

### **4.1. Introduction**

Fish like any other organisms depends on the energy received from its food to perform its biological processes such as growth, development, reproduction and other metabolic activities. Hence, food is the basis to all function of an individual fish as well as the population. Feeding is one of the main concerns of daily living in fishes, in which fish devotes large portion of its energy searching for food. Detailed data on the diet, feeding ecology and trophic inter-relationship of fishes is fundamental for better understanding of fish life history including growth, breeding, migration (Bal and Rao, 1984) and the functional role of the different fishes within aquatic ecosystem (Blaber, 1997; Wootton, 1998; Hajisamae *et al.*, 2003).

Study of the diet and trophic ecology of the commercially important estuarine fish is also greatly beneficial for fisheries management and conservation (Blaber, 2000). Without knowledge of the food requirements, feeding behaviour pattern, and predator - prey relationships, it is not possible to understand the predicted changes that might result from any natural or anthropogenic intervention.

The same species occupy different habitat may feed on different types of food (Hyndes *et al.*, 1997) or even in the same habitat the diet may vary at

different times. The diets of most fish species changes with age and growth. The time and extent of changes in food and feeding habits varies from species to species and often with changes in the life style or habitat (Blaber, 2000).

An extensive work has been done on the food and feeding ecology of many fish species all over the world. Some of the outstanding works in this field are those of Hynes (1950); Maclean (1971); Hyslop (1980); Gunn and Milward (1985); Motta (1988; 1995); Hyndes *et al.* (1997); Shaheen *et al.* (2001) and Hajisamae *et al.* (2003; 2004; 2006).

A number of scientists have also studied various aspects of food and feeding habits of several fish species from Indian waters (Chacko, 1949; Qasim, 1957a; 1957b; Qasim, 1972; Gowda *et al.*, 1988a; Chandru *et al.*, 1988; Reddy, 1991; Serajuddin and Mustafa, 1994; Serajuddin *et al.*, 1998; Rao and Rao, 2002; Serajuddin and Ali, 2005). The present chapter deals with food and feeding of *S. sihama*.

#### **4. 2. Material and methods**

Fish samples for the present study were obtained by regular fortnightly sampling from Zuari Estuary during January 2004 to April 2005. The specimens were properly cleaned in the laboratory and the total length, total weight, sex stage of maturity and degree of stomach fullness were

recorded. The stomachs were visually classified as gorged, full,  $\frac{3}{4}$  full,  $\frac{1}{2}$  full,  $\frac{1}{4}$  full, trace and empty depending upon the degree of fullness and the amount of food contained in them. The stomachs were dissected out and the food was preserved in 5% formaldehyde for further study. The average intensity of feeding was evaluated by points method. Points were assigned as 1.25, 1.0, 0.75, 0.5, 0.25, 0.10 and 0 for gorged, full,  $\frac{3}{4}$  full,  $\frac{1}{2}$  full,  $\frac{1}{4}$  full, trace and empty stomachs, respectively (Bapal and Bal, 1950). Fishes with stomachs gorged, full,  $\frac{3}{4}$  full were considered as active feeders,  $\frac{1}{2}$  full as moderate feeders and  $\frac{1}{4}$  full and trace full stomachs as poor feeders following the method used by Rao and Rao (2002).

Generally, the stomach is considered for evaluating the food and feeding, however in case of herbivorous fish the alimentary canal is very long and retain most of the food for prolonged period. In the present species the alimentary canal is short; hence the stomach was only considered in this study.

The methods employed for the quantitative and qualitative analysis of stomach contents do not give a complete picture of dietary importance when they singly used. However, when used in combination, such as numerical or frequency occurrence and volumetric or gravimetric, better results are achieved (Srivastava, 1999).

The preliminary analysis of samples revealed that the organisms contained in the stomach reached advanced stage of digestion and was difficult to segregate of different categories of food items, thus it was not possible to adopt any of numerical, gravimetric and volumetric methods separately. Hence, the subjective method of point system (Swynnerton and Worthington, 1940; Hynes, 1950) was followed. The different food categories were assessed by eye and awarded points proportional to its estimated contribution to stomach content and listed under very common, common, frequent, rare and absent. Here consideration was given to the size of the organism. The sum of the points obtained by each food item, for each month, was then converted to percentages, to show the percentage composition of the items, for different months.

Food in relation to size of the fish was also studied by tabulating percentage composition of varying food items against the size groups. Feeding habits were inferred from the nature of food organisms consumed by the fish of various sizes in different months.

Gastro somatic index (Ga.S.I.) was calculated using the method adopted by Desai (1970). For this purpose, the following formula was employed:

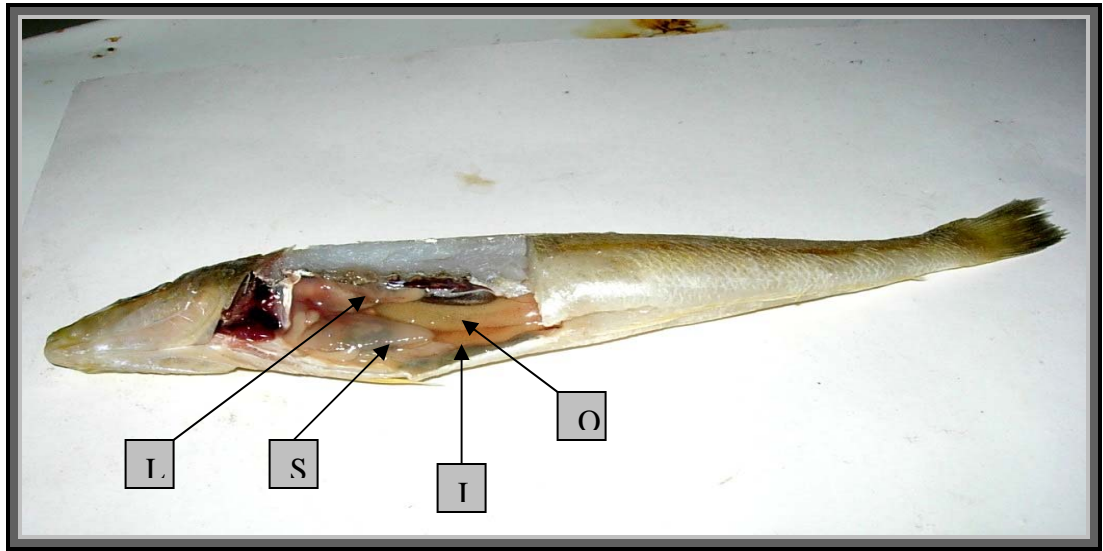
$$Ga.S.I. = \frac{\text{weight of the stomach contents}}{\text{weight of the fish}} \times 100$$

### **4.3. Results**

The various food items recorded from the stomach of *S. sihama* during the study period are presented in Fig. 4.1. Generally, the food items found in the examined stomachs were grouped into eight categories namely Crustacean, polychaetes, fish, nematodes, mollusca, sand grains, digested matter, and miscellaneous. The first two groups e.g. Crustacean and polychaetes form the major food items in the stomach, constituting 28.07 % and 22.33 %, respectively of total food composition. However, digested matter was also found in large quantities (19.91 %) followed by sand grains (11.83 %), fish (5.63%), mollusca (3.59 %) and nematodes (2.49 %). The food items found in negligible quantities were collectively put in miscellaneous items. This group included Sipunculid, phytoplankton, filamentous algae, foraminifera, and unidentified matter and occupied about 6.15 % of the food contents.

