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Food and feeding habits of snow trout, *Schizothorax plagiostomus* in River Lidder, from Kashmir Himalaya

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Abstract

The food and feeding habits of *Schizothorax plagiostomus* in river Lidder was studied by examining 500 guts collected throughout the year. The fish samples used in the present study was within the range of 25.5cm to 40.33cm in total length and weight ranging from 250g to 580g in weight and the sampling duration was from July, 2013 to June, 2014. During the analysis of food and feeding habits of *S. plagiostomus* it was concluded that the fish is benthic herbivorous. Its food mainly consists of plant matter 62.02%. A good amount of miscellaneous food items i.e. mud, sand and detritus 31.01% was also present in the gut of fish along with small quantity of animal food 6.97%. Overall it was concluded that diatoms formed an important constituent of food of *S. plagiostomus* in all months of the year and the presence of detritus, mud and sand indicates that the fish is a detrivorous, bottom feeder. The gastrosomatic index in case of females ranged from 3.88±0.30 to 7.30±2.128 with minimum in July and maximum GaSI in October and 3.37±0.75 to 7.82±2.22 in males with minimum in July and maximum in December.

Keywords*:* Food, feeding habits, gastrosomatic index, *Schizothorax plagiostomus*

1. INTRODUCTION

The Kashmir valley is famous throughout the world for its waters bodies both lotic and lentic. The lotic habitats include numerous streams like Lidder, Veshow, Dudhganga, Sindh etc spreading throughout the valley The Lidder orginates from the high altitude glacier fed Lake Sheshnag, Tarsar and Kolhai glacier. *Schizothorx plagiostomus* is the dominant fish in river Lidder. Fish is locally known as khont and is highly preferred food fish in Kashmir and has an edge over the exotic trouts, because of its taste and good nutritional value.

The study of food and feeding habits of fish is very important component from fisheries point of view. The study on food and feeding habits of fish provides vital clues in developing supplementary feed for fish species in order to increase its production through culture. It also enables the farmers to have clear understanding of dietary requirements with a view to improvising feed for them in aquaculture (Malami *et al*., 2004). The feeding habits of fishes vary monthly and it mainly depends upon the composition of food organisms occurring at different months of the year (Shukla and Patel, 2013). Thus, study of food and feeding habits of fish has received more attention from various workers from different angles. Some of the praise worthy works in this field are those of Hynes 1950; Hyslop 1980; Gunn and Milward, 1985; Hajisamae *et al*., 2003, 2004 and Priyadharsini *et al*., 2012.

2. MATERIAL AND METHODS

2.1. Study sites

During the present study four sites were selected for the collection of samples located along the course of the river Lidder. A through survey of the study area was done to collect the fishes. All along from its origin up to the mouth, its bottom is rocky with gravel and sand. Fishes were collected monthly from four sites selected along the course of river Lidder at S-I (Pahalgam), S-II (Batkoot), S-III (Ashmuqam) and S-IV (Akura).

