CHAPTER V

Food and feeding habit of Hilsa, Tenualosa ilisha

5.1. Introduction:

In the case of aquatic animals, it is not easy to observe directly their feeding in their natural habitat and thus determine accurately what they subsist on. It is only the examination of gut contents of fishes that indicate their natural food from which feeding habits can be inferred. Pillay (1952) in his paper “A critique of the methods of study of food of fishes”, however, observed that the gut contents may sometimes contain only the emergency food items consumed by the fish, and conclusions in regard to its natural food based on such studies are bound to be erroneous. He further suggested that this limitation is generally overcome by the alimentation and organs concerned with the selection and capture of food and study of the availability of food materials in the habitat of the fish.

The Indian shad, Hilsa, Tenualosa ilisha (Hamilton), forms a rich commercial fishery in the Brahmaputra river system. Although considerable knowledge has been gained by various workers on the different aspects of the biology and fishery of the species (Pillay & Rosa, 1963; Halder, 1971), yet little work has been done on the food and feeding habits of the species in the Brahmaputra river. Chacko and Ganapati (1949) have listed the different organisms that occurred in the stomach of the adult specimen of Hilsa from the coastal waters of East Godavari District (Andhra Pradesh). They found the stomach of 150 specimens, examined from the Godavari river to be empty. Hora and Nair (1940 a, b), Pillay & Rao (1962) and Halder (1968) have worked on the food of young Hilsa. This study has been undertaken with the view to ascertain the variations in the intensity of
feeding as well as in the composition of food among the different sized groups in various zones and in different seasons.

The food and feeding habits of Hilsa were studied in the Chilka Lake, Orissa, India by Hora and Nair (1940). The food of the young individuals appears to consist mainly of organic detritus (48.56%), copepods (25.82%), algae (10.32%), molluscan larvae (7.85%), mysids (5.34%) and diatoms (2.10%). This result reveals that the juveniles of the Hilsa of Chilka Lake are predominantly bottom feeders as observed by Halder (1968) in Bengal waters.

In addition to the above-mentioned information, together with that presented by Pillay and Rosa (1963), the stomach contents of this species were analyzed and studied and found to contain predominantly species and varieties of the diatom genus *Melosira*. On the other hand, *Synedra ulna* and *Daphnia* sp. were present in lesser numbers (Nurul Islam 1974). In some regions, *i.e.*, Allahabad, India, the fishes show two periods of maximum feeding alternating with a period of starvation or semi-starvation in both males and females. The juveniles are voracious feeders, and sand particles are comparatively more abundant in their stomachs. Rajyalakshmi (1973) states that the feeding condition in the adults in the monsoon season in the Godavary River was always very negligible, whereas juveniles showed fully fed guts with predominantly copepods and rotifers. Where copepods were dominant, *Spirogyra*, diatoms, and other calonid algae were also prevalent, the average proportions being 50% copepods, 35% *Spirogyra* filaments, 1% *Oscillatoria*, 1% diatoms, 2% nematodes, 0.5% colonial algae, 0.5% Cypredae, and 10% organic detritus. Nurul Islam (1974) states that the food contents in the Hilsa stomach analyzed in March of the year were found to be predominantly diatoms with enough sand particles and very few *Daphnia* sp. His observations agree with those of Swarup (1959) in that sexually mature Hilsa feeds during the spawning migration on the diatom genus *Melosira* forms about
98% of the entire population inside the fish stomach in Nurul Islam's (1974) samples.

On the other hand, Al-Nasiri and Al-Mukhtar (1988) determined the food of Hilsa from Ashar Canal, Basrah (Shatt al-Arab River), Iraq. They concluded that the main food of this species of fish is zooplankton (mainly copepods – Cyclops) and phytoplankton such as dinoflagellates and diatoms. The main food items were Cyclotella, Planktosphaera, Oscillatoria, and Cyclops, and they were found in 100% of the stomachs. The remaining food items, such as Ceratium, Melosira, Bacillaria, and Navicula, were found in high occurrence but not in all stomachs. It was also found that the average volume of food in each stomach is more in small fishes than in large ones.