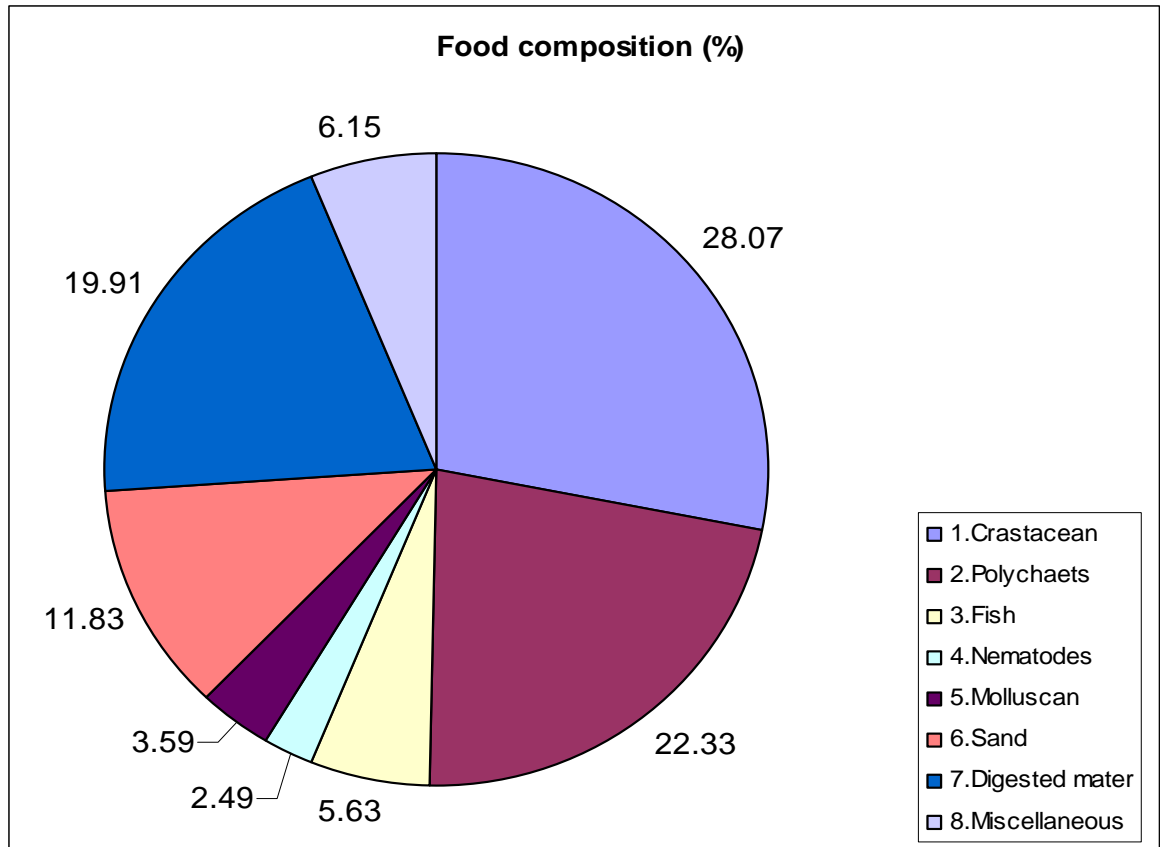
#### **4.3.1. Monthly variation of food composition**

The variation in percentage composition and percentage occurrence of food items in *S. sihama* during different months are shown in Table 4.1., Fig. 4.2. and Table 4.2., respectively. It revealed that percentage composition of different food items varied in different months according to their availability and preference of fish.



**Plate 4.1.** Digestive system and Gonads in female of *S. sihama*.

L: Liver; S: Stomach; I: Intestine; O: Ovary.



**Fig. 4.1.** The average percentage of main food items in the stomach of *S. sihama*.

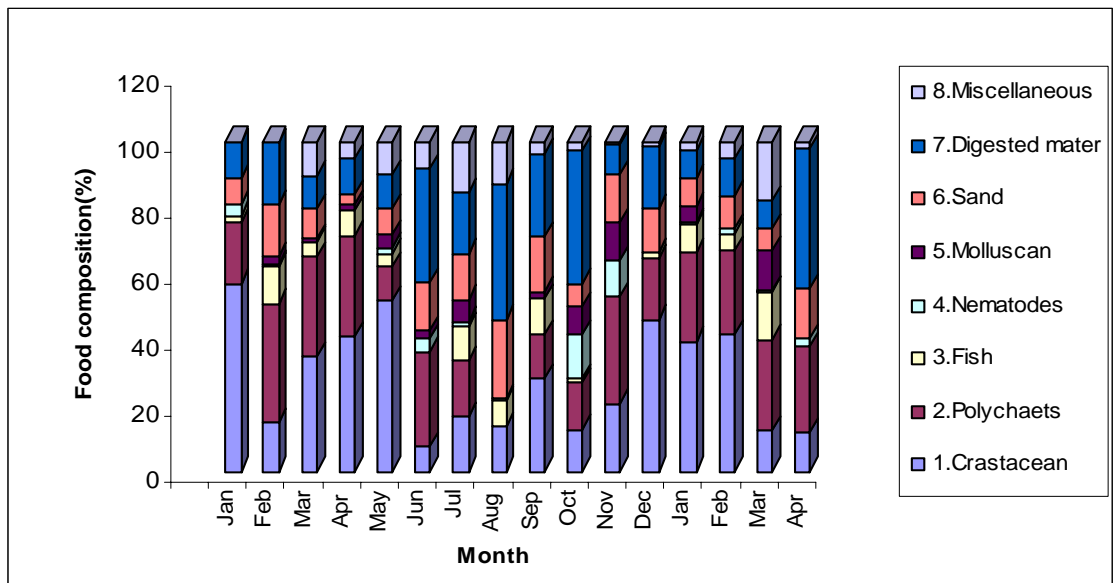
**Table 4.1.** Various food items in the stomach of *S.sihama* during January 2004 - April2005.

Food item/size group	Jan 04	Feb 04	Mar 04	Apr 04	May 04	Jun 04	Jul 04	Aug 04	Sep 04	Oct 04	Nov 04	Dec 04	Jan 05	Feb 05	Mar 05	Apr 05
hytoplankton	0.06	0.08	0.18	0.85	1.21	0.13	0.00	0.76	1.94	0.08	0.21	0.20	0.00	0.10	0.03	0.11
<b>1.Crustacean</b>																
Crab	5.12	5.41		3.42	12.50		6.67	4.45	8.77			10.13			3.48	
Tannaids	16.17	1.16	3.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.36	6.19	9.94	5.72	0.74	0.00
Isopods	13.07	3.11	10.68	0.77	0.76	0.00	0.00	0.00	5.00	0.00	6.32	4.13	8.05	7.61	3.96	0.00
Amphipods	1.63	0.00	0.00	0.31	0.00	0.00	0.00	0.00	2.86	4.72	0.00	0.00	0.00	0.00	0.00	0.00
Small prawn(Penaeid)	0.00	0.00	0.00	0.00	0.00	2.56	1.33	0.00	0.00	0.00	0.00	0.00	4.99	0.00	0.00	0.00
Shrimps	10.58	0.00	13.15	15.19	35.01	1.67	3.33	1.67	0.00	0.00	3.36	2.27	13.78	22.35	0.00	0.00
Mysids	8.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.52	0.00	0.00	0.91	0.00	0.00	0.00	1.92
Copepods	0.00	0.00	1.93	0.00	1.50	2.42	0.00	4.76	0.00	0.83	0.00	2.48	0.00	0.00	0.28	4.81
Lucifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.31	0.00	0.00	0.18	0.00
Egg and Larva	0.33	1.21	0.90	0.00	1.87	0.51	0.50	2.72	2.50	6.72	0.51	15.60	0.35	0.07	0.00	1.67
Unident. crustacean	1.05	3.91	4.99	21.28	0.00	0.20	4.67	0.00	6.43	0.42	8.04	0.00	2.30	5.95	3.61	3.57
<b>2.Polychaetes</b>																
Glycera spp	0.00	0.00	2.48	0.70	0.00	0.00	4.67	0.00	0.00	6.55	0.00	0.00	0.00	0.00	5.36	0.00
Scoloplus spp	0.00	7.27	3.31	6.32	0.00	2.67	0.00	0.00	0.00	0.00	0.00	0.00	4.02	4.55	0.00	0.00
Eunicidae family	0.00	0.00	3.64	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00
Spionidae	0.00	0.00	0.00	0.46	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.64	0.00
Poecilochaetus	5.55	11.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.65	4.40	15.55
Nereid	10.49	0.00	0.00	8.40	0.00	0.00	0.00	0.00	0.00	3.33	0.00	0.00	5.50	0.00	2.12	0.00
Unidentified polychaets	2.57	17.07	21.19	12.85	10.27	20.27	12.61	0.00	13.52	4.61	32.63	18.36	17.42	15.15	11.56	10.36
<b>3. Fish</b>																
Fish larvae	0.00	11.32	0.00	0.17	0.00	0.00	9.33	0.00	3.13	0.00	0.00	0.00	7.00	4.65	14.39	0.00
Fish scales	1.16	0.00	1.89	5.40	2.49	0.07	1.00	8.01	5.59	1.22	0.00	2.12	0.50	0.50	0.19	0.00
Fish eggs	0.98	0.00	2.49	1.83	1.66	0.00	0.00	0.00	2.24	0.00	0.00	0.00	0.81	0.00	0.00	0.00
<b>4.Nematodes</b>	3.20	0.49	0.00	0.00	1.88	3.76	1.33	0.60	0.00	12.90	10.85	0.00	0.69	1.58	0.32	2.20
<b>5.Molluscan</b>	0.00	2.50	0.76	1.93	3.89	2.36	6.72	0.00	2.01	8.57	11.36	0.00	5.17	0.00	12.16	0.00
<b>6.Sand</b>	8.05	15.71	9.23	3.00	7.90	14.90	13.95	23.83	16.86	7.03	14.61	13.38	8.51	9.91	6.83	15.51
<b>7. Digested matter</b>	11.03	19.00	10.00	10.77	10.40	34.64	18.65	41.19	25.04	40.17	9.07	18.45	8.44	11.04	8.14	42.51
<b>8.Miscellaneous</b>																
Sipunculid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.83	0.00