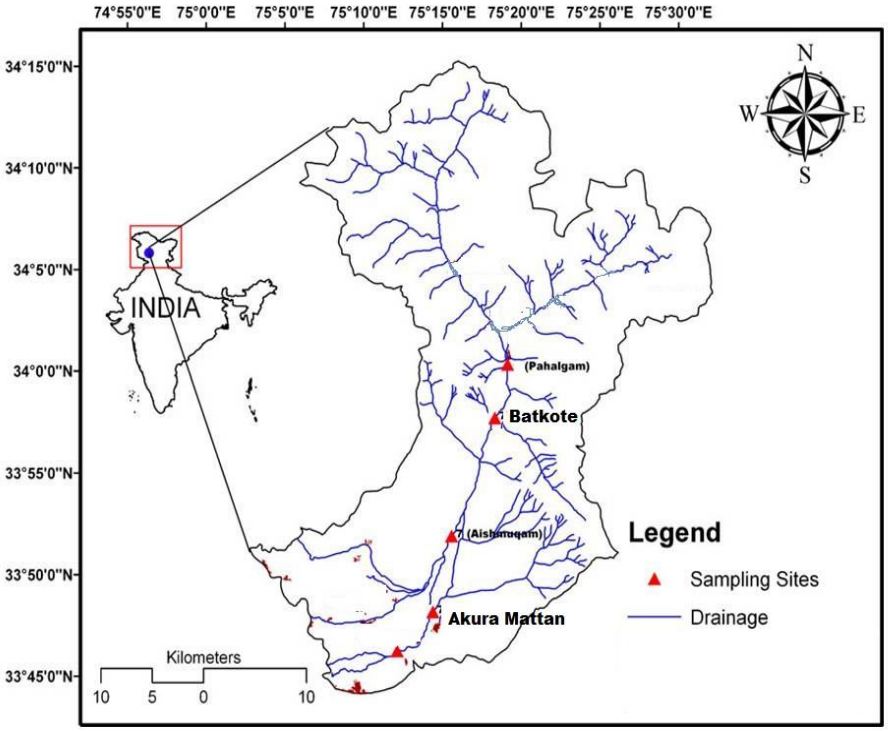

Figure 1: Map of study area showing location of different fish sampling sites

2.2. Methods used for the determination of food and feeding habits of *Schizothorax plagiostomus*

For gut analysis of fishes, guts were cut open and weighed with and without food. After this gut contents were spread in petridish to enable their macroscopic observation. For further study gut contents were preserved in 5% formaldehyde in labelled vials. Large food items were easily recognised with the naked eye, while as microscopic ones were teased to disperse their aggregates on cleaned slide for examination under binocular microscope (Model TCM-400) which is connected to the photomicrograph to enhance proper viewing and identification of organisms at (400x). All recognised food items were identified according to (Edmondson, 1959; Pennak, 1978).

The methods employed for the quantitative and qualitative analysis of stomach contents was volumetric method and frequency of occurrence method. Volumetric method was employed for quantitative analysis of gut content. As Hynes (1950) pointed out volume forms a very suitable form of assessment, this is especially so in the case of herbivorous and mud feeding fishes. There are various methods for volumetric analysis of gut content. In the present study displacement method was followed. However, these methods do not provide complete picture when used singly. Therefore, in the present study both methods were used in combination so as to get exact picture of dietary importance (Shrivastava *et al*., 1999). Finally index of preponderance was followed (Natarajan and Jhingran, 1969).

2.3 Strip count method

The gut contents collected from each specimen was taken in a cavity block and was diluted four times. Out of this 1ml was shaken well to separate the items and then scanned under a microscope in a sedge wick-rafter cell. The number of different food items identified was counted in 1ml. The total number of food items was calculated by multiplying the number of each food item in 1ml by the total volume of the sample and was calculated by using the following formula:

Total no of each food item = No. of food items calculated × volume of total sample

2.4 Frequency of occurrence method

After collection, fishes were dissected and stomach contents were removed and placed on Petridish. The individual food organisms were sorted and identified. The number of stomachs in which each item occurs is recorded and expressed as percentage of the total number of the stomachs examined (Hynes, 1950):

$$\text{Frequency of occurrence (Oi)} = \frac{Ni}{N} \times 100$$

Where, Ni is number of fish containing prey i and N is the number of fish with food in their stomach.

2.5 Displacement method

The displacement method is probably the most accurate one for assessing the volume. The volume of entire food in the stomach was determined by displacement method by using a graduated cylinder. After this the food items were separated and the volume of each food item is determined by the same method. The percentage of each food item out of the total volume was calculated according to (Hynes, 1950).

