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FEEDING HABITS AND LENGTH-WEIGHT RELATIONSHIP OF *NEMACHEILUS TRIANGULARIS* (DAY, 1865) FROM KALLAR STREAM IN SOUTHERN WESTERN GHATS.

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Abstract: The present study was to understand the food and feeding habits and to findout the length-weight relationship of *Nemacheilus triangularis* (Day, 1865) collected from Kallar stream in southern Western Ghats region during the period from December 2011 to November 2012. Standard procedures were used for studying the food and feeding habits and length- weight relationship of *N. triangularis*. The monthly variation of condition factor (k) of the experimental fish was also estimated during the study period. The Index of preponderance with percentage volume of the different food items revealed the highest value was shown by crustacean parts (22.09%) followed by body parts of aquatic insects (21.45%), algal matter (18.28%), and miscellaneous/semi digested parts (11.35%). The '*b*' value for female group (2.864, SE= 0.2220) were higher than that of male group(2.654, SE= 0.1575). The monthly variation of condition factor (k) ranged from 0.31 to 1.16 with a mean of 0.56 showed a fair condition. The highest condition factor value (1.16) was recorded in August and the lowest (0.31) in the month of March. The observed RLG value ranged from 0.8 to 0.96 implies that the fish has omnivorous feeding habit, feeding predominantly on animal matter. The study confirmed that lowest 'k' values during the advanced stages of maturity might be due to the resource transfer to the gonads during the reproductive period. The present study the '*b*' value showed variation from the cube law, hence it found that *N. triangularis* following negatively allometric growth pattern. The difference in the '*b*' value for males and females was due to the gonadal maturity of the females. The information generated from the study will form a strong preliminary tool for the conservation and management of this valuable ornamental fish in Kallar stream which is already facing myriad of stress due to tourism and change in land use patterns.

Key words: *Nemacheilus triangularis*, Index of preponderance, Condition factor, Allometric growth.

INTRODUCTION

Fishes encompass the most numerous vertebrate group characterised by an exclusive diversity of feeding habits and food items. The dietary analysis of fishes indicates the trophic segregation pattern among the members of the fish community in that area. The functional morphology of feeding deserves detailed exploration because of its intimate linkage to all aspects of fish evolution and biology. The basic knowledge on the food preference and feeding habits of species are of primary importance for ascertaining its suitability for aquaculture Kishore *et al.* (1998). Diet related studies from natural habitat also help in understanding the autecology, production and ecological role of fish population. Sometimes the rate of feeding will also have a direct bearing on spawning behaviour of the fish. So obviously the best method of ascertaining its food is by examination of its gut contents Sharma *et al.* (1992). The dietary habits of fish based on stomach content analysis is also widely used in fish ecology as an important means of investigating trophic relationship in aquatic communities.

The length weight relationship in fishes can be affected by a number of factors including season, habitat, gonad maturity, sex and diet. Total body length is closely related to many factors such as age, different size groups and sex. This will help to estimate the general wellbeing of different sizes of the fish. The objective of the study was to understand the food and feeding and length-weight habits of fresh water fish, *Nemacheilus triangularis*.

MATERIALS AND METHODS

The species used for the present study was *N. triangularis* (Day, 1865) collected from Kallar stream in Southern Western Ghats (8°41'28" N, 77°07'59" E) during the period of study from December 2011 to November 2012. The species shows great deal of variation in their colour pattern with respect to age, habitat and locations. This species is endemic to Western Ghats of Kerala and Tamilnadu (Menon, 1987; Jayaran, 2010). Fishes were collected by scoop net. Immediately after collection, the specimens were preserved in 10% formalin and brought to the laboratory for further analysis.

The food and feeding habits of *N. triangularis* was done by Index of preponderance (Natarajan and Jhingran, 1963). Index of preponderance (I_i) a combination of occurrence (Quantitative method) and volume (Qualitative method) of food contents. This can be expressed as

$$I_i = \frac{ViOi}{\sum ViOi} X100$$

Where, I_i is the index of preponderance, V_i and O_i represent the percentage volume and occurrence of particular food respectively.