**Table 4.2.** Monthly variation of Percentage Occurrence of food composition during January2004-April2005.

Month	Crustacean	Polychaete	Fish	Nematode	Molluscan	Sand	Digested matter	Miscellaneous
Jan	100.00	85.71	85.71	42.86	0.00	71.43	85.71	14.29
Feb	66.67	44.44	11.11	11.11	22.22	87.50	66.67	0.00
Mar	91.67	66.67	58.33	0.00	8.33	90.91	72.73	16.67
Apr	100.00	76.92	69.23	0.00	30.77	61.54	69.23	15.38
May	68.75	18.75	37.50	6.25	12.50	18.75	37.50	50.00
Jun	18.75	62.50	6.25	12.50	12.50	86.67	53.33	6.25
Jul	37.50	37.50	18.75	6.25	12.50	53.33	53.33	6.25
Aug	38.46	0.00	53.85	15.38	0.00	83.33	58.33	7.69
Sep	50.00	42.86	71.43	0.00	14.29	100.00	64.29	35.70
Oct	26.67	33.33	20.00	33.33	26.67	60.00	66.67	31.25
Nov	71.43	85.71	0.00	42.86	50.00	71.43	42.86	14.29
Dec	83.33	8.33	25.00	0.00	0.00	100.00	72.73	16.67
Jan	90.00	80.00	40.00	0.00	20.00	80.00	60.00	20.00
Feb	86.67	86.67	20.00	13.33	0.00	93.33	80.00	20.00
Mar	43.48	78.26	30.43	4.35	0.00	56.52	39.13	30.43
Apr	37.50	75.00	0.00	12.50	0.00	75.00	75.00	12.50



**Fig. 4.2.** Monthly variation of food composition of *S. sihama*

#### **4.3.1.1. Crustacean**

It forms the bulk of the fish diet. The highest percentage recorded was 56.91 % in January followed by 51.64 % in May and, the lowest percentage recorded was 7.16 % in June. In general, crustacean intake was low during June - November. They were recorded in all the months of the year with maximum percentage occurrence (100 %) in January and April 2004. It was represented by the following groups.

**Crabs:** Juveniles of the crab formed 3.75 % of the annual average food composition. The highest percentage was recorded in the month of May (12.50 %), and the lowest was in April (3.42 %). It was found in the stomach content in the months of January, February, April, May, July - September and December 2004 and March 2005.

**Tannaids:** They represented 2.83 % of the annual average food composition. The percentage composition varied from 0.74 % in March to 16.17 % in January. They were also recorded during November 2004 to March 2005.

**Isopods:** Isopods contributed 3.97 % to the annual average food composition. They were absent in June - August and October. The maximum percentage of isopods was 13.07 recorded in January and the minimum 0.76 in May.

***Amphipods:*** Amphipods were present in the stomach content in January, April, and September - October with maximum value of 4.72 % in October and minimum 0.31 % in April. They form only 0.59 % of the annual average food composition.

***Penaeids:*** They contributed a small percentage of 0.56 to the annual average food composition. Penaeids were reported in June - July and January. The maximum abundance was 4.99 % in January and the minimum of 1.33 % occurred in July.

***Shrimps:*** Shrimps formed 7.64 % of the crustacean food items. They were absent in January, September - October 2004 and March - April 2005. The maximum percentage (35.01 %) was recorded in May and the minimum (1.47 %) in June.

***Mysids:*** They contributed 0.89 % to the annual average food composition. They were present in January, September, December 2004 and April 2005. The maximum percentage (8.96) was recorded in January and the minimum (0.91 %) in December.

***Copepods:*** They formed 1.19 % of the annual average food composition. The highest percentage was recorded in April 2005 (4.81 %) and the lowest was in March 2005 (0.28 %). They were recorded in March - June, August, October and December 2004 and March - April 2005.

**Lucifers:** They formed a minute percentage of 0.28 of the annual average food composition. They were recorded in December 2004 and March 2005 forming 4.31 % and 0.18 %, respectively.

**Egg and larvae:** They contributed 2.22 % to the annual average food composition. They were present in all the months of the year except in April 2004 and March 2005. The maximum percentage 15.60 was recorded in December and the minimum of 0.07 in February.

**Unidentified crustacean:** Body parts of crustacean of 4.15 % formed the unidentified crustaceans. The highest percentage of this group was recorded in April (21.28) and the lowest in June (0.20).

#### **4.3.1.2. Polychaetes**

Polychaetes formed the second most abundant item in the food of *S. sihama*. They occur in high quantities throughout the year except in August. The maximum percentage occurrence of polychaetes recorded was 85.71 and 86.67 in January 2004 and February 2005, respectively. Different taxa identified belonged to the following groups and families.

**Glycera spp:** It was varying from 6.55 % in October to 0.70 % in April. It was present in March - April, July and October 2004 with an average percentage of 1.23.

***Scoloplus spp:*** This species constituted from 7.27 % to 2.67 % in February and June, respectively. It occurred during February - April and June 2004 and January - February 2005. It formed 1.76 % of the annual average of food composition.

***Eunicidae:*** Members of this family were found in the stomach of *S. sihama* during March – April 2004 and March 2005, forming only 0.38 % of the annual average of food composition.

***Spionidae:*** Members of this family were found in the stomach of *S. sihama* during March, June 2004 and March 2005, forming only 0.63 % of the annual average of food composition.

***Poecilochaetus:*** Its composition varied from 15.55 % in April to 4.40 % in July 2004. It was consumed in January - February 2004 and February - April 2005 with an average percentage of 2.68.

***Nereid :*** Nereid formed 1.87 % of the annual average of food composition. Nereid worms were recorded during January, April, October 2004, January, and March 2005.

The largest portion of polychaetes forming 13.78 % of the annual food constituents could not be identified. They were recorded round the year except in August and December. The maximum and minimum percentages were 32.63 and 1.57, respectively.

#### **4.3.1.3. Fish**

**Fish Larvae:** Fish larvae were encountered in January - April, July and September. They formed 3.12 % of annual average food composition with maximum percentage of 14.39 recorded in March 2005 and minimum percentage of 0.17 in April 2004.

**Fish eggs:** This group formed a small portion of the food of *S. sihama*, contributing 0.63 % of total food composition. Its maximum percentage of 2.49 was recorded in March 2004 and the minimum percentage 0.81 in January 2005.

**Fish scales:** Different types of fish scales were observed in the stomach content of *S. sihama* in most of months except in February and November 2004 and April 2005. The highest percentage was recorded in August (8.01) and the lowest in June (0.07). Fish scales constituted 1.88 % of total food composition.

#### **4.3.1.4. Nematodes**

Nematodes were encountered in small quantities in the diet of *S. sihama* (2.49 %). The percentage fluctuated between 12.90 in October 2004 and 0.32 in March 2005. The percentage occurrence of this group was found to be high in January and November 2004 (42.86 %) and low in March

2005 (4.35%). They were absent in March, April and December 2004 and January 2005.

#### **4.3.1.5. Mollusca**

Molluscan shells and larvae were found in the stomach content of *S. sihama*. The average contribution was 3.58 % of the food composition. The minimum of 0.76 % in March 2005 and maximum value of 11.36 % was recorded in November 2004. The percentage occurrence analysis revealed that Molluscs were present in most of the months except January, August and December 2004 and February and April 2005. They were recorded in 13.11 % of the total stomach examined.

#### **4.3.1.6. Sand grains**

Sand grains were abundant throughout the year. The percentage fluctuated between 3.00 % in April 2004 and 23.83 % in August, with an average of 11.83 % of food composition. Percentage occurrence of sand in the diet of *S. sihama* was 100 % of the examined stomachs in September and December. Sand appeared in 74.36 % of the total examined stomachs during the study period.

