# FOOD PARTITIONING IN FOUR SPECIES OF PENAEID PRAWNS IN THE BOLGODA LAGOON SRI LANKA

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**Abstract**

*Penaeid prawns of the Bolgoda Lagoon feed on* Caridina *spp, clams,* Harpacticoid *spp, Nerine and* Nereis *spp fish larvae, diatoms, green leafy matter and detritus. Their frequency of occurance and the number of crops containing a particular diet varies from species to species studied. The overlap co-efficient of food between two species of the same genus is greater than that of two species of two different genera. vacuity index of* M. ensis *indicated seasonality in feeding. The distribution of prawns in the lagoon has a direct relationship to the benthic fauna fiand ora.*

Key Words: Overlap co-efficient, Vacuity index

Running Title: Food of penaeid prawns.
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## Introduction

There is an established *Penaeid* and *Palaemonoid* prawn fishey in the Bolgoda Lagoon In this lagoon the prawns are caught at night in three different ways, using (i) traps mad out of bamboo, (ii) seines and (iii) encircling nets. Of the seven species of penaeid prawns found in the lagoon (Bruin, 1971), four species form the bulk of the commercial catch, namely *Paneeus monodon, P. indicus, Metapenaeus ensis* and *M. dobsoni.* further, *Macrobrachium rosenbergii* is also caught along with penaeid prawns in the upper part of the lagoon. But only population idensity and population dynamics of *P. indicus* (Jayakody and Costa, 1988; Sideek, 1978), the taxonomy, food, feeding and fecundity (Costa, 1979; Costa and Wanninayake, 1986), fishery and spawning seasons (Jinadasa, 1985) of *M. rosenbergii* in some water bodies have been worked out. The taxonomy of other shrimps of Sri Lanka have also been reported (Arudpragasam and Costa, 1962; Benzie and Silva, 1984). The biology, specially aspects such as the food and feeding habits, growth rates, spawning seasons and grounds, behaviour during day and night of commercially important penaeid prawns in the Bolgoda lagoon, have not been well documented. An understanding of the above factors are important for the successful commercial exploitation of these species and also for their commercial cultivation. Further, in the Bolgoda lagoon *P. monodon* and *M. ensis* are present throughout the lagoon. *P. indicus* mostly inhabit the lower two thirds of the lagoon and *M. dobsoni* is mostly found in the upper part of the lagoon. Some species are seasonal in distribution and indicate migration behaviour (Bruin, 1971). Therefore, there is an overlap in their distribution.

The diet of penaeid prawns mostly consists of polychaete worms, amphipods, bivalves, gastropods, nematodes, other epibenthic animals, detritus, fresh leaves and roots (Kutyama, 1974- George, 1972; Dall,-1968: Hall 1962). The dietary overlap among demersal fishes (Pleuronectiformes) found along with prawns in the same area has been documented (De Groot,1971; Rodgers and Jinadasa, 1988). Further, *M. rosenbergii* that inhabits the same lagoon feeds on leaves, benthic algae and animal matter (Costa and Wanninayake, 1986). Therefore, there is possibility for overlap of food among the five species of prawns as well. In the light of this situation it was considered valuable to study the food of penaeid prawns in the Bolgoda lagoon in order to understand whether there is a direct dietery overlap among the four species.

## 2. Materials and Methods

The work reported in this paper was carried out from 1980 to 1982. During this period a random sample of about 50 prawns was taken once a fortnight from two commerciale prawn landing sites and immediately fixed in 5% formalin solution. In the laboratory, the species were identified, their carapace lengths were measured, and grouped according to lengths. Their crops were cut open dorsally and the contents were taken into petridishes separately according to groups. The volume of the contents of the crops was measured by the water displacement method and expressed in milli-litres. The animal and plant contents of the diet were identified to the generic level where-ever possible. Tissues of fresh plants from the lagoon were used as references when-ever needed to confirm indentification. Their numbers in the crops, frequency of crops containing a particular diet and the number of empty stomachs were recorded.

Two glass aquaria (90 × 45 × 45 cm) were set up, containing sediment obtained frcm the lagoon. Water was allowed to enter the aquaria and subsequently allowed to leave the aquaria at 5 ml per minute using rubber tubings. Seventy *M. ensis* with carapace length 2 - 3 cm were placed in each of the aquaria and acclimated for a day. On the second day five prawns from each of the aquaria were caught once in two hours and their crops contents were studied as before. Three experimental traps were also set up in the lagoon and their catches were obtained once in two hours for 24 hours. The contents of their crops was also studied as before. The experiment was repeated twice.