The study of food and feeding habit of fish helps us to study the various aspects of its biology. Some fishes depend on plant sources for food and are herbivorous; other depend on animal sources and are carnivorous while still others derive their requirements from both plants and animals and are omnivorous. There are still fishes that depend on phyto-and zoo-plankton and are called plankton feeders. According to Nikolskii (1963), the food of fishes is classified into i) main food or the natural food which the fish prefers under favorable conditions and on which it thrives best, ii) Occasional food which is well-liked by the fish and consumed as and when available and iii) Emergency food which is consumed for mere survival and when the naturally preferred food items are not available.

Nikolskii (1963) made a similar classification based on the relationship between the fishes and their food, namely:

(i) Basic food, which the fish consumes comprising the main part of the gut content.
(ii) Secondary food, which is frequently found but in small quantities in the gut of the fishes.

(iii) Incident food which is consumed along with the primary food or enters the gut through the respiratory water current, and

(iv) Obligatory food which is consumed in the absence of the basic food. (Khanna, 1993) remarked that fishes are highly adaptable in their feeding habits and utilize the readily available food.

The structure of the buccal cavity, pharynx and gut of teleosts varies in different species in relation to their feeding habits. Each fish species has its own structural adaptations in the alimentary canal towards its specific food habit, which varies greatly in regard to the ratio of animal and plant food material ingested. Thus attempts have been made by Yadav et al., (1989) to study the general morphology and structure of gills in the hill-stream fishes. Thus, the study of bucco-pharynx and gut is very important in the food and feeding habit of the fish species. Another important criteria which is very important in such a study is the nature of the gill-rakers and the spacing between them. The study on food and feeding habit of fish will help fishery biologist for the optimum management, better production and conservation of the various commercially important fishes.

Food and feeding habit of Hilsa gives a comprehensive account of the qualitative and quantitative analysis of the food of Hilsa for a period of one year. The composition of feeding groups contains of all size groups of Hilsa was estimated by point and occurrence method. It is evident from Table 5.1 that the major parts of the food consists of filamentous algae, insects matters, plant debris, sand and stone granules. The occurrence of sand and stone granules throughout the year indicates that the fish is a bottom feeder. Further, it has been observed that a greater percentage of full stomachs was found generally in the months of September and October and a lower percentage from December to February. This
Food and feeding habit

may be due to the effect of low temperature and less abundance of food during December to February.

Feeding intensity was determined by fullness of the stomach and gut was measured arbitrarily as full, \( \frac{1}{2} \) full, \( \frac{1}{4} \) full and empty. Food items were defined to the lowest practical taxa with a compound microscope and blotted weight and number were recorded for each. They were then preserved in 5\% formalin for future study. The different food items were identified up to the generic level and their composition determined by the eye estimation method of Pillay (1953). The percentage of occurrence and food of the fish was identified by the "Point method" proposed by Hynes (1950).

5.2. Observations:

Table -5.1. shows the index of preponderance of different food items in Hilsa during various months. From Fig-5.A. it was seen that during August the amount of preponderance were highest (80.92\%) compared to the April (15.65\%) which was recorded as the lowest amount of preponderance. The other values of preponderance were as in January it was 60.00\%; in February it was 70.54\%; in March it was 66.30\%; in May it was recorded as 20.20\%; in June it was 32.79\%; in July it was 41.30\%; in September it was recorded as 78.66\%; in October it was 66.84\%; in November it was in 71.27\% and in December it was encountered as 61.50\%. The chief food items were encountered as algae, diatoms, copepods, rotifers, insects, sand and organic detritus.
Table 5.1: Index of Preponderance of different Food items in Hilsa during various months.

