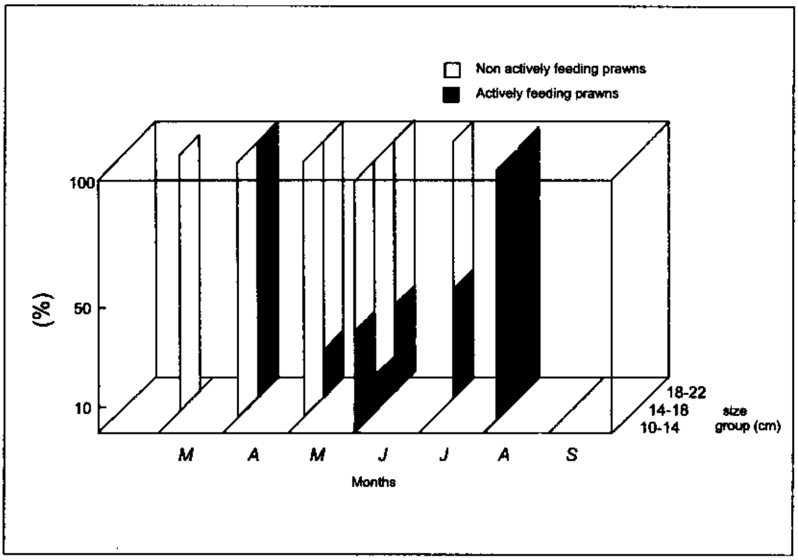


Fig. 5. Percentage occurrence of actively and non-actively feeding prawns (male).

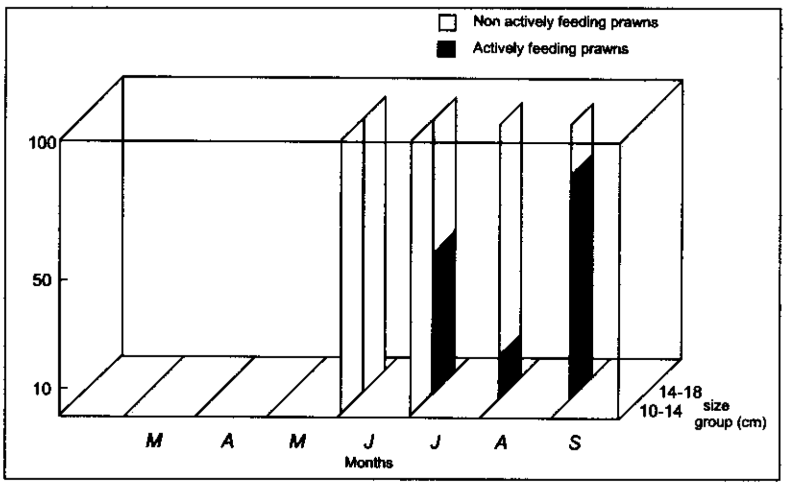


Fig. 6. Percentage occurrence of actively and non-actively feedings prawns (female).

The gut contents of subadult and adult specimens of *M. choprai* under the present study exhibited a wide range of food items including different groups of phytoplankton, zooplankton, benthic fauna, parts of other plants and animals, and organic detritus. However, all the animals examined, irrespective of size, sex and season, subsisted more on organic detritus. Consumption of large amounts of organic detritus by both sexes may be due to their bottom-feeding habit coupled with easy intake of detritus without much effort and manipulation. Further, the microorganisms present in detritus also serve as food to the prawns (Chong and Sasekumar 1981).

It was further observed that in general, animal matter was less common than plant matter in the gut contents. This may have been due to a year-round depressed population of zooplankton in the river coupled with a comparatively dwindling population of benthic fauna during late summer and monsoon seasons when the animals were engaged in active feeding. It

Table 7. Food components and feeding intensity of juveniles.

