CHAPTER VIII

ANALYSIS OF GUT CONTENTS
The analysis of gut contents has revealed that crustaceans, polychaetes, molluscs, echinoderms and small fishes (only in case of fishes of larger body length) constitute the main food items of the fishes of present study. It has also revealed the presence of some protozoa, helminths and some sand particles along with the food items. The description of each of the items is given below separately. The percentage composition of volume of various food items in relation to body length and seasons for all the fishes has been presented in separate histograms (Figs. 110, 111, 112, 113). It may be mentioned here that all the food items could not be completely identified as complete forms were not always available.

Amphipods

They form the major food item for the young individuals in all seasons. They decrease gradually in quantity with the increase of body length of the fishes and are lacking in the gut of fishes of larger size groups. This food item also shows seasonal fluctuation. During summer amphipods are relatively reduced in quantity. However, in P. blochii the decrease is marked both during summer and post-monsoon seasons.

Crustacea (other than amphipods)

Crustaceans other than amphipods form another major food item of these fishes. The crustaceans identified are as follows:

1. Phylum - Arthropoda
   Class - Crustacea
   Sub-class - Malacostraca
   Super order - Hexapoda
   Order - Stomatopoda
   Family - Squillidae
   Squilla sp. (Juveniles)

2. Super order - Peracarida
   Order - Isopoda
   Family - Cirolanidae
   Cirolana porcellana Barnard

...
3. Super-order - Bucarida
Order - Decapoda
Infra order - Penaeidea
Penaeid shrimp

3a. Infra order - Caridea
I. Family - Alpheidae
Alpheid shrimp
II. Family - Crangonidae
Crangonid shrimp

3b. Infra order - Brachyura
Scylla serrata (Juveniles)

The crustaceans (other than amphipods) though present in less quantity in the smaller individuals, increase gradually with the increase of body length of the fishes and ultimately become the primary food item of the larger fishes. No remarkable seasonal variation in the quantity of this food item has been found.

Molluscs

In the fishes of larger body length, molluscs form another major food item and are generally present in large quantities. A list of identified molluscs ingested by the fishes is given below:

Phylum - Mollusca
Class - Bivalvia
Order - Balamellibranchiata

1. Family - Veneridae
   *Mactra (Mactra) luzonica* Deshayes
2. Family - Semelidae
   *Theora opalina* (Hinds)
3. Family - Tellenidae
   *Tellina iridescens* Benson
   *Tellina casta* Hanley
4. Family - Solenidae
   *Solen* sp.
Seasonal variation of this food item is very remarkable. They are available in plenty in the guts during winter but are reduced from summer onwards and becomes almost negligible in the early monsoon period.

Polychaetes

Polychaetes belonging to the family Eunicidae also constitute a substantial food item of the diet. They were found to have been taken in large quantity by the fishes of intermediate size groups, that is in *G. arel* (175 mm - 275 mm), *G. lingua* (225 mm - 325 mm), *G. bilineatus* (175 mm - 325 mm) and *P. blochii* (115 mm - 215 mm). Polychaetes as a food item also show seasonal fluctuation. During winter season they were found to have been consumed in sufficient quantity but they were reduced during summer and monsoon seasons.

Echinoderms

The vertebra like ossicles of the Brittle or Serpent stars belonging to sub-class - Ophiuroidea of class Stelleroidea were occasionally found in the gut contents of fishes of larger size. However, they were never found in the intact form as a result it was not possible to identify them in detail. *P. blochii* was never found to have taken this food item.

Fishes

Fishes form an irregular item of the diet and occasionally, partially digested fish body and skeletons were found in the gut contents of fishes of larger body length. But *P. blochii* was never found to have taken this item.
Protozoa

The gut contents were found to contain some shelled protozoans. They were found almost in all fishes irrespective of their size and season. The protozoans as identified were,

Phylum - Protozoa
Class - Rhizopoda
Order - Foraminifera

1. Rotalia pulchella d'arbigny
2. Rotalia calcar Hofker

Parasites

Intestinal parasites were common among the fishes and were found in most of the fishes examined irrespective of their body length and the season. However, no morphological abnormalities has been found due to the presence of the parasites. A list of the identified parasites is given below.