The bottom sediment of two stations of the lagoon, namely, Molpe (near the head end) and Deegarolla (near the mouth) were taken using an Ekmans grab. The contents of six samples from each of the stations were seived through a set of aeives with mesh size 1, 0.5, 0.25 and 0.125 mm. The contents on each of the seives were then identified. The proportional diet overlap among species was calculated using the overlap coefficient (C) of Schiener (1970) according to the following formula.

$$C - 1 - 1/2 \, J, (P_{ij} - P_{hi})$$

Where Pij and $P_{hi}$ are the proportional occurrence of prey (or food) type j in the diets of species i and h. The coefficient assumes its minimum value of 0 when i and h share no diet resources and has a maximum value of 1 when the diet resource is the same.

The percentages of empty crop were converted into vacuity index according to Euzen (1987), which is an estimate of the voracity of the prawns.

## 3. Results

The diet of the four species of prawns consisted of crustacea (mostly *Caridina* spp), molluscs (mostly clams), copepods (mostly bottom dwelling *Harpacticoid* spp), polychaetes (mostly *Terribelidae* spp, *Nerine* and *Nereis* spp,), fish larvae, diatoms, green leafy matter (mostly tissues of *Apponogitum* spp., *Salvinia molesta*) and detritus (Table 1). However, their occurrence in the crops was different to a large extent among the species. The percentage of crops containing the components of the diet indicated that polychaetes, *Gammarus* spp., copepods and other non copepod crustacea, detritus and filamentous algae were high in *P. monodon* (Table 2). Whereas non-copepod crustacea, polychaetes, green algae and detritus were high in *M. ensis*. The above trend was different in *P. indicus* in that the percentages of polychaetes and diatoms were very high. The trend in *M. dobsoni* was quite different from all the above in that a high percentage of crops contained filamentous green algae (mostly *Enteromorpha* spp.) and green leaves.

The percentage frequency of occurrence of different components in the diet indicated high percentages of crustaceans, polychaetes and green algae in *P. monodon* (Table 3). Crustaceans, filamentous green algae, green leaves and detritus were high in *M. ensis*. The above pattern was quite different in *P.*

*indicus*, where the percentage frequency of polychaetes was very high and detritus component was very low. In *M. dobsoni*, the percentage frequency of polychaetes was very low and that of crustaceans, filamentous green algae and detritus was very high.

The above results indicate that the diet of the four species of prawns has the same basic dietary components, the percentage of crops containing a particular diet and the percentage frequency of occurrence of the components of the diet slightly differenc. Therefore, there is a possibility for diets to overlap directly.

The overlap coefficient (C) between *P. monodon* and *P. indicus* for polychaetes and filamentous green algae are 0.98 and 0.96 respectively and between *M. ensis* and *M. dobsoni* for detritus and green leaves are 0.98 and 0.99 respectively. These results show that the main components of the diet of the species within the genus overlap very heavily. The overlap coefficient (C) between the two genera for polychaetes, filmanetous green algae and green leaves were 0.95, 0.93, and 0.92 respectively. These values are less than that of the species within the genus *Penaeus* or *Metapenaeus* and indicates that there is dietary overlap even between the species of *Penaeus* and *Metapenaeus*, but at a lower level than species of the same genus (the mean C value between species of two genera is 0.91 and that between two species of the same genus is 0.97).

The volume of the food in the crops of *M. ensis* that were in the aquaria ranged from about 0.1 to 0.35 ml per crop and the value peaked around 10 and 11 pm (Fig. 1A). The corresponding value for *M. ensis* caught in traps ranged from about 0.15 to 0.43 ml per crop, and it peaked around 11 pm. These two patterns also showed that the feeding pattern throughout the day is almost the same, the difference noted was only in the volume of food eaten.

The percentage of empty crops of the prawns caught in the traps recorded during the period were 36 (SD—S.3) in *P. monodon*, 39 (SD—6.7) in *P. indicus*, 29 (SD—7.9) in *M. ensis* and 21 (SD—11.8) in *M. dobsoni*.

The seasonal fluctuations of the empty stomachs in *M. ensis* indicated high percentages from about April to June (Table 4), which is the end of inter-monsoon and beginning of monsoon period for the southwest coast where the lagoon is located.

