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## Study on gut morphometric parameters of *Schizothorax esocinus* Heckel, 1838

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**Abstract**

The examination of morphological features related to feeding in fish, as well as their relation with body length, are of increasing scientific interest. In the present study, intestine (gut) morphometrics have been analysed and discussed. The Gut morphometric parameters studied to investigate the feeding habit of *Schizothorax esocinus* are Gut length, Gut weight, Relative gut mass (RGM), Relative length of gut (RLG), Zihler's index (ZI) and Gut Vacuity index (GVI). According to the results, total length and total weight of fish ranged from 145.05 to 428.97 mm and 69.74 to 719 g, respectively. The overall relative gut mass (RGM) and relative length of gut (RLG) values ranged from 0.01 to 0.13 with a mean value of  $0.03 \pm 0.02$  and  $0.63$  to  $2.56$  with a mean value of  $1.22 \pm 0.33$ , respectively thereby exhibiting that *S. esocinus* is omnivorous in nature. The results revealed the Zihler's index (ZI) values to be in the range of 3.05 to 12.75 with a mean value of  $5.81 \pm 1.56$ , indicting the fish to be an omnivore. GVI values ranged from 0 to 33.33 with a mean value of  $10.28 \pm 9.80$  which revealed that *S. esocinus* is a relatively gluttonous species. This study will provide relevant information about the digestive habits and characteristics of the digestive tract of the specie, along with its position in the food chain.

**Keywords:** *Schizothorax esocinus*, relative gut mass, relative length of gut, zihler's index and gut vacuity index

**1. Introduction**

*Schizothorax* is a genus of cyprinid fish found in southern and western China, through northern South Asia (Himalaya) and Central Asia to Iran. They are primarily found in highland rivers, streams and lakes, although a few species occur in lower-lying locations [1, 2, 3, 4]. The Snowtrouts are economically significant, indigenous food fishes of Himalayas in India. Fishery scientists find potential in the snowtrouts to project them as a candidate species for their propagation in the coldwater bodies of Indian Himalaya [5, 6, 7, 8, 9, 10, 11]. These species are in high demand in the market due to their good taste, great nutritional value and fair availability throughout the year. These species fill the growing fish demand of a vast population, making them commercially and economically significant food fishes of the Kashmir Himalaya [5, 7, 10, 11, 12, 13]. The *Schizothorax* species found in water bodies of Kashmir are; *Schizothorax esocinus* (Churru), *Schizothorax curvifrons* (Satter gad), *Schizothorax niger* (Ale gaad), *Schizothorax plagiostomus* (Khont), *Schizothorax labiatus* (Chosh) [5, 7, 10, 11, 14, 15]. In fishes, both external (e.g., shape and size) and internal morphology [e.g., stomach shape and size, gut length (GL)] provide important information on a species' feeding ecology [16, 17, 18, 19, 20, 21]. Exploration of the relations between various feeding-related morphological characteristics with body length [22] and GL [23, 24], are of great importance for understanding the biology and ecology of fishes [21, 25, 26, 27, 28], as well as pinpointing the ecological role of a species in the aquatic food webs [22, 28]. Gut length, in particular, provides important information on species' feeding habits in almost all vertebrate classes, including fishes [26]. There is little information regarding certain gut morphometric parameters and somatic indices such as relative gut mass, relative gut length, Zihler's index, gut vacuity index and fullness index of *S. esocinus*. This information is necessary to determine its feeding habit as the population of these fishes seems to be declining in Kashmir region.

**2. Material and Methods**

The research work on *S. esocinus* was conducted in Fisheries Resource Management (FRM) laboratory, Faculty of Fisheries, SKUAST-K, Rangil, Ganderbal. The study involved the following steps for meeting the various objectives of the work.

### 2.1 Collection of fish samples

30 fish samples of *S. esocinus* of different size groups were collected monthly for a period of one year from Dal lake landing centre, Srinagar. Samples were transported to FRM laboratory (FoFy) in insulated boxes containing ice packs. The fish samples were then cleaned under running tap water and dried with a clean cotton cloth. After cleaning, total weight and total length of each sample was measured using electronic weighing balance up to the nearest 0.5 gram and digital Vernier Caliper to the nearest 0.01 millimeter respectively.