Phylum - Platyhelminthes
Class - Trematoda Rudolphi, 1808
Sub-class - Digenea Van Beneden, 1858
Order - Prosostomata Odhner, 1905

I. Family - Lepocreadiidae (Odhner, 1905) Nicoll, 1935
   Sub-family - Lepocreadiinae Odhner, 1905
   Genus - Lepocreadioides Tamaguti, 1936
   Lepocreadioides indicus Srivastava, 1941

II. Family - Opecoelidae Ozaki, 1925
    Sub-family - Flagioporinae Manter, 1947
    Genus - Plagioporus Stafford, 1904
    Plagioporus sp.
Phylum - Nemathelminthes
Class - Acanthocephala Rudolphi, 1801
Order - Palaeacanthocephala Meyer, 1931
Super family - Echinorhynchoidea (Cobbold, 1876) Golvan and Houin, 1963
Family - Rhadinorhynchidae Travassos, 1923
Sub-family - Serrasentinae Petrotschenko, 1956
Genus - Serrasentis Van Cleave, 1923
*Serrasentis sagittifer* (Linton, 1889) Linton, 1932

Sand

A small amount of sand particles were invariably found in the gut contents of most of the fishes examined.
<table>
<thead>
<tr>
<th>Body length, group (in mm)</th>
<th>Polychaete</th>
<th>Amphipod</th>
<th>Crustacea (other than amphipod)</th>
<th>Mollusca</th>
<th>Ophiuroid</th>
<th>Pisces</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 - 175</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>175 - 225</td>
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<tr>
<td>225 - 275</td>
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<tr>
<td>275 - 325</td>
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<td></td>
</tr>
<tr>
<td>325 - 375</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10. *C. bilineatus*
<table>
<thead>
<tr>
<th>Body Length Group (in mm)</th>
<th>Polychaete</th>
<th>Amphipod</th>
<th>Mollusca</th>
<th>Ophiuroid</th>
<th>(other than amphipod)</th>
<th>Crustacea</th>
</tr>
</thead>
<tbody>
<tr>
<td>225 - 275</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.74</td>
<td>3.47</td>
<td>9.20</td>
</tr>
<tr>
<td>275 - 325</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.47</td>
<td>3.47</td>
<td>9.20</td>
</tr>
<tr>
<td>325 - 375</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.47</td>
<td>3.47</td>
<td>9.20</td>
</tr>
<tr>
<td>375 - 425</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.47</td>
<td>3.47</td>
<td>9.20</td>
</tr>
</tbody>
</table>

**Table 9.**

Legends as given in the Table.
<table>
<thead>
<tr>
<th>Body Length Group (in mm)</th>
<th>Mollusca</th>
<th>Amphipoda</th>
<th>Ophiuroid</th>
<th>Polychaeta</th>
<th>Crustacea (Other than amphipod)</th>
<th>V. u. x. v. w j x x 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 - 0.44</td>
<td>4.08</td>
<td>7.14</td>
<td>0.46</td>
<td>0.55</td>
<td>4.05</td>
<td>2.57</td>
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<tr>
<td>0.45 - 0.99</td>
<td>0.03</td>
<td>9.46</td>
<td>2.99</td>
<td>0.49</td>
<td>1.23</td>
<td>0.81</td>
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<td>1.00 - 1.49</td>
<td>0.02</td>
<td>3.96</td>
<td>0.46</td>
<td>0.55</td>
<td>2.57</td>
<td>0.03</td>
</tr>
<tr>
<td>1.50 - 1.99</td>
<td>0.02</td>
<td>9.46</td>
<td>2.99</td>
<td>0.49</td>
<td>1.23</td>
<td>0.81</td>
</tr>
<tr>
<td>2.00 - 2.49</td>
<td>0.03</td>
<td>9.46</td>
<td>2.99</td>
<td>0.49</td>
<td>1.23</td>
<td>0.81</td>
</tr>
<tr>
<td>2.50 - 2.99</td>
<td>0.02</td>
<td>3.96</td>
<td>0.46</td>
<td>0.55</td>
<td>2.57</td>
<td>0.03</td>
</tr>
<tr>
<td>3.00 - 3.49</td>
<td>0.02</td>
<td>3.96</td>
<td>0.46</td>
<td>0.55</td>
<td>2.57</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*V. u. x. v. w j x x 1* indicate the volume and occurrence index of a food item (indicated by their percentages). *I_A* is the index of preponderance for the food item.
<table>
<thead>
<tr>
<th>Body length group (in mm)</th>
<th>115 - 165</th>
<th>165 - 215</th>
<th>215 - 265</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food items</td>
<td>( V_1 )</td>
<td>( O_1 )</td>
<td>( I_1 )</td>
</tr>
<tr>
<td>Polychaete</td>
<td>12.44</td>
<td>12.71</td>
<td>5.34</td>
</tr>
<tr>
<td>Amphipod</td>
<td>50.60</td>
<td>37.08</td>
<td>63.34</td>
</tr>
<tr>
<td>Crustacea (other than amphipod)</td>
<td>18.42</td>
<td>25.85</td>
<td>16.07</td>
</tr>
<tr>
<td>Mollusca</td>
<td>18.54</td>
<td>24.36</td>
<td>15.25</td>
</tr>
<tr>
<td>Ophiuroid</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fish</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Legends as given in the Table 8
FIG. II0 PERCENTAGE COMPOSITION OF VOLUME OF VARIOUS FOOD ITEMS OF C. areli IN RELATION TO ITS BODY LENGTH AND SEASONS.
PERCENTAGE COMPOSITION OF VOLUME OF VARIOUS FOOD ITEMS OF *C. lingua* IN RELATION TO ITS BODY LENGTH AND SEASONS.
Fig. 112 Percentage composition of volume of various food items of *C. bilineatus* in relation to its body length and seasons.
**FIG. 113** PERCENTAGE COMPOSITION OF VOLUME OF VARIOUS FOOD ITEMS OF *P. blochii* IN RELATION TO ITS BODY LENGTH AND SEASONS.
The study of food of fish is an important aspect of the knowledge on its biology. A vast wealth of information has been accumulated in this line due to the contribution of a great number of workers as mentioned below.