The vacuity index of *M. ensis* showed high values from about January to March and October to December. Similarly, when the above index **was** calculated for all the other species, it was found that *M. dobsoni* recorded the lowest vacuity index. The crops of all species also contained large quantities of sand grains. the number of which varied from about 14 to 76 per crop in *M. ensis*. The size of the particles of the bottom sediment ranged from about 0.125 mm to 2.00 mm. The finest particles were found at Molpe (head end), where the mean size of the particles was 0.40 mm and that of Deegarolla (near mouth) 0.70 mm, where the coarsest particles were found.

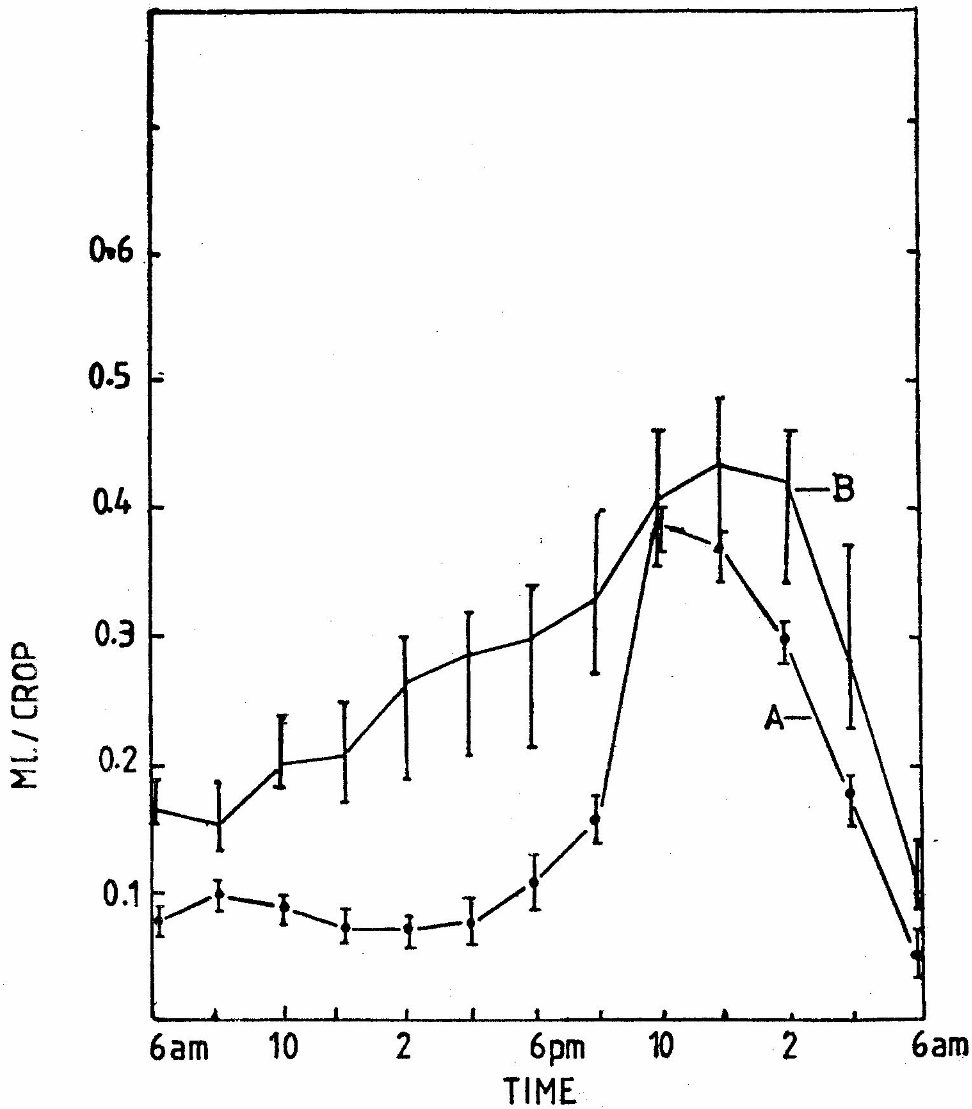


Fig. 1 Volume of the crop contents of *M. ensis*, A. Prawn kept the aquaria, B. Prawns caught using traps.

The percentage volume of the detritus was 38% at Molpe and 15% at Deegarolla. The detritus component consisted of decaying leaves of *Aponogitum* and *S. molests*. The *S. molesta* component was about 28% by volume of the total detritus matter and its highest percentage was found from May to June and November to December. The detritus component at Deegarolla was mostly composed of mangrove leaves. *S. molesta* and Aponogitu were completely absent there.