2.6 Index of preponderance

The grading of food elements was calculated by the methods of index of preponderance (Natarajan and Jhingran, 1969). This method is a combination of both occurrence (qualitative method) and volume (quantitative method) of food contents found in the gut of fish which determined the grading of different food items which can be expressed with following equation as:

$$I_i = \frac{ViOi}{\Sigma ViOi} \times 100$$

Where I_i represents the index of preponderance
V_i represents the percentage of volume of a particular food
O_i represents the percentage of occurrence of particular food

2.7 Gastrosomatic index (GaSI)

The gastro somatic index was calculated by using the method as described by Biswas (1993) and the following formula was employed:

$$GaSI = \frac{\text{Total weight of full gut}}{\text{Total weight of fish}} \times 100$$

3. RESULTS

3.1. Monthly variation in the food composition of *S. plagiostomus*

The variation in composition of different food items in *S. plagiostomus* during different months of the year are shown in Table 1. The study of food and feeding habits of *S. plagiostomus* indicates that the fish is a benthic herbivore. During the analysis of food and feeding habits of *S. plagiostomus* it was concluded that the fish is benthic herbivorous. Its food mainly consists of plant matter 62.02%. A good amount of miscellaneous food items i.e. mud, sand and detritus 31.01% was also present in the gut of fish along with small quantity of animal food 6.97% (Table 1, Fig, 2). Overall it was concluded that diatoms formed an important constituent of food of *S. plagiostomus* in all months of the year and the presence of detritus, mud and sand indicates that the fish is a detrivorous, bottom feeder.

Table 1: Mean percentage values of annual diet composition of different food items found in the gut of *S. plagiostomus*

Plant matter (algal matter, unidentified plant matter)	62.02%
Animal matter (Zooplankton and macro invertebrates)	6.97%
Miscellaneous (sand, mud and detritus)	31.01%

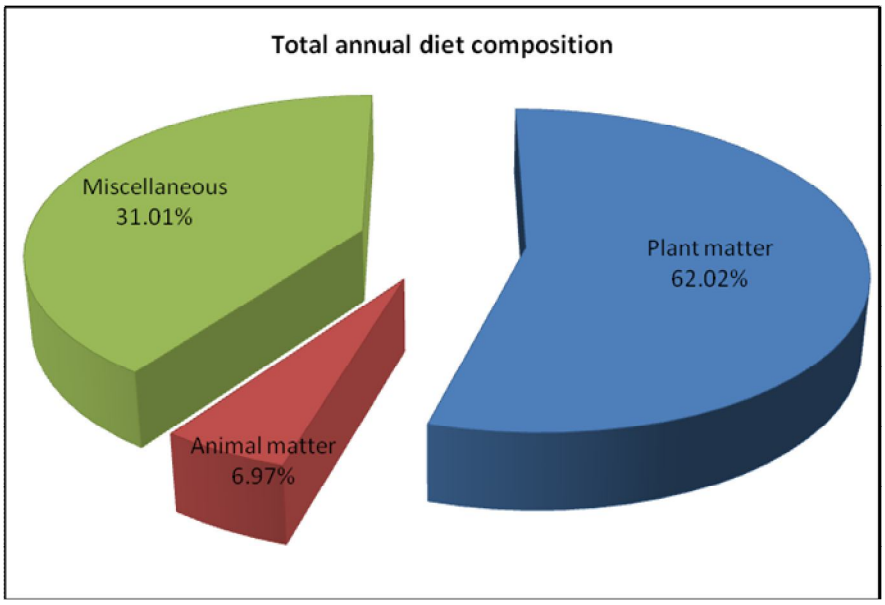

Figure 2: Showing mean percentage of total annual diet composition found in the gut of *S. plagiostomus*

The quantitative and qualitative analysis of the gut contents was carried out by employing percent volume and percent occurrence methods. The food items found in the examined guts were grouped into 6 categories namely algal matter, unidentified plant matter, zooplanktons, macro invertebrates, detritus, mud and sand which were further broadly classified into three major groups like plant matter, animal matter and miscellaneous. Plant matter contributed 54.57% by volume, 57.51% by occurrence with index of preponderance as 56.98%. Animal matter contributed 5.27 percent by volume, 8.41 percent by occurrence with index of preponderance as 5.36 percent. Miscellaneous

contributed 40.16 percent by volume, 34.07 by occurrence with index of preponderance 37.66% (Table 2, Fig. 3, 4, 5).