Todd (1914) studied the food of plaice. Steven (1930) observed the bottom fauna and the food of fishes. Sayehiro (1942) investigated the digestive system and feeding habits of different groups of fishes including Pleuronectidae. Mookerjee et al. (1946) investigated the food of the Mugil peregus (Ham) and made some valuable suggestion for their culture in the freshwater ponds of Bengal. Jones (1952) studied the bottom fauna and the food of the flatfishes off the Cumberland Coast. Pillay (1953) investigated the food of Mugil tade Forskal and correlated it with the structure of alimentary tract. Seshappa and Bhimachar (1955) observed the food of Cynoglossus semifasciatus in detail. Kuthalingam (1957) observed the feeding habits of early larval stages of C. lingua in the laboratory. For the study of the diet of the adults he observed only 59 specimens. Pradhan (1959) investigated the food and feeding habits of Pseudorhombus elevatus Ogilby of the Bombay Coast. Noble (1962) observed the food and feeding habits of Rastrelliger kanagurta (Cuvier). Sivaprakasam (1963) and Kuthalingam (1963) worked on the food and feeding habit of Parastromatus niger and Pampus argenteus respectively. Kagwade (1964) observed the food and feeding habits of Sardinella longiceps Valenciennes. Ryland (1964) made a comparative study of the feeding habit of plaice and sand eel larvae in the Southern North Sea. Nordeng and Bratliard (1971) studied the feeding habit of larvae of Pleuronectes platessa and Gadus morhua. De Groot (1971) did a brilliant work by correlating the morphology of the alimentary canal with the food and feeding habits of different groups of flatfishes. Though his study included family Cynoglossidae, his investigation did not include the fishes under the present study. Devadoss and Pillai (1973) found larval and post larval forms of polynemus, sciaenids, thrissocles, anchoviella and leiothymidis in the
stomach contents of juvenile *Psettodes erumei* (Bloch).

The above information reveals that till now no literature is available regarding the food of the fishes under the present investigation. So the present investigator has tried to make a detail study of the food and feeding habits in relation to their body length and season. The investigator has also made an attempt to correlate the result of the gut content analysis with the remarks made in the previous chapters.

The present investigation indicates that the gut contents consisted of polychaetes, crustaceans, molluscs, ophiuroids, fishes, shelled protozoans and some sand particles as well. The sand and the foraminiferan shells may not be considered as the food item as they enter into the gut probably along with the bottom living organisms on which the fishes feed. Seshappa and Bhimachar (1955), and Kuthalingam (1957) were also of the same opinion that mud and foraminiferan shells enter along with the bottom living food organisms.