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae</td>
<td>2.73</td>
<td>26.74</td>
<td>5.55</td>
<td>3.64</td>
<td>6.00</td>
<td>4.15</td>
<td>8.74</td>
<td>8.46</td>
<td>8.16</td>
<td>16.02</td>
<td>6.36</td>
<td>3.35</td>
</tr>
<tr>
<td>Diatoms</td>
<td>7.50</td>
<td>6.24</td>
<td>5.20</td>
<td>3.00</td>
<td>6.63</td>
<td>3.40</td>
<td>13.00</td>
<td>12.91</td>
<td>13.67</td>
<td>6.60</td>
<td>5.00</td>
<td>15.72</td>
</tr>
<tr>
<td>Copepods</td>
<td>12.11</td>
<td>7.00</td>
<td>12.02</td>
<td>1.20</td>
<td>0.90</td>
<td>4.00</td>
<td>8.87</td>
<td>12.91</td>
<td>13.67</td>
<td>6.60</td>
<td>5.00</td>
<td>15.72</td>
</tr>
<tr>
<td>Rotifers</td>
<td>17.8</td>
<td>4.81</td>
<td>6.23</td>
<td>0.80</td>
<td>1.29</td>
<td>2.76</td>
<td>4.96</td>
<td>10.25</td>
<td>10.84</td>
<td>9.03</td>
<td>8.72</td>
<td>15.42</td>
</tr>
<tr>
<td>Insects</td>
<td>11.44</td>
<td>4.28</td>
<td>11.90</td>
<td>0.45</td>
<td>1.41</td>
<td>3.16</td>
<td>3.80</td>
<td>5.08</td>
<td>16.40</td>
<td>16.22</td>
<td>6.00</td>
<td>18.46</td>
</tr>
<tr>
<td>Sand</td>
<td>4.21</td>
<td>10.06</td>
<td>9.20</td>
<td>1.41</td>
<td>2.76</td>
<td>5.27</td>
<td>1.86</td>
<td>6.00</td>
<td>17.61</td>
<td>14.30</td>
<td>8.55</td>
<td>10.90</td>
</tr>
<tr>
<td>Organic detritus</td>
<td>4.21</td>
<td>9.81</td>
<td>12.02</td>
<td>2.76</td>
<td>1.86</td>
<td>6.00</td>
<td>17.61</td>
<td>14.30</td>
<td>8.55</td>
<td>10.90</td>
<td>6.41</td>
<td>61.50</td>
</tr>
<tr>
<td>Total food index (monthwise)</td>
<td>60.00</td>
<td>70.54</td>
<td>66.30</td>
<td>13.65</td>
<td>20.02</td>
<td>32.79</td>
<td>41.30</td>
<td>82.92</td>
<td>82.92</td>
<td>78.66</td>
<td>66.84</td>
<td>71.27</td>
</tr>
</tbody>
</table>

*Table-5.1: Index of Preponderance of different Food items in Hilsa during various months.*
Fig-5.A: Bar diagram showing Index of preponderance of different Food items during different months.
5.2.1. Food preferences of Hilisa:

The samples were divided into eight size groups for gut analysis studies according to their length viz. (i) 10-15 cm. (ii) 16-20 cm. (iii) 21-25 cm. (iv) 26-30 cm. (v) 31-35 cm. (vi) 36-40 cm. (vii) 41-45 cm. and (viii) 46-50 cm. Food preference of all the three size groups are presented in Table 5.2. and Fig-5.B.

a. **Size group 10-15 cm**:

Analysis of gut contents of 125 specimens revealed that the zooplankton was the main food of this size class with an (index of preponderance) average of 53.29%. Copepods and Rotifers were represented the chief food materials in that size group. Phytoplankton encountered second highest (10.34%) preferable food materials which is constitute mainly of algae and diatoms. Organic detritus registered as 22.41% while sand (8.54%) and Insects (5.42%) came next in order of dominance.

b. **Size group 16-20 cm**:

Analysis of gut contents of this range revealed that the zoo-plankton and phyto-plankton both were the main food content representing 38.70% and 15.34%; while sand granules were recorded as the next with 16.40%. Among Zooplankton, Rotifer and Copepods are the chief food materials. Among Phyto-plankton; Blue-green Algae and Diatoms are the main constituents of the gut. Miscellaneous registered an 21.26% and Insect come (8.30%) to the next.
c. **Size group 21-25 cm:**

Analysis of this group revealed that the zoo-plankton (30.31%) were highly preferred by the young Hilsa than in the phyto-plankton (14.24%). Sand granules were recorded as the high numbers with 20.16%. Miscellaneous registered as 23.10% while insects (12.50%) recorded a large amount in order of dominance.

d. **Size group 26-30 cm:**

Phytoplankton was the chief food items of this groups of ilisha. It registered a total of 45.00% of the total gut content. Zoo-plankton were recorded as the next highest food item (20.30%). Sand granules (8.50%) and insects (6.25%) were come to the next category while miscellaneous were recorded as 20.00% of the main food content.

e. **Size group 31-35 cm:**

This size group may be considered as the young group. At this stage it was seen that the fish preferred both phyto and zoo plankton in more or less same volume. From the table it was recorded that young ilisha preferred zooplankton (35.12%) and phyto-plankton (38.50%) as a same amount. Sand granules were encountered as 12.80% while insects recorded as least number or no record of insect dominance. Miscellaneous represented 15.50% of total food content.

f. **Size group 36-40 cm:**
In this group of fishes are categorized as the adult fish. Gut analysis of this group of fishes reveals that the Hilsa prefer predominantly phyto-plankton with an average of 45.40% of the total food contents. Zooplankton recorded as very little amount as 4.10%. Insects encountered about 12.18% while miscellaneous and undigested food registered 30.57% of the total food materials.

g. Size group 41-45 cm:

Phytoplankton specially algae and diatoms were recognized the chief food item constituting 45.50% of the total food materials. Zooplankton constitute the 7.10% while sand granules also encountered 7.75% of the total food materials. Insects reveal 12.18% while miscellaneous and undigested food registered 27.57% of the gut content.

h. Size group 46-50 cm:

In this group of fish a mixed types of food materials was observed. It also depends upon various locality where they found. Though both phyto-plankton and zoo-plankton are the chief food materials in this group, phyto-plankton encountered more predominant, 28.40% while zoo-plankton comprises only 6.20%. Sand granules recorded 28.18% and insects encountered 4.33% and undigested materials and miscellaneous items composed 32.89% of the total food materials in the gut.
Table-5.2: Index of Preponderance of different food items of Hilsa in different size groups.

<table>
<thead>
<tr>
<th>Food item</th>
<th>10-15 cm</th>
<th>16-20 cm</th>
<th>21-25 cm</th>
<th>26-30 cm</th>
<th>31-35 cm</th>
<th>36-40 cm</th>
<th>41-45 cm</th>
<th>46-50 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoplankton</td>
<td>10.34</td>
<td>15.34</td>
<td>14.24</td>
<td>45.00</td>
<td>38.50</td>
<td>45.40</td>
<td>45.40</td>
<td>28.40</td>
</tr>
<tr>
<td>Zooplankton</td>
<td>53.29</td>
<td>38.70</td>
<td>30.31</td>
<td>20.30</td>
<td>35.12</td>
<td>4.10</td>
<td>7.10</td>
<td>6.20</td>
</tr>
<tr>
<td>Sand</td>
<td>8.54</td>
<td>16.40</td>
<td>20.16</td>
<td>8.50</td>
<td>12.80</td>
<td>7.75</td>
<td>7.75</td>
<td>28.18</td>
</tr>
<tr>
<td>Insects</td>
<td>5.42</td>
<td>8.30</td>
<td>12.50</td>
<td>6.25</td>
<td>-</td>
<td>12.18</td>
<td>12.18</td>
<td>4.33</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>22.41</td>
<td>21.26</td>
<td>23.10</td>
<td>20.00</td>
<td>14.50</td>
<td>30.57</td>
<td>27.57</td>
<td>32.89</td>
</tr>
</tbody>
</table>

5.2.2. Food Preferences by Season:

The relative contribution of different food items and seasonal variation are in Fig-5.C.