Algal matter mainly consists of Chlorophyceae (Green algae), Bacillariophyceae (Diatoms) and Cynophyceae (Blue green algae) and contributes 4.23, 40.74 and 0.74 percent by volume and 4.20, 40.32 and 0.66 percent by occurrence with index of preponderance as 6.12, 42.62 and 0.90%, respectively. Unidentified plant material included all other items in the gut and constituted 8.86% by volume and 12.33 by percent of occurrence with index of preponderance 7.34%. Zooplanktons like protozoa, rotifer, cladocera, ostracoda and copepoda constituted 0.36, 1.31, 0.50, 0.13 and 1.77 by percent occurrence. Macro invertebrates which include insect larvae, insect adults and annelids contributed 1.63, 1.81 and 1.83 percent by volume and 1.95, 1.32 and 1.05 percent by occurrence with index of preponderance as 1.91, 1.51, and 1.94 percent, respectively. Detritus constituted 20.95% of the food item by its volume and 20.02 percent by occurrence with index of preponderance as 19.43 percent. Sand and mud particles formed 19.21% of the gut content by its volume and 14.04 percent by occurrence with index of preponderance 18.23% (Table 2, Fig. 3,4, 5)

Table 2: Index of volume, index of occurrence and index of preponderance of different food items of *S. plagiostomus* (mean)

	Food items	**Index of volume (Vi)**	**Index of occurrence (Oi)**	**ViOi**	**Index of preponderance (Ii)**
Plant matter	Chlorophyceae	4.23	4.20	17.766	6.12
	Bacillariophyceae	40.74	40.32	1642.63	42.62
	Cynophyceae	0.74	0.66	0.488	0.90
	Unidentified-plant matter	8.86	12.33	109.24	7.34
	Total	**54.57**	**57.51**		**56.98**
Animal matter	Protozoa	-	0.36	-	-
	Rotifera	-	1.31	-	-
	Cladocera	-	0.50	-	-
	Ostracoda	-	0.13	-	-
	Copepoda	-	1.77	-	-
	Insect larvae	1.63	1.95	3.17	1.91
	Insect adults	1.81	1.32	2.38	1.51
	Annelids	1.83	1.05	1.92	1.94
	Total	**5.27**	**8.41**		**5.36**
Miscellaneous	Detritus	20.95	20.02	419.54	19.43
	Mud and sand	19.21	14.04	246.464	18.23
	Total	**40.16**	**34.06**		**37.66**