Seshappa and Bhimachar (1955) did not observe a change in the feeding habits of *C. semifasciatus* with the increase of their body length. However, change in the feeding habit of fishes with the increase of body length has already been observed by many previous workers. Amongst them Kuthalingam (1957) observed in *Cynoglossus lingua* that while the larva after 72 hours of hatching feeds on copepod nauplii and diatoms, 10 days after hatching it feeds only on adult copepods. But the diet of the adult was found to be consisting of polychaetes, crustaceans, lamellibranchs and gastropods. Some sand and foraminiferan shells were also found to be associated with the food. Pradhan (1959) found in *Paedichromis elongatus* Ogilby that, in the body length group (6-10 cm) and (11-15 cm) crabs form the major food item and prawns and fishes form the second food item. In the body length group (21-25 cm) fishes form the major (99%) of the food item. Such changes in the feeding habit of the fishes have also been confirmed by De Groot (1971). The above author observed in *Lepidorhombus whiffiagonis* and *Reinhardtius hippoglossoides* of which the juvenile stages feed mainly on crustaceans, but the adults on fishes.
The result of the present investigation is remarkable. It indicates a clear shift in the feeding habits of the fishes with the increase of body length. It has been found, that the preponderance index of amphipods is the highest in the fishes of smallest length group and gradually decreases with increase of body length and finally becomes zero in the largest length group (Tables 8-11). Unlike the amphipods, the preponderance index of crustaceans (other than amphipods) is low in the smallest length group, increases with the increase of body length and finally becomes highest (Tables 8-11). So a clear inverse relationship is found between the preponderance index of amphipods and crustaceans (other than amphipod). Polychaetes which form the third major food item of the fishes of smaller length group decrease gradually with the increase of body length and become an insignificant item or may be altogether absent in the fishes of the largest length group (Tables 8-11). In P. blochii polychaetes form the third and fourth major food item in the largest and smallest fishes respectively (Tables 8-11). Seshappa and Bhimachar (1955) observed that the polychaetes which form a dominant food item of C. semifasciatus during the post monsoon period are reduced during the monsoon and premonsoon period. The present author has also found a similar fluctuation.

Molluscs form the fourth major food item in the small individuals which gradually increase with the increase of body length and become the second or third item in the larger fishes. However, in P. blochii molluscs form the third major food item in the smallest length group and is elevated to the second rank in the larger body length group (Tables 8-11).

Serpent stars are generally found to have been consumed by the fishes of larger size. Suyehiro (1942) also reported the presence of echinoderms in the stomach contents of Hippoglossoides elassodon and Lepidopsetta mohigarei. However, P. blochii was never found to have consumed this food item as revealed from the present study.

The presence of well developed accessory sac (vide Chapter-VI) suggests the bottom dwelling habit of the fishes. The availability of
sand particles and the bottom living organisms (polychaetes, crustaceans and molluscs) in the gut contents also confirms the above suggestion.

The in-depth analysis of the gastrointestinal tract specially the low value of relative gut length (vide Chapter-VII) suggests the carnivorous nature of the fishes. The result of the gut contents analysis also provides support to the above contention.

The teeth pattern of the jaws and os pharyngeus bones (vide Chapter-I) indicates that the fishes are predacious in nature and eat upon hard bodied animals like molluscs and crabs etc. The result of gut content analysis also lends support to the suggestion made.

The absence of gill rakers in the fishes under the present study (vide Chapter-VII) suggests that the fishes prey upon less active animals like crustaceans, polychaetes and molluscs. Also the presence of a relatively small pharyngeal cavity suggests that the fishes are not piscivorous (De Groot, 1971). The same author divided the flat fishes into three groups depending upon the morphology of the alimentary canal and the form of gill rakers.

Fish feeders - Psettodidae, Bothidae, Pleuronectidae type - I.

Crustacean feeders - Pleuronectidae of type - II, Cynoglossidae.

Polychaete molluscs feeders - Soleidae, Pleuronectidae of type - III.

However, the present study of the food of the fishes does not lend support to the contention of De Groot (1971). It has been revealed that besides crustaceans, polychaetes and molluscs are also conspicuously present in the diet. Seshappa and Bhimachar (1955) noticed the presence of fish remains in some gut contents of C. semifasciatus only during the months of August and October, 1950. It may be mentioned that the present worker has observed the presence of small
fishes in the gut contents of the fishes of larger size groups, during all the seasons except in P. blochii. The absence of fish remains in the gut of smaller length groups and its presence in the gut of longer length groups of fishes indicate that the pisces may supplement the food items in the latter groups. Of course, it is evident from the low preponderance index (Tables 8-11) that the pisces are not an item of regular diet. The relatively high preponderance index (20.04) in C. lingua is an exception which may be due to some unforeseen reasons.

To precise the discussion made above, it can be said that the fishes under the present study are purely carnivorous in nature, their food consists mainly of polychaetes, crustaceans and molluscs. A remarkable shift in the food habit has been observed with the increase of body length. The fishes of smaller body length prey mainly upon the amphipods, the larger ones mainly feed upon crustaceans (other than amphipods). It is also noteworthy to mention here that the proposition which was made regarding the probable food and feeding habit from the study of their olfactory organ and morphology of alimentary canal has been found to be correct from the result of gut content analysis.