Algae:

Blue-green algae specially *Spirogyra, Eudornia* and *Pediatrum* were encountered in the pre-spawning periods with an average $I_1$ value of 14.53%. In the spawning and post-spawning periods the average $I_1$ value was 4.41% and 6.31% respectively. The maximum utilization of algae was in the month of February (28.34%) and March (26.74%). The group was predominant in most of the months except November, December and January.
Food and feeding habit

Fig- 5.B: Diagram shows average food preference of Hilsa in different size range.
Food and feeding habit

**Spawning (Apr-July)**

**Post-spawning (Aug-Nov)**

**Pre-spawning (Dec-Mar)**

Fig-5.C : Average index of Preponderance of individual food item consumed by adult Hilsa during Pre-spawning, Spawning and Post-spawning periods.
Diatom:

Diatom encountered predominant in the spawning months with an average $I_1$ of 10.88%. The chief diatoms were *Synedra* and *Oscillatoria*. In the spawning and pre-spawning periods the average $I_1$ value were 4.56% and 9.60% respectively. The predominance of the food item was in March (21.30%) followed by October (16.02%), August (13.00%).

Copepods:

Copepods specially *Cyclops* were the chief food materials preferred by smaller sized ilisha. The predominance of the food item was encountered in the pre-spawning periods with an average $I_1$ value of 11.71%. In the spawning and post-spawning periods the average $I_1$ value was 3.74% and 9.55% respectively. The maximum utilization of algae was in the month of September (13.67%) and January (12.11) followed by March (12.02)%). Low number was found in spawning period.

Rotifers:

Rotifers specially *Keratella* and *Monostyla* were encountered in the pre-spawning periods with an average $I_1$ value of 12.14%. In the spawning and post-spawning periods the average $I_1$ value was 2.80% and 10.07% respectively. The maximum utilization of algae was in the month of December (19.70%), January (17.4%) and November (13.20)%. 

Insects:

Insects comprises of protozoan larvae were encountered in the post-spawning periods with an average $I_1$ value of 11.00%. In the spawning and pre-spawning periods
periods the average $I_1$ value was 4.60% and 9.41% respectively. Semi-digested nymphs were recorded in few stomachs.

**Sand:**

Sand granules are found more or less in all seasons. It is high during post-spawning periods with an average $I_1$ value of 14.27%. In the spawning and pre-spawning periods the average $I_1$ value was 3.36% and 7.37% respectively. It shows that Hilsa fed in all layers of water from bottom to the top.

**Organic detritus:**

The organic detritus comprises of decayed matter, semi digested or undigested food materials. It is high during post-spawning periods with an average $I_1$ value of 12.84%. In the spawning and pre-spawning periods the average $I_1$ value was 3.98% and 8.11% respectively. Its maximum contribution was in the month of August (17.61%) and Sept. (14.30%).

**Stomach Fullness:**

An arbitrary estimation of stomach fullness was made and points allocated as follows:-

<table>
<thead>
<tr>
<th>Stomach Fullness</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorged</td>
<td>10</td>
</tr>
<tr>
<td>Full</td>
<td>8</td>
</tr>
<tr>
<td>¾ full</td>
<td>6</td>
</tr>
<tr>
<td>½ full</td>
<td>4</td>
</tr>
<tr>
<td>¼ full</td>
<td>2</td>
</tr>
</tbody>
</table>
The mean number of point per stomach (fullness index) was determined for each month sample (Table-5.3). It was observed that in breeding seasons (April-July) most of the stomach were empty (86.64% and 74.32% ). Again in winter migration it also seen that a greater number of stomach were found to be empty or very little food in their stomach (66.88% ). February and March and October-November stomachs were more then ½ full while in other months stomachs had less then ½ full contents. In August-September (66.84%) and December-January (67.30%) the fullness of stomach is seen.