#### **4.3.1.7. Digested matter**

This group was also found throughout the year. It was fluctuated between 8.14 % in March 2005 and 42.51 % in April 2005, with an average value of



20.47 % of total food composition. Digested matter was present in 62.34 % of total number of stomachs examined. The lowest abundance of 37.50 % noticed in May 2004 and the highest of 85.71 % in January 2004.

#### **4.3.1.8. Miscellaneous**

The food items, which form a minute percentage of total food composition or accidentally taken by fish were group under this category. It included Sipunculids, phytoplankton, Algal filaments and Foraminifera contributing 1.75 %, 0.37 %, 0.73 % and 0.09 %, respectively. These items were not present in the stomach regularly. In addition to these items a percentage of 3.91 of food items could not be identified due to advanced state of digestion.

#### **4.3.2. Food composition in relation to size group**

The percentage composition and percentage occurrence of various food items in the stomach of *S. sihama* belonging to various size groups are presented in Table 4.3., Fig. 4.3. and Table 4.4.

##### **4.3.2.1. Crustacean**

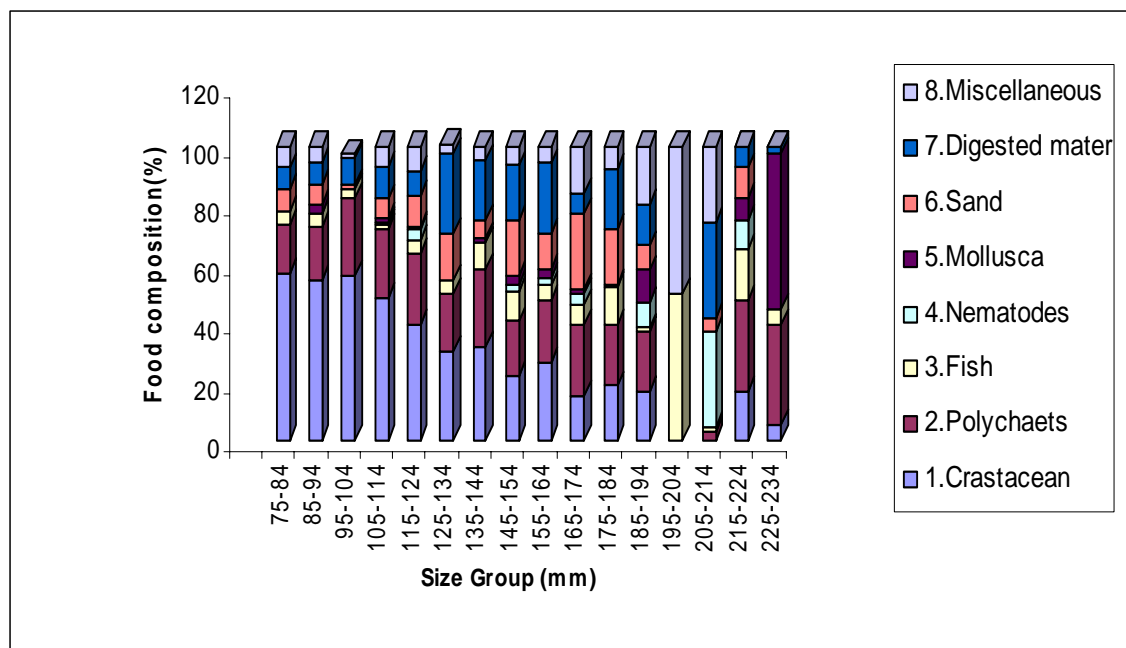
Generally, there was gradual decrease in the occurrence of crustacean in the diet of various size groups of *S. sihama*. The percentage composition ranged from 56.30 % in the size group 75 - 84 mm to 3.38 % in the size

**Table 4.3.** Food composition in different size groups in *S. sihama*.

Food item/size group	75- 84	85- 94	95- 104	105- 114	115- 124	125- 134	135- 144	145- 154	155- 164	165- 174	175- 184	185- 194	195- 204	205- 214	215- 224	225- 234
<b>1.Crustacean</b>																
Crab	0.00	0.00	0.00	2.76	12.86	2.00	1.30	2.14	4.79	0.00	5.33	1.78	0.00	0.00	0.00	0.00
Tannaids	0.00	0.00	0.00	3.37	2.49	2.32	1.86	2.33	5.05	1.51	2.30	0.00	0.00	0.00	0.00	0.00
Isopods	0.00	0.00	0.00	5.20	3.63	7.13	5.59	2.61	3.86	1.65	2.35	1.25	0.00	0.00	0.00	0.00
Amphipods	0.10	0.35	0.00	0.00	0.50	0.00	0.12	0.00	1.56	1.74	0.00	0.00	0.00	0.00	0.00	5.38
Small prawn(Penaeid)	8.70	7.90	0.00	0.00	0.00	1.24	0.07	1.68	0.00	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Shrimps	10.25	10.05	25.00	21.30	17.94	9.93	14.87	0.65	6.32	2.17	4.71	0.00	0.00	0.00	0.00	0.00
Mysids	6.52	4.75	4.00	4.83	1.00	0.00	0.47	1.04	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copepods	15.48	12.50	0.00	0.00	0.00	0.17	1.68	0.87	0.31	1.34	0.00	9.50	0.00	0.00	0.00	0.00
Lucifer	6.38	3.90	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.41	0.00	0.00	0.00	0.00	0.00
Egg and Larva	6.50	7.25	0.00	0.00	0.17	4.59	0.24	0.48	0.51	3.59	1.00	0.89	0.00	0.00	16.67	0.00
Unidentified crus.	2.40	7.75	26.85	10.85	0.61	2.74	5.33	10.18	2.08	3.09	2.30	0.63	0.00	0.00	0.00	0.00
<b>2.Polychaetes</b>																
Glycera spp	0.00	0.00	0.00	0.00	7.14	0.93	2.12	1.27	0.00	3.55	0.00	7.81	0.00	0.00	0.00	0.00
Scoloplus spp	0.00	0.00	10.56	0.00	0.00	0.00	1.21	2.12	1.56	3.96	4.02	0.00	0.00	0.00	0.00	0.00
Eunicidae family	0.00	0.00	0.00	0.00	0.00	1.87	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spionidae	0.00	0.00	0.00	0.00	0.86	2.07	2.00	0.00	0.00	0.00	0.00	6.25	0.00	0.00	0.00	0.00
Poecilochaetus	0.00	0.00	0.00	10.92	1.00	1.06	3.85	2.42	4.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nereid	0.00	15.99	15.65	5.18	0.00	1.45	3.84	0.00	1.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentifiedpolychaets	17.00	2.35		7.46	15.10	12.20	13.42	11.97	13.51	16.34	17.03	6.46	0.00	3.08	30.77	33.78
<b>3.Fish</b>																
Fish Larvae	0.00	0.00	0.56	0.00	2.86	0.00	7.54	7.02	0.00	5.07	8.96	0.00	50.00	0.00	13.85	3.30
Fish scales	0.00	0.00	2.40	0.63	1.22	3.41	0.87	2.41	3.79	1.67	3.33	0.98	0.00	1.67	3.33	1.89
Fish eggs	4.53	4.27	0.00	0.53	0.90	1.01	0.48	1.13	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>4.Nematodes</b>	0.00	0.00	0.00	0.98	3.41	0.00	0.63	1.60	2.52	4.34	1.38	8.39	0.00	32.50	10.00	0.00
<b>5.Molluscan</b>	0.00	2.87	0.00	1.50	1.05	0.24	1.22	3.41	2.90	1.10	0.00	11.25	0.00	0.00	7.69	52.81
<b>6.Sand</b>	7.55	7.11	3.84	6.37	10.10	15.87	5.90	18.62	12.17	26.01	18.71	8.34	0.00	4.10	10.19	0.34
<b>7.Digested matter</b>	7.12	7.10	10.15	10.94	8.50	27.47	20.38	18.73	23.98	6.99	20.17	13.96	0.00	32.50	7.50	2.50
<b>8.Miscellaneous</b>																
Sipunculid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.05	8.00	19.97	50.00	25.64	0.00	0.00
phytoplankton	0.40	0.00	0.00	0.38	0.56	0.36	0.00	1.09	0.79	0.82	0.00	0.03	0.00	0.15	0.00	0.00
Algae	0.00	0.00	0.00	4.61	0.00	0.00	0.00	0.84	2.06	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Foraminifera	0.00	0.00	1.00	0.00	0.00	0.13	0.36	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified items	7.07	5.86	0.00	2.20	8.11	2.46	4.64	4.68	3.15	2.88	0.00	0.00	0.00	0.36	0.00	0.00