The fauna of the bottom sediment was composed of polychaetes, amphipods, *Caridina* spp, clams and brackish water snails. Polychaetes outnumbered all the others at Deegarolla and that of *Caridina* spp. and copepods at Molpe.

## 4. Discussion

Penaeid prawns generally feed on small and large polychaete worms, crustaceans, filamentous green algae, fish larvae, green leaves and detritus (Hall, 1962; Chopra 1939; Gopalakrishna, 1952). However, the percentages of the above in the diets varies from species to species studied. For example, non-copepod large crustacean fragments are more prominent in the diet of *P. monodon*. The diet also varies seasonally, namely pre — and post-monsoon seasons (Kuttiyama, 1974). The present study too demonstrated a seasonal feeding pattern by *M. ensis*, which is attributed to the availability of detritus, one of its major food items, in the lagoon. During the monsoon period the lagoon contains almost fresh water due to heavy rains (Jinadasa, 1985). As a result the entire lagoon flushes out, creating turbulence, mixing the sediments, and removing some of the sediments to the sea along with receding water during low tides.

*P. indicus* feeds on amphipods, polychaete worms and large crustaceans (George 1972 b). Here too seasonal variations were noted. Similarly, *M. elegans* feeds on small crustaceans filamentous green algae and detritus (Hall, 1962). *M. ensis* on the other hand also feeds on the above and green leaves as well. In *M. dobsoni*, crustaceans were more common during monsoon periods and fresh plant matter was high during monsoon periods (Kuttiyama, 1974). However, none of the above workers has demonstrated to what extent their feeds overlap and whether there is a competition for food among the above commercially important penaeid prawns.

The present study which concentrated on four species of commercially important penaedi prawns also show the basic components of their diet are similar with a clear indication of dietary overlap leading to competition for food. However, their distribution in the Bolgoda Lagoon tend to reduce the competition to a large extent by partitioning the dieta. Bruin (1971) had showed that *P. indicus* and *M. dobsoni* migrate out of the lagoon during May, November and December. Thus reducings the population density seasonally, which means more food is available for resident species during the above period. Further, our sampling and discussions with the fishermen indicated that these four species are not uniformly distributed throughout the lagoon. *P. indicus*, for instance, is confined more twards the lower one third of the lagoon, where the water has high salinity. In this region the benthic fauna and the detritus component is quite different from the rest of the lagoon. There the fauna is dominated by polychaete worms and amphipods, which are mostly stenohaline species, Similarly, the diet of *P. indicus* contained high percentages of the above fauna, which are not available for other species as they are not mostly found there due to high salinity.

*P. monondon* on the other hand is distributed throughout the lagoon and its diet is composed of a wider spectrum of benthic fauna and flora consisting of polychaetes, *Gammarus* spp, copepods and other non copepod crustaceans, *caridina* spp, clams, filamentous green algae. *Caridina* spp and filamentous green algae are mostly found towards the head end of the lagoon. Thereby reducing the dietary overlap with that of *P. indicus*. *M. ensis*, and *M. dobsoni* are mostly confined to the upper one third of the lagoon, except *M. dobsoni* during the migratory period. In this part of the lagoon the salinity is low and the fauna and flora are different. For example, *caridina* spp and *S. molesta* are more abundnat there than at the lower part of the lagoon. The above fauna and flora form the bulk of the diet of *M. ensis*. Therefore, reducing the dietary overlap and competition for food with the other species to a large extent. Further, the vacuity index, which is a measure of voracity, is the lowest in *M. dobson*. Similarly, *M. ensis* is more detritivrous than *M. dobsoni*. Therefore, the dietary overlap and competition for food is minimised between *M. ensis* and *M. dobsoni*.

The diurnal feeding pattern of *M. ensis* is slightly different from most of the other penaeid prawns in that it is most active during the early hours of the night and morning whereas other penaeid prawns are active throughout the night (George, 1962). The present study too demonstrated a feeding peak from abcut 10—11 pm for *M. ensis*. Therefore, their feeding behaviour further helps to avoid competition for food. The above account indicates that the diet of the penaeid prawns of the Boigoda Lagoon basically have the same components but in different proportions. That is, there is diet overlap among them. However, their pattern of distribution and that of the benthic fauna along with the feeding behaviour of some of them help to reduce dietary overlap and competition for food.