The useful index which gives an idea of the nature of food is relative length of gut (RLG). The RLG value is calculated by taking the ratio of gut length and body length, i.e. (Al Hussaini, 1949).

$$\text{Relative Length of Gut (RLG)} = \frac{\text{Length of gut}}{\text{Total body length}}$$

The length weight relationship of *N. triangularis* assessed by measuring the total length (TL) to the nearest 0.1 cm and weighed (total weight, TW) to the nearest 0.01 g. The length- weight relationship was established using linear regression analysis, TW vs TL (log-transformed): TW= log (a) + b log (TL), where *'a'* is the intercept of the regression curve (coefficient related to body form) and *'b'* the regression coefficient (exponent indicating isometric growth when equal to 3). The significance of the regression was assessed by ANOVA, and the b-value of this species was tested by t-test to verify that it was significantly different from the isometric growth value (b = 3) (Sokal and Rohlf, 1981). All data on LWR of different fish species were subjected to t-test analysis at $p<0.001$. The monthly variation of Condition factor (K) (the degree of fatness or corpulence or well-being of a specimen) was calculated by using the formula, $K=100W/L^3$ (Pauly, 1983) where *W*= weight of fish and *L*= total length of fish.

RESULTS

The Index of preponderance with percentage volume of the different food items revealed that the highest value was shown by crustacean parts (22.09%) followed by body parts of aquatic insects (21.45%), algal matter (18.28%), and miscellaneous/semi digested parts (11.35%). Negligible amount of (2.43%) fish scales were also observed (Table 1). The index of preponderance with percentage volume of the different food item is depicted in pie diagram (Figure 1). The figure 2 shows monthly variation of RLG value in *N. triangularis* which ranged between 0.8 and 0.96. The percentage index of stomach fullness of *N. triangularis* in different months during study period also assessed and it presented in Table 2. The stomach fullness indices of the species showed a high feeding intensity in either pre spawning or post spawning period.

The figure 3 Shows the monthly variation of condition factor (K) which ranged from 0.31 to 1.16 with a mean of 0.56 showed a fair condition. The highest condition factor value (1.16) was recorded in August and the lowest (0.31) in the month of March.

The study of length weight relationship of *N. triangularis* showed that regression coefficient '*b*' varied significantly from the expected cubic value (Table 3). The '*b* value of pooled data was 2.741 (SE= 0.1288). The result of the study showed that the '*b*' value for females (2.864, SE= 0.2220) were higher than that of males (2.654, SE= 0.1575). The intercept '*a*' in the result of male (-1.4648), females (-1.8247) and Pooled (-1.6143) were estimated. The correlation coefficient in the present study showed that the regression

Table 1. Food items and index of preponderance of *N. triangularis*

Sl. no	ITEM	Dec	Jan	Feb	Mar	Apr	May	June	July	August	Sept	October	November	%
1	Algal matter	271.48	256.6	245.7	262.5	195.	206.4	196.	128.4	192.41	187.15	244.75	225.11	18.28
2	Diatoms	247.85	272.9	220.3	196.9	154.	129.8	155.	150.3	225.05	161.94	170.26	248.80	16.32
3	Crustacean parts	384.81	251.0	348.2	256.6	228.	136.1	204.	403.1	229.54	241.70	267.85	208.92	22.09
4	Aquatic insect parts	305.27	246.8	290.0	252.3	225.	158.8	493	205.2	241.67	280.98	227.88	140.63	21.45
5	Tubeworms	26.179	74.49	142.4	85.05	28.9	16.27	16.7	26.29	46.49	66.39	39.70	25.91	4.16
6	Fish scales	26.179	31.65	14.03	37.12	7.12	3.10	3.22	33.86	43.01	34.38	37.49	76.793	2.43
7	Sand particles & Detritus	45.08	52.78	14.26	52.88	17.6	17.24	20.0	135.7	51.83	25.48	96.72	32.51	3.92
8	Miscellaneous/ Semi digested	114.04	106.17	159.64	149.7	101.	167.3	143.	77.14	153.63	140.59	142.24	168.23	11.35
	OiVi	1420.8	1292.5	1434.77	1293.	960.	835.1	1233	1160.	1183.6	1138.6	1226.8	1126.9	100