### 2.2 Gut morphometric and Somatic indices analysis

For gut morphometric analysis, each specimen of fish was measured to its total length to the nearest of millimeter (mm) and weighed to the nearest of gram (g). Each sample was then discreetly dissected by making incision at anus and extending it anteriorly along the fish belly towards the head and their guts were removed out carefully.

Gut morphometric parameters and somatic indices were then recorded with the help of digital Vernier Caliper and digital weighing balance. Total gut length was measured with the help of digital Vernier Caliper by carefully stretching out the whole gut and then removing the attaching tissues like adhering fat and viscera cautiously with the help of forceps. Length of gut was recorded from the anterior end to the cloacal aperture. The gut was then weighed carefully on a digital weighing balance to the nearest milligrams. Following parameters were calculated:

1. Gut length (GL)
2. Gut mass (GM)
3. Relative gut mass (RGM)

It was calculated using formula

$$RGM = \frac{\text{Total Gut mass(g)}}{\text{Total body mass (g)}}$$

4. Relative length of gut (RLG) or Intestinal Quotient (IQ)

Its value was calculated using following formula [29]:

$$RLG = \frac{\text{Total gut length}}{\text{Total length of fish}}$$

5. Zihler's Index (ZI)

It was calculated by the following formula [30]:

$$ZI = \frac{\text{Total gut length(mm)}}{10 \times (\text{body mass})^{\frac{1}{3}}}$$

6. Gut Vacuity Index (GVI)

It was calculated using the following equation [31]:

$$GVI = \frac{\text{Number of empty guts(EG)}}{\text{Number of surveyed guts (TG)}} * 100$$

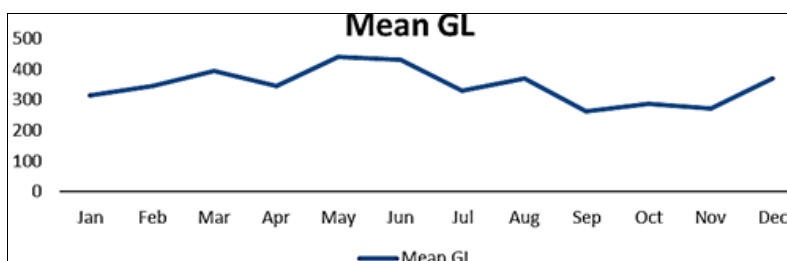
### 3. Results and Discussion

In the present study, 30 fish samples of *S. esocinus* of different size groups were collected for a period of 12 months and gut morphometric parameters such as gut length (GL), gut weight (GW), relative gut mass (RGM), relative length of gut (RLG) or intestinal quotient (IQ), Zihler's index (ZI) and Gut vacuity index (GVI) were then recorded (Table 1).

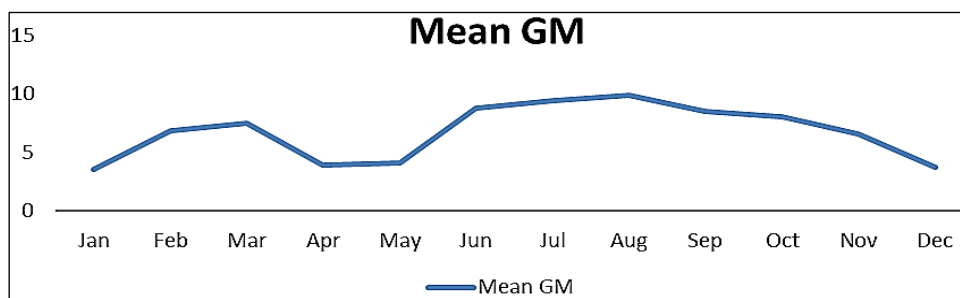
**Table 1:** Descriptive statistical summary of gut morphometric parameters of *S. esocinus*

	Min	Max	Mean±SD
Total Length (mm)	145.05	428.97	287.37±59.90
Total Weight (g)	69.74	719	233.46±130.90
Gut Length (mm)	174.36	848.73	347.07±115.93
Gut Weight (g)	0.17	18.91	6.73±3.31
RGM	0.01	0.13	0.03±0.02
RLG	0.63	2.56	1.22±0.33
ZI	3.05	12.75	5.81±1.56
GVI (%)	0	33.33	10.28±9.80