Size group	Food components		Feeding intensity	
Below 25 mm	Blue green algae			
	Microcystis	10%	Food in traces	81%
	Rivularia	5%	Half filled	10%
	Coelosphaerium	5%	Full	9%
	Diatoms	15%		
	Animal matter			
	Crustacean and insect larvae in semidigested condition	5%		
	Miscellaneous			
	Food in semi-digested condition	60%		
25-40 mm	Blue green algae			
	Microcystis	12%	Food in traces	34%
	Coelosphaerium	13%	Half filled	10%
	Diatoms	20%	Full	56%
	Animal matter			
	Larval forms of crustacea	5%		
	Miscellaneous			
	Other algae and plant materials in semi-decomposed condition	50%		
40-55 mm	Blue green algae			
	Coelosphaerium	10%	Food in traces	30%
	Fragments of filamentous blue green algae	10%	Half filled	12%
			Full	58%
	Diatoms	10%		
	Miscellaneous			
	Food in semi-digested condition	70%		

is also possible that animal tissues are digested relatively faster, and that the animal matter observed in the gut actually represented undigested leftovers. It was further observed that none of the stomachs examined included an animal in complete form. This might be due to the efficient masticating mechanism of these prawns. A similar observation has been reported by Hall (1962) in *P. semisulcatus*. The occurrence of fish bones in the stomachs of all size groups of males only coincides with the relatively high feeding efficiency of males due to their large and strong chelate legs.

The appreciable quantity of a variety of algal flora in the gut contents of *M. choprai* leads to the conclusion that this species, besides feeding on bottom, often visits the water column to supplement its diet with algal flora. It is possibly due to a relatively denser population (93%) of planktonic algal forms in the media. This view is supported by Rao (1988) who reported that *M. monoceros*, besides brousing on the epiflora of mud substrate, feeds to some extent in the water column also.

However, no planktonic group or benthic form could be ascertained as the preferential food component of this species due to the complex nature of consumed food observed in semi or fully digested or deformed condition. It is possible that the animal is able to digest cellulose efficiently which enables it to feed on all items of food available in the medium and found within reach.

No distinct variation in food selection of adult prawns belonging to different size groups could be recognized. It was, however, observed that males of the smallest size group did not consume insects, crustaceans and molluscs. Compared to the smaller ones, males measuring above 18 cm depended more on green and blue green algal forms. In both males and females, decomposed organic matter was more abundant in the stomachs of smaller animals than in larger ones. Parts of higher plant materials were absent in gut contents of small male and female individuals. This conforms with the observation of Menon (1951) who reported that detritus content was greater in smaller prawns, and this was replaced by vegetable matter in larger prawns.

In the present study, it was observed that females with immature ovaries subsisted more on phytoplankton, suggesting more frequent visits to the water column for feeding. The presence of large amounts of decomposed organic matter in the stomachs of animals with mature ovaries and sand in those with mature and spent ovaries indicate that these animals feed actively on the river bed.

No definite reason could be assigned to the existence of empty stomachs in almost all the male prawns in March/April when they became active and started appearing in the catches after a long inactive phase during the winter months. The females too were found either with empty stomachs or with traces of food in June when they started appearing in the catches. Possibly the clue lies in the pre-mating conditions of both sexes of this prawn species. It also appears that temperature, more than any other factor, affects the resumption of active feeding and breeding. Williams (1955) also reported minimum feeding activity in winter, and increased feeding activity in other seasons of the year. However, such seasonal differences were not observed by Thomas (1980) and Rao (1988) in *P. semisulcatus* and *M. monoceros*, respectively.

In the present study, a number of female individuals in mature as well as in berried states were found with empty stomachs or with traces of food, and it could not be ascertained whether this species breeds with an empty stomach. But from what has been observed, it may be concluded that poor availability of food at least, does not limit breeding activity in *M. choprai*. This is in contradiction to that observed by Nagabhushanam et al. (1987) who suggested that reduced availability of food may limit breeding activity in *M. affinis*. Durbin et al. (1992), however, report that food limitation affects body weight more than egg production in *Acartia hudsonica* (a copepod).

The absence of organic detritus in the food components of juvenile prawns may be due to its non-benthic behavior.

From the preceeding account, it can be inferred that adult individuals of this species of prawn, irrespective of size and sex, are chiefly bottomfeeders feeding on organic detritus accumulated on the river bed and supplemented with varied planktonic forms, without any distinctive preference for a particular animal or plant group. On the other hand, juveniles (<25 mm) are distinctly plankton feeders, depending largely on blue green algal forms and diatoms supplemented by crustacean larvae.

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