## 5. Conclusions

The diet of commercially important penaeid prawns of the Bolgoda Lagoon consist of small and large crustaceans, fish larvae, polychaeta worms, green algae, green leaves of mangrove and aquatic weeds and detritus. Their frequency of occurrence and the percentage number of crops containing a particular diet varied among the species. However, there is dietary overlap and competition among them, which are minimised by the pattern of distribution of benthic fauna, flora and prawns as well as the feeding behaviour.

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Table I : The diets of four species of Penaeid Prawns of the Bolgoda Lagoon.

| Type of Diet | Species | | | |
|---|---|---|---|---|
| | *P. monodon* | *P. indicus* | *M. ensis* | *M. dobsoni* |
| Filamentous green algae | | | | |
| *Enteromorpha* spp | + | + | + | ++ |
| Others | + | + | + | ++ |
| Crustaceans | | | | |
| *Caridina* spp. | + | — | + | ++ |
| *Harpacticoid* spp. | + | ++ | — | — |
| *Gammarus* spp. | + | ++ | — | — |
| Diatoms | — | ++ | — | — |
| Detritus | + | + | ++ | ++ |
| Fish Larvae | + | +++ | — | — |
| Others | + | ++ | + | — |
| Green Leaves | + | + | ++ | ++ |
| Invertebrate eggs | + | + | ++ | ++ |
| Molluscs | | | | |
| Bivalves | + | + | — | — |
| Gastropods | — | + | — | — |
| Polychaetes | | | | |
| *Naries* spp. | + | + | + | — |
| *Terribelides* spp. | + | + | — | — |

—absent + present in less than 25% ++ present in more than 50%

**Table 2**: The percentages of crops containing the components of the diet.

| Species | Components of the diet | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Filamentous algae | *Gammarus* spp. | Copepods | Other crustacea | Detritus | Diatoms | Green leaves | Fish larvae | Polychaetes | Others unidentified | Molluscs | N | Carapace Length range (cm) |
| *P. monodon* | 30.7 | 38.7 | 31.7 | 100. | 61.5 | 15.8 | 47.2 | 15.8 | 76.9 | 100 | 23 | 390 | 1.9 — 4.0 |
| *P. indicus* | 61.7 | 71.4 | 42.4 | 72.4 | 57.1 | 28.3 | 37.4 | 14.2 | 85.7 | 37 | 14.2 | 876 | 1.7 — 3.2 |
| *M. ensis* | 54.5 | 9.0 | 27.2 | 36.6 | 36.2 | 8.7 | 36.4 | 8.3 | 36.4 | 26 | 8.3 | 1640 | 0.8 — 3.5 |
| *M. dobsoni* | 59.1 | — | 27.6 | 85.7 | 100 | 14.3 | 85.7 | — | 21.4 | 19 | — | 2321 | 0.9 — 2.1 |

N — Number of prawns examined.

**Table 3 :** Percentage frequency distribution of the diet.

| Species | Components of the diet | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Filamentous algae | Gammarus spp. | Copepods | Crustacea Other | Detritus | Diatoms | Fish larvae | Green leaves | Molluscs | Polychaetes | Others | N | Carapace Length range (cm) |
| *P. monodon* | 22.8 | 4.6 | 3.3 | 12.5 | 6.1 | 0.7 | 1.3 | 16.3 | 2.3 | 12.3 | 2.0 | 390 | 1.9 — 4.0 |
| *P. indicus* | 11.8 | 1.3 | 5.1 | 16.4 | 5.3 | — | — | 12.2 | 2.5 | 32.0 | 2.2 | 870 | 1.1 — 3.2 |
| *M. ensis* | 11.6 | 0.2 | 1.3 | 6.5 | 59.1 | 1.0 | — | 6.7 | — | 3.1 | 2.1 | 1670 | 0.8 — 3.5 |
| *M. dobsoni* | 15.0 | — | 2.6 | 49.8 | 1.0 | — | 6.2 | — | — | 3.8 | 1.7 | 2321 | 0.9 — 2.1 |

N = Number of prawns examined.

**Table 4 :** The percentage frequency distribution of the empty crops of *M. ensis* during the year (carapace length 2 - 3cm).

| Month | Jan | Feb | Mar | Apr | May | Jun | Juy | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage (mean) | 19 | 16 | 17 | 41 | 60 | 32 | 23 | 17 | 19 | 23 | 21 | 31 |
| Range | 13-26 | 11-32 | 12-28 | 38-53 | 53-66 | 28-41 | 18-37 | 11-41 | 21-39 | 17-35 | 16-37 | 23-42 |

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