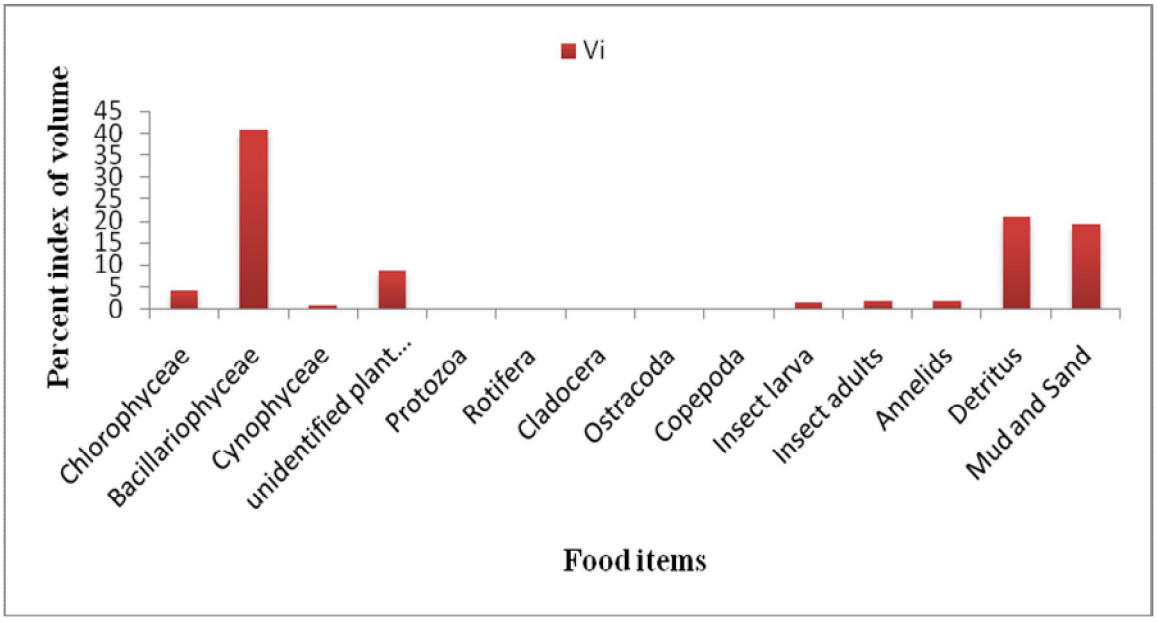

Figure 3: Showing mean percent annual index of volume of different food composition found in guts of *S. plagiostomus*

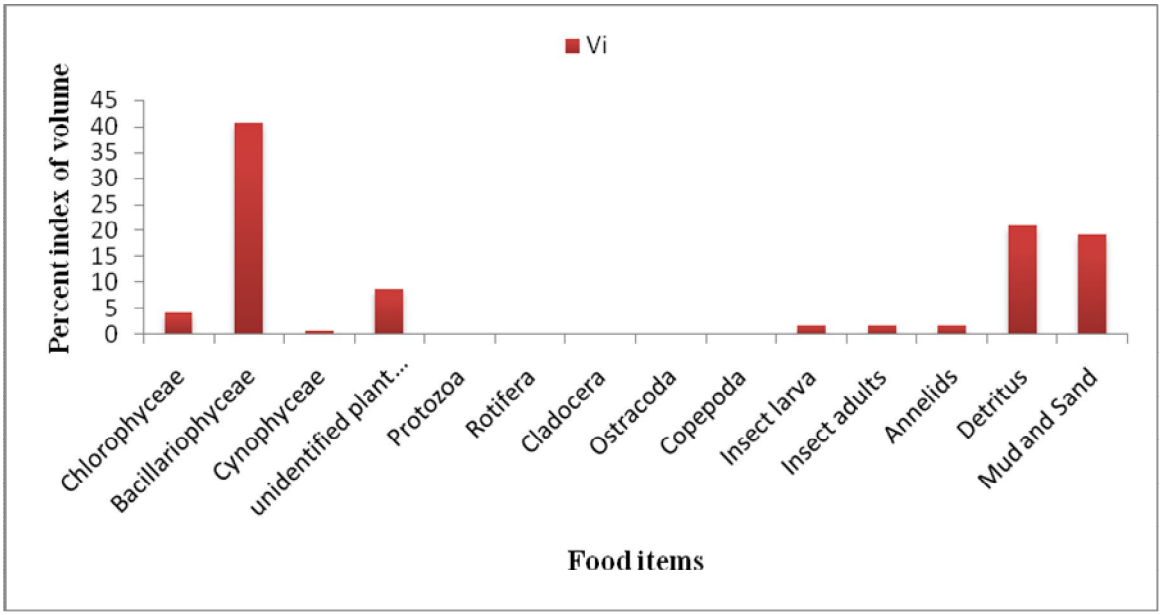

Figure 4: Showing mean percent annual index of volume of different food composition found in guts of *S. plagiostomus*