The length range of the gut of the *S. esocinus* was found to be between 174.36 mm to 848.73 mm (17.43 cm to 84.87 cm) and weighed from minimum of 0.17 g to a maximum of 18.91 g. It is reported that one of the most widely recognized anatomical features of vertebrates is that herbivores exhibit longer digestive tracts than carnivores, and this pattern appears to be consistent among mammals [32, 33], birds [34], reptiles and amphibians [33] and fishes [35, 36, 37, 38]. Authors have noted that carnivorous fish have relatively shorter intestines than herbivorous fish. In a study of flatfish, De Groot [39] found that the relative intestine is shortest in Psettodidae which eat fish and larger invertebrates, and longest in Soleidae which eat smaller invertebrates. Zihler [30] also stated that piscivorous, paedophagous and crustacean eating species have short intestines with little or no coiling whereas herbivorous, planktivorous and detritivorous forms have complicated and much coiled intestines. Odum [40] found an extremely rapid lengthening of the gastrointestinal tract as mullet shifted from primarily an animal diet to a plant diet. These trends suggest that the relative length of the gastrointestinal tract is one of the adaptive features of the feeding ecology of fish. Hence, the relatively shorter length of gut in *S. esocinus* as stated in the present study suggests that the specie shows a somewhat omnivore behavior in comparison to other shizothoracines. Figure 1 and 2 shows the monthly mean values of gut length and gut weight in *S. esocinus*.



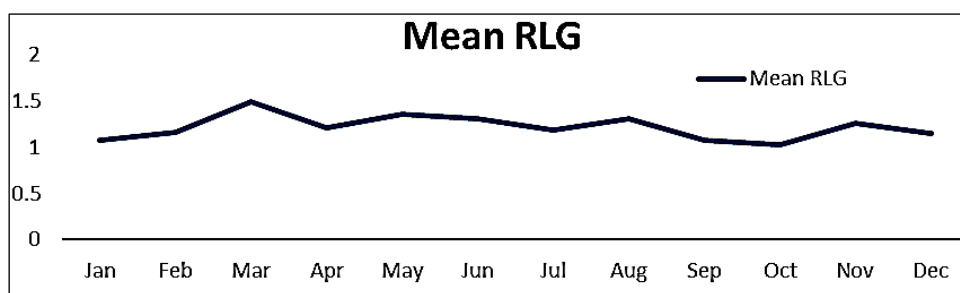
**Fig 1:** Monthly Mean GL values of *S. esocinus*.



**Fig 2:** Monthly Mean GM values of *S. ecosinus*.

The structure of alimentary canal and its modification has a direct bearing on the nature of diet consumed by the fish. In the present study, the observed RLG value in *S. ecosinus* ranged between 0.63 and 2.56. This implies that, the fish has omnivorous feeding habit, feeding predominantly on diatoms, macrophytes and crustaceans. Dasgupta [41] observed an average RLG value of 0.7 for carnivorous fishes, 3.7 for planktivorous fishes and 4.7 for herbivorous fishes and the RLG value increased with increase of plant matter and decreased with animal matter in the gut content. Gharaei [42] reported the average relative length of gut in *S. zarudnyi* as 1.71 and termed it as herbivore. The RLG value of grass carp

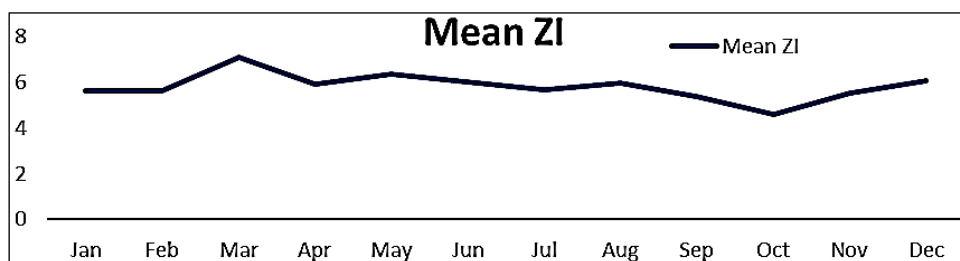
reported by Buddington *et al.* [43] is 1.90 and the RLG value of large herbivore specimens of *Brycon guatemalensis* was also reported to be 2.3 by Drewe *et al.* [44]. In the present analysis, the average relative gut length (RLG) in *S. ecosinus* was measured as 1.22. Johari *et al.* [45] reported if RLG is  $\gg 1$ , then the fish is a herbivore, if RLG = 1, then the fish is an omnivore, and if RLG is  $\ll 1$ , then the fish is a carnivore. As the RLG value is almost equal to one and slightly greater than it, therefore, based on this *S. ecosinus* can be categorized as an omnivore fish. Figure 3 indicates the monthly change in mean values of RLG in *S. ecosinus*.