**Table 4.4.** Percentage Occurrence of food composition in different size groups.

Month	Crustacean	Polychaete	Fish	Nematode	Molluscan	Sand	Digested matter	Miscellaneous
75- 84	100.00	66.67	33.33	0.00	0.00	33.33	33.33	33.33
85-94	100.00	50	50.00	0.00	50	50	50	0.00
95-104	100.00	75.00	50.00	0.00	0.00	50.00	50.00	0.00
105-114	76.92	46.15	46.15	7.69	15.38	61.54	53.85	15.38
115-124	71.43	57.14	35.71	14.29	14.29	50.00	35.71	21.43
125-134	68.00	68.00	32.00	0.00	4.00	88.00	72.00	20.00
135-144	57.58	54.55	21.21	3.03	6.06	63.64	66.67	18.18
145-154	67.65	50.00	50.00	11.76	17.65	79.41	61.76	20.59
155-164	65.63	59.38	40.63	12.50	15.63	81.25	62.50	15.63
165-174	47.83	52.17	17.39	17.39	21.74	91.30	34.78	17.39
175-184	50.00	50.00	20.00	30.00	0.00	80.00	40.00	20.00
185-194	75.00	100.00	25.00	25.00	25.00	75.00	50.00	32.00
195-204	0.00	0.00	50.00	0.00	0.00	0.00	0.00	50.00
205-214	0.00	33.33	33.33	100.00	0.00	33.33	66.67	33.33
215-224	50.00	50.00	50.00	50.00	50.00	100.00	50.00	50.00
225-234	50.00	50.00	50.00	0.00	100.00	50.00	50.00	50.00



**Fig 4.3.** Food composition in the stomach of different size groups of *S. sihama*.

group 225 - 234 mm. The percentage occurrence of crustacean was 100 % in the size groups 75 - 84 and 95 - 104 mm followed by gradual decrease in the next higher size groups.

**Crabs:** Crab juveniles were observed in the diet of fish of size groups 105 - 114 mm to 185 - 194 mm. Their percentage fluctuated between 1.30 in size group 135 - 144 mm to 12.86 in 115 - 124 mm.

**Tannaids:** Tannaids were present in the fish of size group 105 - 114 mm to 175 - 184 mm. Their abundance varied from 1.51 % in size group 165 – 174 mm to 5.05 % in 155 – 164 mm.

**Isopods:** This food item was abundant in the diet of fish of size groups 105 - 114 mm to 185 - 194 mm. Its percentage ranged between 1.25 in size group 185 - 194 mm and 7.13 in size group 125 - 134 mm.

**Amphipods:** Amphipods were recorded in size groups 75 – 84 mm, 85 – 94 mm, 115 – 124 mm, 135 - 144 mm, 155 - 164 mm, and 165 - 174 mm and again in the size group 225 – 234 mm. Its percentage varied from 0.10 in size groups 75 - 84 mm to 5.38 in size group 225 - 234 mm.

**Penaeids:** Small prawns like Penaeids were found in the fish of size groups 125 – 134 mm, 145 – 154 mm and 185 – 194 mm. The juveniles made their appearance in size groups 75 - 84 to 95 - 104 mm. Penaeids

formed 0.07 % of total food composition of size group 135 - 144 mm and 8.70 % in size group 75 - 84 mm.

***Shrimps:*** They were present in the fish of size groups 75 - 84 mm to 175 - 184 mm. They formed 0.65 % - 25.0 % of total food composition in size group 145 - 154 mm and 95 - 104 mm, respectively.

***Mysids:*** They were not recorded with regularity in the sample and therefore did not form the regular food item of the fish. They appeared in the size groups 75 - 84 to 85 - 94 mm, 105 - 114 to 115 - 124 mm and 135 - 144 to 155 - 164 mm. The lowest percentage was 0.47 in the size group 135 - 144 mm and highest was 6.52 in size group 75 - 84 mm.

***Copepods:*** Copepods were present in the fish of size groups 75 - 84 to 85 - 94 mm, 125 - 134 mm to 185 - 194 mm and in 175 - 184 mm. Its percentage fluctuated between 0.17 in size group 125 - 134 mm and 15.48 in 75 - 84 mm.

***Lucifers:*** Lucifers formed a very small percentage (0.09 %) of total food, and were observed in the small individuals of size groups 75 - 84 to 85 - 94 mm and in adults of size groups 155 - 164 mm and 175 - 184 mm only.

***Eggs and larvae:*** Different quantities of crustacean eggs and larvae recorded in the stomach of fishes of various size groups from juveniles to

adults. The percentage composition of crustacean eggs and larvae fluctuated in different size groups and ranged between 0.17 % in the size group 115 - 124 mm and 16.67 % in the size group 215 - 224 mm.

**Unidentified crustacean:** There was a good quantity of unidentified crustacean in the fish from size group 95 - 104 mm to 185 - 194 mm. They ranged between 0.61 % in size group 115 – 124 mm and 26.85 % in 95 – 104 mm.

#### **4.3.2.2. Polychaetes:**

The percentage of polychaetes as food of fish fluctuated in various size group. It was high (30.77 % & 33.78 %) in the size groups 215 - 224 and 225 - 234 mm, respectively. In the other size group percentage of polychaetes ranged between 3.08 in the size group 205 - 214 mm and 26.44 in the size group 135 - 144 mm. This food item showed maximum percentage occurrence (100 %) in the size group 185 - 194 mm and minimum (33.33 %) in the size group 205 - 214 mm, while the percentage occurrence was 50 % in the size group 175 - 184, 215 - 224, and 225 - 234 mm. Absence of polychaetes in the size group 195 - 204 mm may be due to insufficient number of fish specimens.

**Glycera spp:** The percentage composition of this species ranged from 0.93 % in the size group 125 - 134 mm to 7.81 % in the size group 185 - 194 mm. Fish of the size group 115 - 124 to 145 - 154 mm recorded this

food regularly in the stomach. *Glycera spp* appeared again in the diet of size groups 165 - 174 mm and 185 - 194 mm.

***Scoloplus spp:*** *Scoloplus spp* started appearing in the small fish of size group 95 - 104 mm; it disappeared in the next three groups and again occurred in the size groups 135 - 144 mm to 175 - 184 mm.

***Eunicidae:*** Worms belonging to the family Eunicidae occurred in the size groups 125 - 134 mm and 145 - 154 mm, forming 1.87 % and 0.44 % of food composition, respectively.

***Spionidae:*** Members of this family were present in the food of the size groups 115 – 124 mm to 135 - 144 mm and 185 - 194 mm. The lowest percentage recorded was 0.86 % in the size group 115 - 124 mm and the highest 6.25 % in the size group 185 - 194 mm.

***Poecilochaetus:*** This food item was utilized by the size group 105 - 114 mm to 155 - 164 mm as a part of their food. The lowest percentage recorded 1.00 % in the size group 115 - 124 mm and the highest was 4.91% in the size group 155 - 164 mm.

***Nereid:*** Nereid was recorded in the stomach content of size groups 85 - 94 mm to size group 155 - 164 mm. It was one of the important dietary components of small fishes upto 104 mm (17.65 %) and low in the size group 125 - 134 mm (1.45 %).



**Unidentified polychaetes:** Some body parts of polychaete were recorded in large quantities in all the size groups except in the size groups 95 – 104 and 195 - 204 mm. Its percentage was lowest 2.35 % in size group 85 – 94 mm and highest 33.78 % in size group 225 - 234 mm.

#### **4.3.2.3. Fish:**

Fish larvae, scales and eggs were found in a considerable quantity. They were present in high percentage (50 %) of total stomach examined in size group 85 – 94 mm and 49.15 % in size groups 95 – 104 and 105 – 114 mm. This high percentage occurrence could be attributed to the planktonic feeding behaviour.

**Fish Larvae:** It was recorded in the stomach content of size groups 95 – 104 mm and in 115 - 124 mm onwards. The lowest value was recorded in size group 95 - 104 mm and the highest in 195 – 204 mm.

**scales:** It was observed in size groups 95 – 104 mm onwards. The lowest value was recorded in size group 105 - 114 mm and the highest in 155 – 164 mm.

**Fish eggs:** It was observed in size groups 75 – 84 mm to 155 – 164 mm. Its percentage varied from 0.48 % in 135 - 144 mm to 4.53 % in 75 - 84 mm.

#### **4.3.2.4. Nematodes**

Nematode worms were recorded in the stomachs of fish of the size groups 105 - 114 to 115 - 124 mm, 135 - 144 to 185 - 194 mm and 205 - 214 to 215 - 224 mm. They were found in small percentage except in the size group 205 - 214 mm, where they formed 32.50 % of total food composition. The percentage occurrence of Nematodes fluctuated between 3.03 % in size group 135 - 144 mm and 100 % in size group 205 - 214 mm and 225 - 234 mm. They were absent in other size groups.