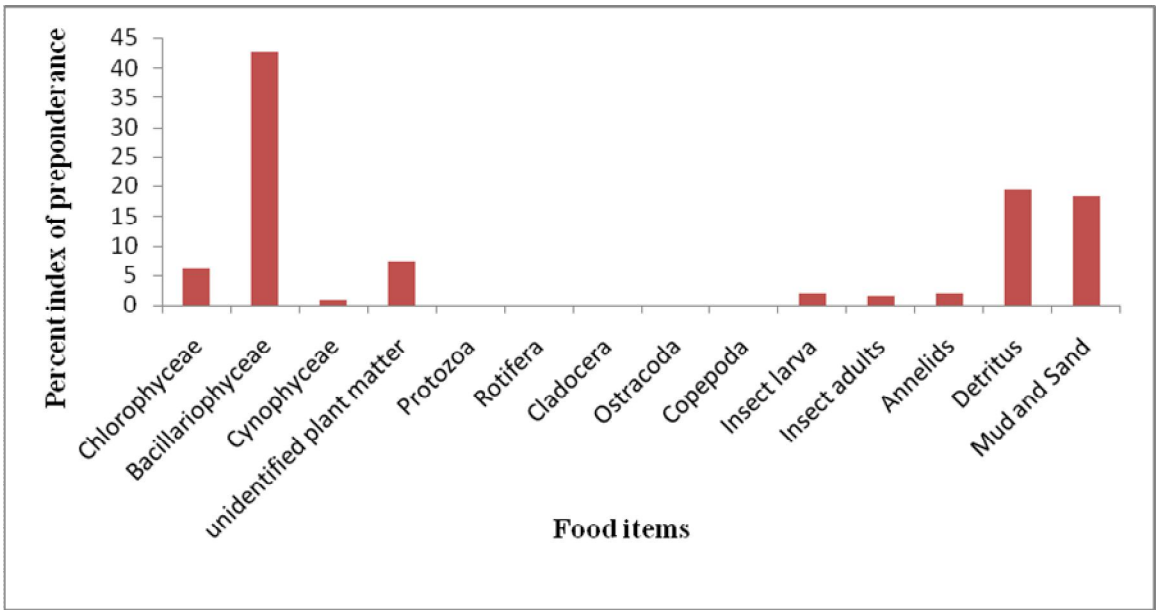

Figure 5: Showing mean percent annual index of preponderance of different food composition found in guts of *S. plagiostomus*

3.2. Gastrosomatic index (GaSI)

The gastrosomatic index of both females and males of *S. plagiostomus* in various months of the year are presented in Table 3, 4 respectively. The gastrosomatic index in case of females ranged from 3.88±0.30 to 7.30±2.128 with minimum in July and maximum GaSI in October and 3.37±0.75 to 7.82±2.22 in males with minimum in July and maximum in December.

Table 3: Average gastro somatic index (GaSI) and feeding intensity (FI) of *S. plagiostomus* females in various months of the year (Mean ± SD)

Months	No. of stomachs examined	Average gastro somatic index±SD
July	30	3.88±0.30
August	32	6.75±1.92
September	35	6.59±2.07
October	34	7.30±2.12
November	38	6.60±2.17
December	20	4.64±2.14
January	21	5.31±2.00
February	32	5.07±1.98
March	30	6.00±1.90
April	35	4.90±1.86
May	34	4.63±1.89
June	35	4.19±1.88

Table 4: Average gastro somatic index (GaSI) and feeding intensity (FI) of *S. plagiostomus* males in various months of the year (Mean ± SD)

Months	No. of stomach examined	Average gastro somatic index ±SD
July	20	3.37±0.75
August	21	4.47±0.90
September	18	5.78±1.62
October	34	8.16±2.22
November	26	6.88±2.18
December	17	7.82±2.22
January	19	6.52±2.34
February	25	7.57±2.36
March	32	6.52±1.40
April	19	5.09±1.28
May	34	4.15±2.15
June	37	4.04±0.78