**Fig 3:** Monthly Mean RLG values of *S. ecosinus*

Relative gut length (RLG) is the gut length index probably used most commonly in comparisons among fishes with different diets [35, 36, 44], but this index ignores differences in body mass. Zihler's Index, which relates gut length to body mass rather than standard length, offers a potentially powerful approach that takes into account differences in body mass. In the present analysis, the average Zihler's index (ZI) in *S. ecosinus* was measured as 5.81 and the ZI values ranged from 3.05 to 12.75. Karachle and Stergiou [46] while studying the intestinal morphometrics of fishes reported the mean ZI values as 20.31, 3.75, 5.3 and 4.3 of herbivores, omnivores

with preference to animal material, carnivores with preference to decapodes and fish and carnivores with preference to fish and cephalopods respectively. In another study by Kramer and Bryant [38], fishes were classified according to their ZI as carnivores (ZI = 2.3-3.2), omnivores (ZI = 2.4-5.8) or as herbivores (ZI = 11.6-55.0). Therefore, based on this classification, based on a ZI mean value  $5.80 \pm 1.55$ , *S. ecosinus* can be classified as an omnivore fish. Figure 4 indicates the monthly change in mean ZI values in *S. ecosinus*.



**Fig 4:** Monthly Mean ZI values of *S. ecosinus*

Gut length is not the only important morphometric character of the digestive tract relating to diet in fishes because gut surface area [47, 48, 49] and gut mass [50, 51, 52, 53] are also

important. Relative gut mass (RGM) takes body mass into account and may be an informative method for determining the relative quantity of tissue dedicated to the gut in different

species of fish with different diets. However, comparisons of RGM between herbivorous and carnivorous fishes appear to be lacking in the literature. When used together with gut length, RGM ought to provide a useful measure for comparing total gut size in herbivores and carnivores. In the present analysis, the average relative gut mass (RGM) in *S. ecosinus* was measured as 0.03 and the values ranged from 0.01 to 0.13. Hani *et al.* [54] recorded the RGM values of three

spine sticklebacks (*Gasterosteus aculeatus*) ranged from 0.034 to 0.052. Fuentes and Cancino [55] found that the RGM was higher in individuals of *Girella laevis* consuming a 50% algae diet than in individuals of this species consuming a carnivorous diet. Therefore, a higher RGM value is an indication towards herbivorous diet and a lower value represents an omnivore or carnivorous diet. Figure 5 indicates the monthly changes in mean values of RGM in *S. ecosinus*.

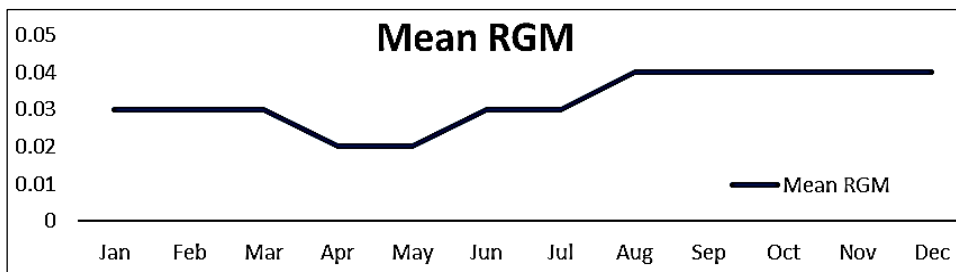


Fig 5: Monthly Mean RGM values of *S. ecosinus*

In the present analysis, the mean Gut Vacuity Index (GVI) in *S. ecosinus* was measured as 10.28 with values ranging from 0 to 33.33. According to Euzen [31], GVI is used to work out the appetite of the species, where numbers of empty guts are surveyed. Johari *et al.* [45] stated that if GVI<20, then the species is considered gluttonous. If GVI<40, then the species