#### **4.3.2.5. Mollusca**

Molluscan shells formed a part of the food items of *S. sihama* during different stages of its life. They were found in the diet of size groups 85 - 94 mm, 105 - 114 to 165 - 174 mm, 185 - 194 mm and 215 - 224 to 225 - 234 mm. The percentage ranged between 0.24 in size group 125 - 134 mm and 11.25 in size group 185 - 194 mm. Their occurrence was 100 % in the size group 225 - 234 mm.

#### **4.3.2.6. Sand grains**

The sand grains also formed a part of the stomach content of *S. sihama*. As the fish feed on benthic organisms, it takes some quantities of sand and mud. The lowest was 0.34 % in size group 225 – 234 mm and the highest percentage observed was 26.01 % in size group 165 - 174 mm.

Percentage occurrence revealed that sand grains were found in all size groups.

#### **4.3.2.7. Digested matter**

Digested matter was also found in all size groups in comparatively good quantities. The minimum (2.50 %) in the size group 225 - 234 mm and the maximum value of 32.50 % found in the size group 205 - 214 mm. Percentage occurrence of digested matter ranged between 33.33 % in the size group 75 - 84 mm and 72.00 in the size group 125 - 134 mm.

#### **4.3.2.8. Miscellaneous**

Sipunculids recorded in the size groups 165 - 174 to 205 - 214 mm. With percentage fluctuated between 8.00 and 50. Its percentage occurrence was 50 % in the size group 195 - 204 mm and 13.04 % in the size group 165 - 174 mm. A very small quantity of phytoplankton particularly diatoms were recorded in all size group except in 85 - 94, 95 - 104, 175 - 184 and 195 - 204 mm. They formed 1.09 % of total food composition in the size group 145 - 154 mm and 0.03 % in the size group 185 - 194 mm. The percentage occurrence was 33.33 % in the size groups 75 - 84 mm and 205 - 214 mm and 6.06 % in the size group 135 - 144 mm.

Presence of algae in the stomach content of *S. sihama* was also poor, restricted to the size group 105 - 114 and 145 - 154 to 165 - 174 mm. The

percentage occurrence recorded was 15.38 % in the size group 105 - 114 mm and 2.94 % in the size group 145 - 154 mm. Unidentified organisms were recorded in the size groups 75 - 84 mm, 85 - 94 mm, 105 - 114 to 165 - 174 mm and in 205 - 214 mm. Their percentage occurrences varied from 0.36 in the size groups 205 - 214 mm to 7.54 in the size group 115 - 124 mm.

#### **4.3.3. Feeding intensity**

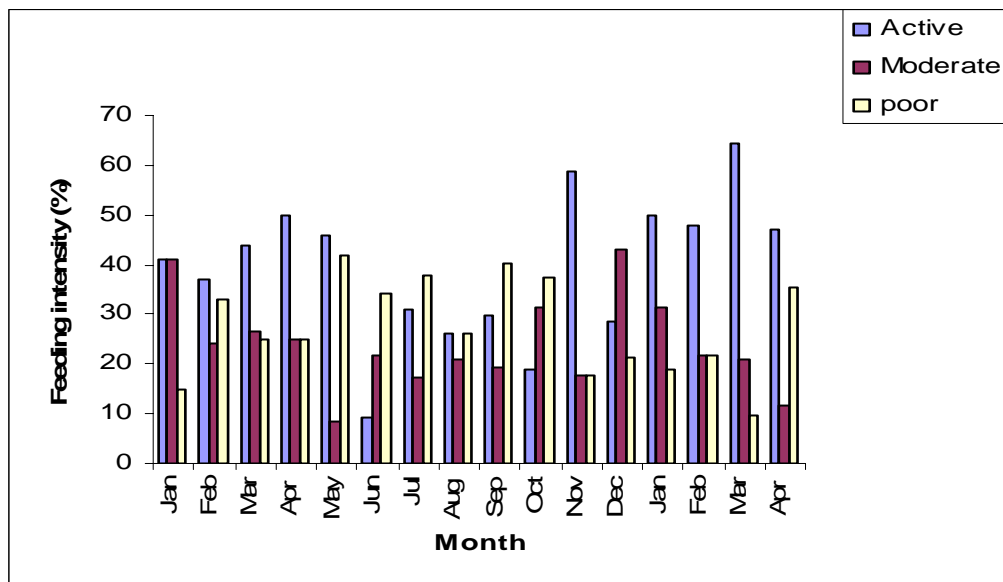
##### **4.3.3.1. Stomach condition**

Monthly fluctuation in the percentage occurrence of stomachs in different degrees of fullness and feeding condition are given in Table 4.5. Fig. 4. 4.

Month - wise occurrence of actively feeding fishes showed that *S. sihama* fed actively during pre-monsoon (February - May) with peak activity in April. During monsoon, sudden decrease in feeding activity was observed in June. In July, feeding intensity increased followed by decrease in August and remains low (poor) until October. Sharp increase in feeding activity was observed in December and January (Post-monsoon). Month - wise occurrence of empty stomachs showed a wide range of fluctuations from 2.94 % in January to 34.38 % in June. Generally, it was low from January to May, high during June - October and low from December onward coincident with the feeding intensity.

**Table 4.5.** Monthly variation of stomach condition of *S. sihama*.

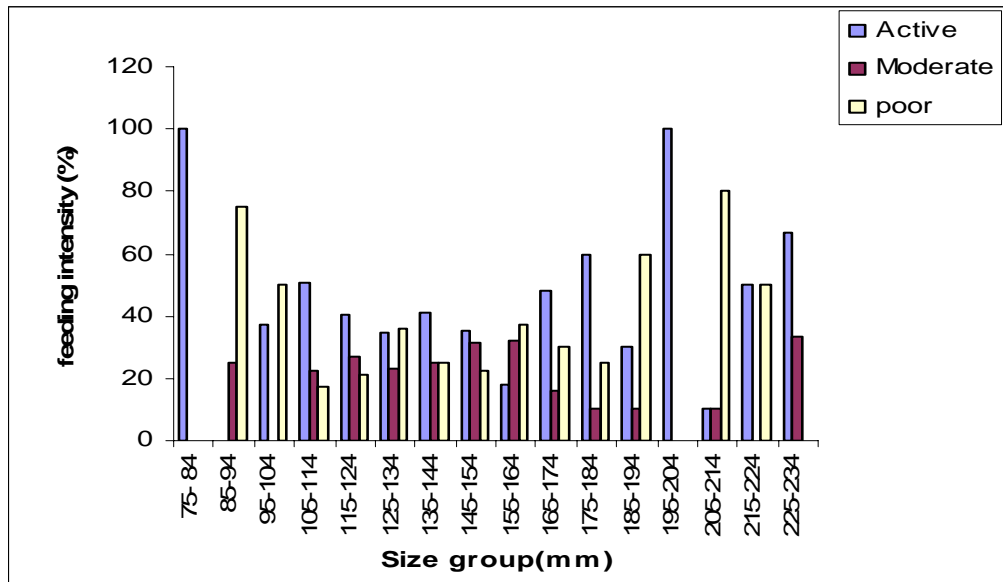
Month	No. of fish	Active feeding			Moderate feeding	Poor feeding		Empty
		Gorged	Full	3/4Full	1/2Full	1/4Full	trace	
Jan	34	5.88	29.41	5.88	41.18	5.88	8.82	2.94
Feb	140	8.57	12.86	15.71	24.29	15.71	17.14	5.71
Mar	128	10.94	15.63	17.19	26.56	10.94	14.06	4.69
Apr	48	25.00	16.67	8.33	25.00	16.67	8.33	0.00
May	54	16.67	16.67	12.50	8.33	16.67	25.00	4.17
Jun	64	0.00	6.25	3.13	21.88	12.50	21.88	34.38
Jul	52	3.45	24.14	3.45	17.24	10.34	27.59	13.79
Aug	38	5.26	15.79	5.26	21.05	15.79	10.53	26.32
Sep	94	10.64	12.77	6.38	19.15	25.53	14.89	10.64
Oct	32	0.00	6.25	12.50	37.50	25.00	6.25	12.50
Nov	34	5.88	17.65	35.29	17.65	5.88	11.76	5.88
Dec	28	7.14	7.14	14.29	42.86	7.14	14.29	7.14
Jan.05	32	6.25	25.00	18.75	31.25	18.75	0.00	0.00
Feb	46	8.70	21.74	17.39	21.74	13.04	8.70	8.70
Mar	62	6.45	29.03	29.03	20.97	3.23	6.45	4.84
Apr	14	0.00	14.29	28.57	14.29	14.29	28.57	0.00