4. DISCUSSION

The present study on the analysis of food and feeding habits of *S. plagiostomus* revealed that the fish is benthic herbivorous. On an average its food mainly consists of plant matter mostly diatoms. A good amount of miscellaneous items i.e. mud, sand and detritus or decaying organic matter and a small quantity of animal food was also recorded in the gut of fish. These results are in conformity with the results of Sunder (1984) who reported that the diet of *S. curvifrons* contained on an average dissolved organic matter (40.33%), sand and mud (17.51%), phytoplankton (38.78%), zooplankton (2.00%) and miscellaneous matter (1.38%). Similar findings were also reported by Subla and Das (1970) while studying on the feeding habits, food and seasonal fluctuations of nine local fishes of Kashmir. Langer (1984-85) while studying on food and feeding habits of *S. longipinus* also reported that detritus constitute the main component of food, followed by plant material and animal food. Sand and mud were also recovered from the gut contents. Kausar *et al*., 2012 studied the seasonal fluctuations in the gut contents of *S. esocinus* and *S. curvifrons* and reported that gut contents were found to contain on an average animal matter (12.43%), vegetable matter (51.25%), unidentified animal matter (6.25%), unidentified vegetable matter (27.67%) and sand particles (2.595%) which is again in agreement with the present study.

In the present study, it is concluded that diatoms formed an important constituent of food of *S. plagiostomus* in all months of the year. The *S. plagiostomus* was found to contain maximum quantity of plant matter in its diet along with good amount of mud, sand and small quantity of animal matter. Variation in food components in different size groups of fishes were noticed in *L. fimbriatus* (Bhatnagar and Karinchandini, 1970), while increased proportion of detritus mud and sand in fish is attributed to their bottom feeding and browsing habit (Kurup, 1993).

The gastrosomatic index (GaSI) is related to feeding intensity of fish (Desai, 1970). In the present study, the GaSI of *S. plagiostomus* exhibits variation in different months of the year. The gastrosomatic index was generally low during April, May, June and July when the guts were even found with poor food content and some guts were even found empty. The low feeding activity during peak breeding season may be due to fully developed gonads which occupies maximum space in the abdomen there by squeezing the gut and reducing its capacity for storage of food. Feed intake fluctuates more in females as compared to males because of the fact that ovaries in case of *S. plagiostomus* are more spacious than testes. It was also noticed that GaSI varied slightly with different months of the year and thus indicates that the fish does not feed at the same rate. The high feeding intensity of *S.*

plagiostomus were found during the months of August, September, October and November and almost maintains the high rate up to March (non-spawning period and pre-spawning) and low in April, May, June and July (spawning-period) in both sexes. High rate of feeding intensity during non spawning period may be due to extra energy required for building up of gonads, besides this the number of empty stomachs were also noticed from May-June which is accounted to breeding season of fish (Jayaprakash and Nair, 1981) and sometimes intense feeding was also noticed in these months which may be due to some other factors other than breeding. Gastrosomatic index and stomach fullness have positive correlation. During gonad maturation it has been found that both indices (GaSI and fullness) were low and continues to remain so till the end of spawning season (Balendra *et al.,* 1997). The same type of feeding intensity in relation to the stage of maturity has also been reported by Khan (1988) and Serajuddin *et al.* (1998) in *Cyprinion macrostomus* and *Mastacembelus armatus*, respectively. Arthi *et al.* (2011) also worked on the feeding intensity or the gastrosomatic index of the fish *Ompokmpokbi maculatus* and *Ompok malabaricus*s, have found low feeding intensity during August and June which they suggest that it may not be due to shortage of food items, but due to the spawning season of the fish. Their findings are again in agreement with the present study in which the feeding intensity of *S. plagiostomus* was high during non-spawning period and reduced during spawning period.

Ethical Approval

Not required as per the guidelines of Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA).

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Conflict of interest

There is no conflict of interest to disclose

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