Table 5.3 : Monthly Fluctuations in the intensity of feeding.

<table>
<thead>
<tr>
<th>Month</th>
<th>Full</th>
<th>% Full</th>
<th>% Full</th>
<th>% Full</th>
<th>Trace</th>
<th>Empty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr-May</td>
<td>1.54</td>
<td>2.10</td>
<td>0.74</td>
<td>1.11</td>
<td>7.84</td>
<td>86.64</td>
</tr>
<tr>
<td>Jun-July</td>
<td>2.74</td>
<td>3.88</td>
<td>1.33</td>
<td>12.70</td>
<td>4.40</td>
<td>74.32</td>
</tr>
<tr>
<td>Aug-Sept</td>
<td>66.84</td>
<td>8.99</td>
<td>-</td>
<td>4.66</td>
<td>2.77</td>
<td>16.74</td>
</tr>
<tr>
<td>Oct-Nov</td>
<td>10.29</td>
<td>8.30</td>
<td>4.38</td>
<td>3.73</td>
<td>8.44</td>
<td>66.88</td>
</tr>
<tr>
<td>Dec-Jan</td>
<td>67.30</td>
<td>7.34</td>
<td>1.89</td>
<td>0.90</td>
<td>4.78</td>
<td>18.47</td>
</tr>
<tr>
<td>Feb-Mar</td>
<td>38.16</td>
<td>14.12</td>
<td>8.46</td>
<td>5.32</td>
<td>3.12</td>
<td>30.82</td>
</tr>
</tbody>
</table>
5.3. Discussion:

Southwell and Prashad (1918) inferred from the large number of empty stomachs, that adult Hilsa do not feed while ascending the river. Hora (1938 & 1940) recorded that the young Hilsa between 20 mm and 40 mm in length feed mostly on diatoms and sparingly on crustaceans and that slightly larger specimens up to 100 mm were found to feed on smaller crustaceans and also on insects and polyzoa. He also inferred that the young Hilsa feed at the bottom as well. Hora and Nair (1940a) found that algae constituted the bulk of the food eaten during February-March, while diatoms formed the main item during the nor’ westers (March-April).

Hilsa is essentially a plankton feeder and does not show any selectivity in feeding with its closely-set sieve-like gill rakers (Hora, 1938 & 1940; Jones and Sujansingani, 1951). Generally, the items which are preponderant are crustaceans (particularly copepods), diatoms, green and blue algae; organic detritus, mud and sand have also been recorded (Hora, 1938 & 1940; Hora and Nair 1940a; Chacko and Ganapati, 1949; Pillay and Rao, 1962; Halder, 1968 & 1971; Quereshi, 1968; Shafi et al. 1976a, to mention a few). Pillay (1958a) has reported that he did not find any evidence of cessation or appreciable decrease in the feeding activity during the spawning period, but some workers have observed that during spawning migration the intensity of feeding decreases or ceases altogether (Pillay and Rosa, 1963). has further observed that the stomach of spawning Hilsa contains considerable quantities of mud and sand, showing that they feed at the bottom and that the intensity of feeding during the post-spawning period appears to be very high. Pillay and Rosa, 1963). noted that both young and adult Hilsa feed at the bottom in the Godavari. Marked variations in the intensity of feeding were recorded by Halder (1968). He later observed that the fish feed at all depths and that in the juveniles up to 120 mm, crustaceans dominated, and in the size
range 120-160 mm diatoms dominated, but the situation was the reverse in the 180-200 mm group (Halder, 1971).

Quereshi (1968) was of the opinion that in Bangladesh waters, the fish appears to feed only in the sea and they stops feeding while ascending the rivers. The fish is probably sustained by the fat accumulated during the feeding phase in the sea which gets gradually reduced during the upstream journey. He has also noticed the presence of sand grains and mud, indicating bottom feeding recorded that the juveniles were voracious eaters and bottom feeders and that the food and feeding habits change with increase in the size of the fish and with changes in the season.