is considered relatively gluttonous. If GVI<60, then the species has a medium nutrition. If GVI<80, then the species has a relatively low nutrition and if GVI<100, then the species has low nutrition. Therefore, based on the results, *S. ecosinus* can be considered gluttonous species. Figure 6 indicates the monthly changes in mean GVI values in *S. ecosinus*.

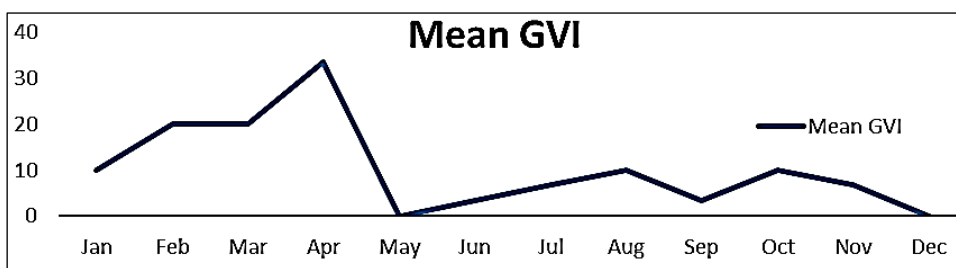


Fig. 6: Monthly GVI values of *S. ecosinus*.

Pearson's correlation of the gut morphometric parameters of the *S. ecosinus* revealed that total length showed positive correlation with fish weight, gut length, gut weight and Zihler's index where as it showed negative correlation with relative gut mass, relative gut length, gut vacuity index and Zihler's index. Fish body weight showed positive Pearson's correlation with total length, gut length, gut weight and relative gut length whereas it showed negative correlation with RGM and GVI. Gut length and gut weight showed positive correlation with all variables under study except GVI. RGM showed positive correlation with GW, RLG and ZI and negative correlation with TL, TW, GL and GVI. RLG showed positive correlation with TW, GL, GW, RGM ZI and GVI while as a negative correlation with TL. ZI showed positive correlation with all the parameters except GVI (Table 2). Riaz and Naeem [56] also reported positive Pearson's correlation of fish weight with total length, gut weight and negative correlation of fish weight with RGM. They also reported positive correlation of TL with GW and GL and positive correlation of Gut weight with RGM, RGL and ZI. Further they found positive correlation of Gut length with RGM and ZI.

Table 2. Pearson's correlation of the traits under study of the *S. ecosinus*

	TL	TW	GL	GW	RGM	RLG	ZI
TL	1	.641**	.501**	.352**	-.273**	-.127	.164*
TW	.641**	1	.600**	.472**	-.431**	.205**	.051
GL	.501**	.600**	1	.427**	-.152*	.780**	.814**
GW	.352**	.472**	.427**	1	.458**	.231**	.173*
RGM	-.273**	-.431**	-.152*	.458**	1	.035	.133
RLG	-.127	.205**	.780**	.231**	.035	1	.839**
GaSI	-.273**	-.431**	-.152*	.458**	1.000**	.035	.133
ZI	.164*	.051	.814**	.173*	.133	.839**	1
FI	-.204**	-.279**	-.073	.379**	.753**	.080	.140

\*\* . Correlation is significant at the 0.01 level (2-tailed).  
 \* . Correlation is significant at the 0.05 level (2-tailed).

**Conclusion**

The study of gut morphometric parameters of *S. ecosinus* revealed that the fish is omnivore in nature. The Relative Length of Gut, Relative Gut Mass and Zihler's Index values suggest the omnivorous feeding habits of the fish. Also the gut vacuity index indicated it to be a gluttonous species. Finally, it is very important to make further studies regarding the dietary aspects of the fish feeding behavior which will provide a better understanding about the nature of these species, which will increase our ability to identify and



introduce the fish to the aquacultural field.

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