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 occurrence 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.
Jinadasa.

Introduction

There is an established Penaeid and Palaemonoid prawn fishery 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
Penaeus 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 dietary 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 commercial 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 wherever possible. Tissues of fresh plants from the lagoon were used as references when-ever needed to confirm identification. Their numbers in the crops, frequency of crops containing a particular diet and the number of empty stomachs were recorded.

Two glass aquaria (90 x 45 x 45 cm) were set up, containing sediment obtained from 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 sieves with mesh size 1, 0.5, 0.25 and 0.125 mm. The contents on each of the sieves were then identified. The proportional diet overlap among species was calculated using the overlap coefficient (C) of Schiener (1970) according to the following formula.

\[ C = 1 - \frac{1}{2} \left( P_{ij} - P_{hi} \right) \]

Where \( P_{ij} \) 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.

### 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 \( P. \)
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, filamentous 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-5.3) 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.

![Graph](image)

*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. molesta*. 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 *Aponogitus* 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 penaeid 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 towards 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. monodon* 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 abundant 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. dobsoni*. Similarly, *M. ensis* is more detritivorous 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 about 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.

6. Acknowledgement

The above study was funded by the grant No. RGB/2/79 of the Natural Resource Science and Energy Authority, which was given to study the possibilities of pond culture of *M. ensis*. The author also likes to thank Professor Winston E. Ratnayake, Head, Department of Zoology University of Sri Jayewardenepura, for revising the manuscript.

Table 1: The diets of four species of Penaeid Prawns of the Bolgoda Lagoon.

<table>
<thead>
<tr>
<th>Type of Diet</th>
<th><em>P. monodon</em></th>
<th><em>P. indicus</em></th>
<th><em>M. ensis</em></th>
<th><em>M. dobsoni</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Filamentous green algae</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td><em>Enteromorpha</em> spp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Others</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Crustaceans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Caridina</em> spp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>Harpacticoid</em> spp.</td>
<td>+</td>
<td>+ +</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Gammarus</em> spp.</td>
<td>+</td>
<td>+ +</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Diatoms</td>
<td>-</td>
<td>+ +</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Detritus</td>
<td>+</td>
<td>+</td>
<td>+ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Fish Larvae</td>
<td>+</td>
<td>+ + +</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>+</td>
<td>+ +</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Green Leaves</td>
<td>+</td>
<td>+</td>
<td>+ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Invertebrate eggs</td>
<td>+</td>
<td>+</td>
<td>+ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Molluscs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bivalves</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gastropods</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Polychaetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Naries</em> spp.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Terribelides</em> spp.</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

—absent + present in less than 25% ++ present in more than 50%
Table 2: The percentages of crops containing the components of the diet.

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

N — Number of prawns examined.
Table 3: Percentage frequency distribution of the diet.

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

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).

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage (mean)</td>
<td>19</td>
<td>16</td>
<td>17</td>
<td>41</td>
<td>60</td>
<td>32</td>
<td>23</td>
<td>17</td>
<td>19</td>
<td>23</td>
<td>21</td>
<td>31</td>
</tr>
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REFERENCES