Hynes (1950) has generalized that any of the more common methods of gut content analysis will give comparable result provided that sufficiently large numbers of fish are examined. Hilsa was found to eat a large number of small organisms in addition to larger ones. In this condition the analysis of the diet in both volume and occurrence gives a better indication of the relative nutritive importance of the different organisms in the diet than either the occurrence or volume method.

The present study indicates that Hilsa, during the early and post-larval stage, are planktophagus and mainly subsist on crustaceans and algae. The juveniles of catfish also prefer crustaceans besides consuming plant matter and insects. In adult Hilsa the preference is shifted to the plant matter and insects followed by detritus and crustaceans. The entire plant matter consumed by the fish may not be utilized fully, since undigested plant matter was observed in the intestine and rectum. The diversity in the intake of different food items indicates that the fish does not have a set preference for any particular diet. It is mostly the availability of food in the environment that matters. Thus, it can safely be inferred that though the catfish is insectivorous, it can also subsist on plant matter, detritus and any
other food like materials that happens to come across its way. The fish has a poor capability to prey, it mostly gropes and scans the environment for food.

De (1986) pointed out that the empty stomachs in fishes during winter, probably were traceable to irregular due to lowered metabolic rates. Labour (1921) also indicated that the empty tracts in summer, probably reflected the low water level and low density of available food organisms. During the present investigations the catfish were observed to have empty stomachs and stomachs with $\frac{1}{4}$ full to $\frac{1}{2}$ full food in the summer and winter months respectively.

The relatively high rate of feeding intensity during the pre-monsoon months may be due to extra energy required for building up of the gonads. The second phase of intensive feeding occurs after the spawning season which is probably utilized for the recovery of fish from spawning and for building up winter reserves (Thakur, 1977).

5.4. Summary:

1. Hilsa is essentially a plankton feeder and does not show any selectivity in feeding with its closely-set sieve-like gill rakers.

2. Generally, the items which are preponderant are crustaceans (particularly copepods), diatoms, green and blue algae; organic detritus, mud and sand have also been recorded.

3. During the early and post-larval stage, Hilsa are planktophagus and mainly subsist on crustaceans and algae.
4. The juveniles of Hilsa also prefer crustaceans besides consuming plant matter and insects.

5. During August the amount of preponderance were highest (80.92%) compared to the April (15.65%) which was recorded as the lowest amount of preponderance.

6. Zooplankton was the main food of the juvenile Hilsa (index of preponderance) average of 53.29%. Copepods and Rotifers were represented the chief food materials in that size range of Hilsa.

7. Phytoplankton specially algae and diatoms were recognized the chief food item constituting 45.50% of the total food materials in the adult mature Hilsa.

8. Blue-green algae specially Spirogyra, Eudornia and Pediatrum were encountered in the pre-spawning periods with an average $I_1$ value of 14.53%.

9. Diatom encountered predominant in the post-spawning months with an average $I_1$ of 10.88%.

10. Copepods specially Cyclops were the chief food materials preferred by smaller sized ilisha. The predominance of the food item was encountered in the pre-spawning periods with an average $I_1$ value of 11.71%.

11. Rotifers specially Keratella and Monostyla were encountered in the pre-spawning periods with an average $I_1$ value of 12.14%.
12. Insects comprises of protozoan larvae were encountered in the post-spawning periods with an average $I_1$ value of 11.00%.

13. Sand granules are found more or less in all seasons. It is high during post-spawning periods with an average $I_1$ value of 14.27%.

14. The organic detritus comprises of decayed matter, semi digested or undigested food materials. It is high during post-spawning periods with an average $I_1$ value of 12.84%.

15. In breeding seasons (April-July) most of the stomach were empty (86.64% and 74.32%). Again in winter migration it also seen that a greater number of stomach were found to be empty or very little food in their stomach (66.88%).