**Fig. 4.4.** Monthly variation in feeding intensity in *S. sihama*.

**Table 4.6.** Stomach condition in different size groups of *S. sihama*

Size group(mm)	No. of Fish	Active feeding			Moderate feeding	Poor feeding		Empty
		Gorged	Full	3/4Full	1/2Full	1/4Full	trace	
85-94	2	0.00	0.00	0.00	0.00	0.00	100.00	0.00
95-104	16	12.50	25.00	0.00	0.00	12.50	37.50	12.50
105-114	116	15.87	19.05	15.87	22.22	6.35	11.11	9.52
115-124	124	7.46	17.91	14.93	26.87	8.96	11.94	11.94
125-134	176	11.54	15.38	7.69	23.08	16.67	19.23	6.41
135-144	136	7.35	23.53	10.29	25.00	14.71	10.29	8.82
145-154	108	5.56	11.11	18.52	31.48	9.26	12.96	11.11
155-164	100	8.00	4.00	6.00	32.00	20.00	21.00	9.00
165-174	50	0.00	16.00	32.00	16.00	16.00	14.00	6.00
175-184	20	10.00	10.00	40.00	10.00	10.00	15.00	5.00
185-194	20	0.00	30.00	0.00	10.00	40.00	20.00	0.00
195-204	2	50.00	50.00	0.00	0.00	0.00	0.00	0.00
205-214	20	0.00	0.00	10.00	10.00	70.00	10.00	0.00
215-224	4	0.00	0.00	50.00	0.00	50.00	0.00	0.00
225-234	6	33.33	0.00	33.33	33.33	0.00	0.00	0.00



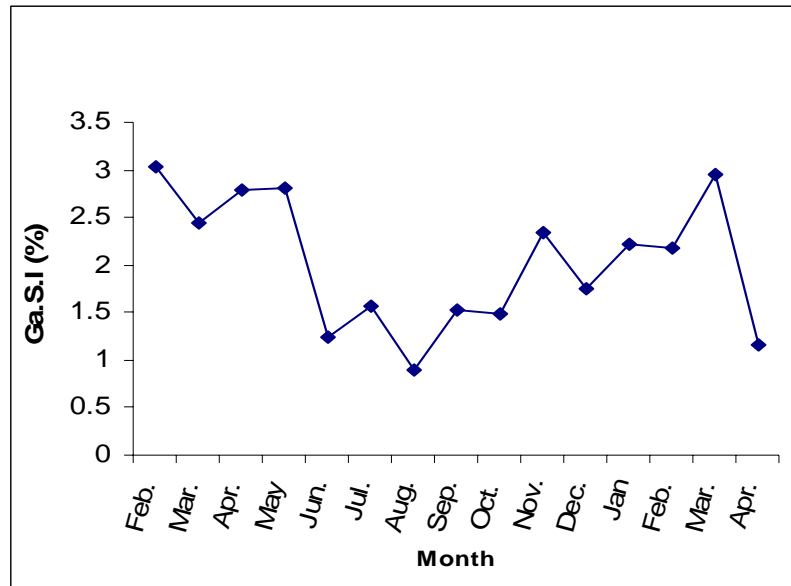
**Fig. 4.5.** Feeding intensity in different size groups in *S. sihama*.



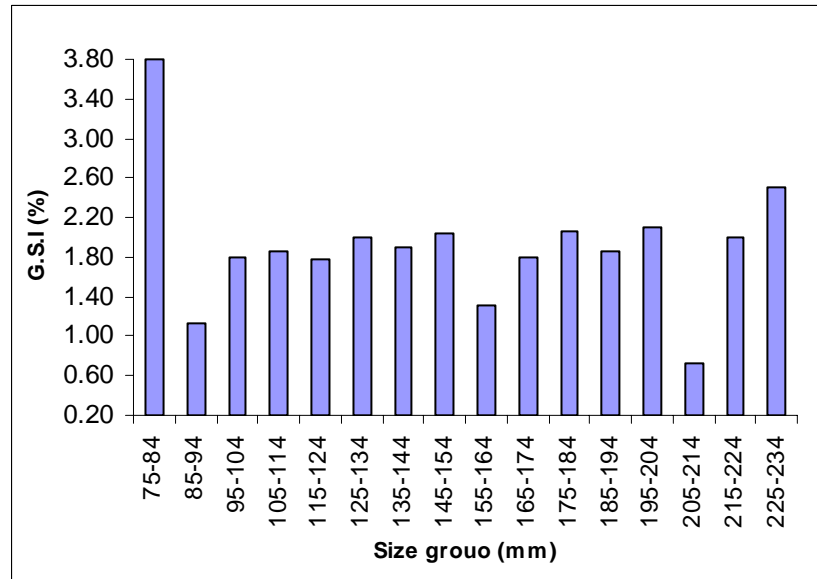
The feeding intensity in relation to size group based on degree of stomach fullness is shown in Table 4.6., Fig. 4.5. The young individuals in the size group 75 - 84 mm appeared to have fed very actively. There was an obvious decline in the feeding activity in fishes of size group 85 - 94 mm. Above this size group, feeding activity increased with the increase in size reaching the maximum activity in the size group 195 - 204 mm. Moderate activity was recorded in the size group 145 - 154 mm and 215 - 224 mm. Fishes observed to be poorly fed in the size group 155 - 164 mm. Other sharp decreases were observed in the size group 185 - 194 and 205 - 214 mm followed by gradual increase until 225 - 234 mm size group. The percentage occurrence of empty stomachs fluctuated from 3 % in the size group 155 - 164 mm to 15 % in the size group 175 - 184 mm.

#### **4.3.3.2. Gastro Somatic Index (Ga.S.I.)**

The Gastro Somatic Index (Ga.S.I.) in different months during the period of this investigation is illustrated in Fig. 4.6. There was an agreement between the monthly variation in gastro somatic index and feeding intensity based on stomach fullness. Monthly average in gastro somatic index varied between  $0.89 \pm 0.051$  in August 2004 and  $3.04 \pm 0.19$  in February 2005. Ga.S.I. was relatively high during pre-monsoon (February - May), low during monsoon until October with minimum value in August. Ga.S.I. increased in November followed by slight decrease in December. However, Ga.S.I. remains high from December onwards.



**Fig. 4.6.** Monthly variation in gastro-somatic index.



**Fig. 4.7.** Gastro-somatic index in different size groups.

Ga.S.I in relation to size group is given in Fig. 4.7. Ga.S.I. increased as the fish increased in length, obvious decrease was noticed in the size group 155 - 164 and 205 - 214 mm. It varied between 0.74 % in the size group 205 - 214 mm and 2.51 % in the size group 225 - 234 mm.

#### **4.4. Discussion**

##### **4.4.1. Food composition**

The length of the intestine of the fish depends upon the feeding habits. Carnivores fishes normally have short and more or less straight intestine. This is because the meat gets digested more easily (Pandey and Shukla, 2005; Serajuddin and Ali, 2005), wherein herbivores fishes the intestine is long and highly coiled because the vegetable food items take more time for digestion. The intermediate condition is found in omnivores. Since, *S. sihama* possesses a relatively short and straight intestine (Plate 4.1.), it can be classified as a carnivores fish.

The analysis of stomach content of *S. sihama* from Zuari estuary revealed that this species consume a variety of food items in this region. Crustacean including crabs and their larvae, tannaids, isopods, amphipods, shrimps, mysids, copepods, lucifers, eggs and larval forms comprised the maximum part of the food of *S. sihama*. Polychaetes formed the second most important item in the food of *S. sihama*. This is in

agreement with findings by Gowda *et al.* (1988a) in *S. sihama* and Hyndes *et al.* (1997) in *S. bassensis*, *S. vittata*, *S. burrus*, *S. schomburgkii*, *S. robusta* and *Sillaginodes punctata*.

Digested and semi digested matter including crustacean appendages and polychaete cilia and organism in an advanced stage of digestion were present and regularly recorded. This category along with sand grains formed a high proportion of stomach content followed by fish larvae. To lesser extents mollusca, nematodes, and other organisms (miscellaneous) also occurred in the stomach of *S. sihama*.

Similar food items were frequently reported in the stomach of *S. sihama* from different regions. They were reported by Radhakrishnan (1957), Gowda *et al.* (1988a), Reddy (1991), Lee (1976), Blaber (1980), Gunn and Milward (1985), McKay (1992), Hyndes *et al.* (1997), Allen *et al.* (2002), Weerts *et al.* (1997), Mohammed *et al.* (2003) and Hajisamae (2006) from India, Taiwan, Australia, South Africa, Iraq and China. Differences in the dominance of different food categories can be attributed to their availability and the habitat where the fish lived at a particular time.

#### **4.4.2. Monthly variation in food composition**

Presence of crustacean in the stomach content in different months showed considerable variations with high percentage during January - May and November - December. Among crustacean Shrimps were the

most dominant item (7.69 %) followed by Isopods (3.94 %). Crab and its larvae ranked the next dominant item (3.75 %) followed by Tanaids, eggs and larvae and Copepods with percentage values of 2.83, 2.22 and 1.19, respectively. However, Amphipods, small prawns (Penaeid), Mysids and Lucifers were found in small quantities. Among polychaetes Poecilochaetus and Nereid were the most abundant items followed by Scoloplus sp and Glycera sp with percentage of 2.68, 1.87, 1.76 and 1.23 of total food composition, respectively. The monthly variations in the quantity of crustacean and polychaetes in the stomach may be related to seasonal variation in their abundance, age, variation in feeding intensity. The results corroborate the findings by Gowda *et al.* (1988a). Similarly, Rao and Rao (2002) found the dominance of fishes in the diet of *Glossogobius giuris* through out the year, while shrimps and prawns were dominant in July – August. This is perhaps due to the abundant of shrimps and prawns during this period.

Although digested matter came next to polychaetes in their abundance in the stomach, the bulk of this category was consisted of crustacean and polychaetes appendages. Hence, they may not considered as an energetic food.

Fish larvae, Molluscs and Nematodes were found in small but significant fractions in the food of *S. sihama*. Occurrence of Molluscs, Nematodes

and Sipunculids, even though in small fractions, they also indicate a bottom feeding tendency.

Occurrence of sand grains throughout the study period with relatively high quantities indicates the bottom feeding habit of *S. sihama* (Blaber, 2000). Sand grains could be taken while fish was burrowing the sand to prey upon benthic animals. Foraminifera and phytoplankton (diatoms) were found in very small fractions in the stomach of few specimens showed that they were probably taken accidentally, along with the sand grains or other items, respectively. Reddy (1991) reported the presence of sand in the stomach of *S. sihama* from Karwar waters. He suggested that sand may be taken accidentally.

#### **4.4.3. Food composition in relation to size group**

The ultimate objective of dietary changes is to maximize the energy intake, enhance growth rate and minimize the risk of predation in competing for food with bigger predators (Brown, 1985). The ontogenetic dietary change was distinctive in *S. sihama* in the present study. The diet of fish changed with the increase in size (length). Small fishes are exclusively planktonic feeders subsisting mainly on planktonic forms of crustacean such as Mysids, Shrimp juveniles, calanoid Copepods, Lucifers, crustacean eggs and larvae. Fish eggs, Molluscs larvae and polychaetes are also taken in small proportions. Similar findings were obtained by Hajisamae *et al.* (2006).

The feeding habit gradually changed in fishes above 94 mm total length. Predominance of planktonic food is replaced by benthic food items (polychaetes, crabs, small prawns, Shrimps, Amphipods, Isopods, Tanaids, Molluscs and fish -larvae).

In a similar study Gowda (1988a) reported that crustacean were preferred by fishes of total length 40 - 100 mm, while in fishes larger than 100 mm diet mainly consisted of polychaetes, crustacean, fishes and miscellaneous food items. A complete dietary shift from planktonic feeding in *S. sihama* of less than 91 mm total length to bottom feeding in fishes of over 90 mm has been recorded in Australian waters by Gunn and Milward (1985), Similarly Reddy (1991) observed bottom feeding in larger fishes of *S. sihama* in Indian waters. Weerts *et al.* (1997) noted that fishes less than 60 mm standard length consumed primarily planktonic prey mainly larvacean and copepods, while larger fishes feed on benthic crustacean, polychaetes and bivalves in coast of Africa. Hajisamae *et al.* (2006) reported that dietary ontogenetic change of *S. sihama* was very distinctive where early life stages started feeding mainly on calanoid copepods before shifting to almost entirely benthic predator that feed mainly on polychaetes in Chinese waters.

#### **4.4.4. Feeding habits**

While studying the food and feeding habit of *S. sihama* Radhakrishnan (1957) and Gowda *et al.* (1988a) classified the fish as omnivores because

of the occurrence of seaweed and phytoplankton in the stomach. In the present investigation occurrence of algal filaments in the stomach of a few of fishes, forming minute proportion of the total food has been observed. More over, they occurred without regularity in different months thus suggesting that algae might have been ingested along with other material accidentally.

According to Moyle and Cech, Jr. (2000), fishes are classified as detritivores, herbivores, carnivores and omnivores based on the type of food. Within these categories they can be further characterized as euryphagous (eating mixed diet), stenophagous (eating limited assortment of food types) and monophagous (consuming only one sort of food). Thus, *S. sihama* can be classified as euryphagous carnivores, feeding on a wide range of food of planktonic and benthic organisms. Many workers (Gunn and Milward, 1985; Reddy, 1991; Weerts *et al.*, 1997; Mohammed *et al.*, 2003 and Hajisamae *et al.*, 2006) have also reported Carnivory of *S. sihama*.

While studying the food and feeding habits of other member of the family Sillaginidae, Chandru *et al.*, (1988) reported that *S. vincenti* feeds primarily on polychaetes, small pawns, worms and mollusks. According to him fishes of less than 100 mm length were found to feed mainly on small pawns, whereas, adults showed greater uptake of polychaetes and Planarians. Study of the dietary composition of five *Sillago* species viz *S.*



*bassensis*, *S. vittata*, *S. burrus*, *S. schomburgkii*, *S. robusta* and *Sillaginodes punctata* showed that crustacean and polychaetes were the taxa most frequently ingested by each of these species (Hyndes *et al.*, 1997). Hajisamae *et al.* (2006) while studying the feeding ecology of *S. sihama* and *S. ingenuua* reported polychaete and other benthic organisms in the gut content and placed them as carnivores as observed in the present study.

#### **4.4.5. Feeding intensity**

The results of Ga.S.I. are in agreement with the stomach fullness, in which Ga.S.I. was high in the active feeder individuals and low in the poor feeder. The feeding activity of *S. sihama* was found to be fluctuated with season as well as maturity stages. The intensity of feeding was high during pre-monsoon (February - May). It may be related to food abundance during this season and to predominance of immature and maturing fishes which feed actively.

Distinctive decline in feeding activity during monsoon can be attributed to spawning, which lasts until November as well as to high water turbidity and heavy silt load as reported by Das (1978) in *Mugil cephalus*. Sharp increase in feeding intensity with the onset of post spawning season can be ascribed to occurrence of high number of spent fishes, which feed actively. Moderate feeding observed during post-monsoon in December may be due to occurrence of spent fishes. High values of percentage

occurrence of empty stomachs during June - October with peaks in June and September indicates a period of poor feeding activity which also coincide with appearance of more number of mature fishes about to spawn.

In relation to size of fish, the poor feeding activity in the size group 85 - 94 mm could be attributed to the size related dietary shift from planktonic to bottom feeding at this size. While poor feeding intensity in the size group 155 - 164, 185 - 194 and 205 - 214 mm may acts as an indicator of physiological strain of maturity and spawning.

The results of feeding intensity analysis of the present investigation corroborated the results of the previous studies on the same species (Radhakrishnan, 1957; Gowda et al., 1988a; Reddy, 1991). Similar results with different shift timing 81 - 90 to 101 - 110 mm size classes are reported by Reddy (1991). The fact that ontogenetic dietary shifts may be influenced by the abundance and type of prey gives an acceptable reason for such difference. Furthermore, the diet of *S. sihama*, in Richards Bay, Durban Bay and Mlalazi Estuary, in South Africa (Weerts *et al.*, 1997), changes from planktonic prey to benthic crustacean, polychaetes and bivalve siphn tips at different sizes. Fish from Mlalazi Estuary began feeding on benthos at a smaller size than those from Richards Bay and Durban Bay.

The occurrence of poor feeding coincident with peak breeding in other fishes has been reported by Desai (1970), Khan *et al.* (1988), Rao and Rao (1991), Piska *et al.* (1991) Serajuddin and Mustafa (1994) and Serajuddin *et al.*(1998). This confirms the dietary shift in the individual fish as a body requirement in general and *S. sihama* in particular.