Table 2. Percentage index of fullness in the gut of *N. triangularis* in different months during the study period

Month	Feeding Stages				
	Empty	Poor	Moderate	Full	Gorged
December	13.79	17.24	24.13	34.48	10.34
January	33.34	20	26.67	13.34	6.67
February	25	15.62	21.87	28.12	9.37
March	30.76	28.21	15.38	23.08	2.56
April	18.42	34.21	26.31	8	7.89
May	13.89	25	38.89	16.67	5.56
June	9.52	38.09	23.81	19.04	9.52
July	36	20	24	16	4
August	16.6	23.08	46.15	11.53	3.84
September	12.90	19.35	35.48	29.03	3.2
October	33.32	21.21	30.30	15.15	3.03
November	13.32	10	30	36.67	10

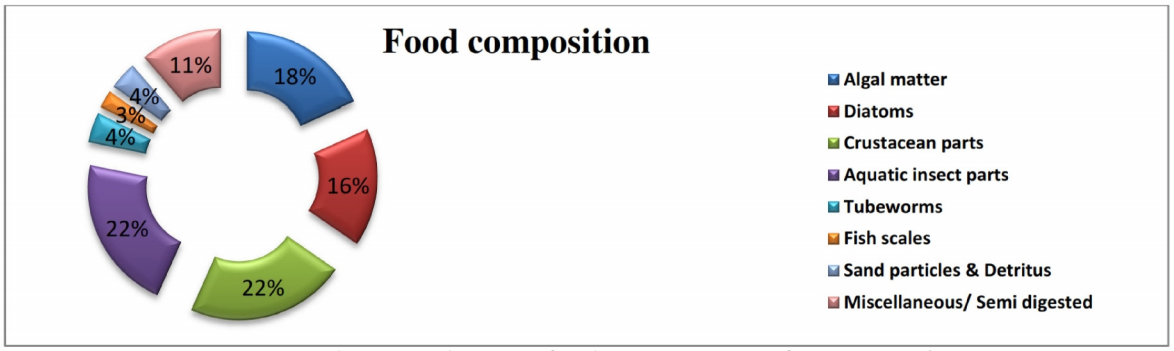

Fig. 1. Pie diagram showing food composition of *N. triangularis*

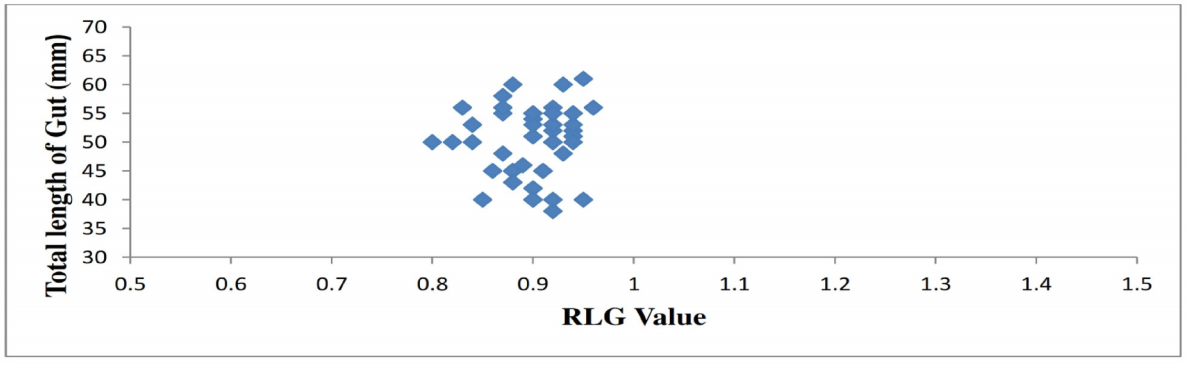

Fig. 2. Monthly variation of RLG value in *N. triangularis*

values were significant ($p<0.001$) which indicated a significant relation between length and weight. The estimated coefficients of length – weight relationships and the statistics of regression for pooled, male and female data also calculated and graphically represented in figs. 4, 5 and 6 respectively.

DISCUSSION

Studies on quantitative composition of the gut contents revealed that *Nemacheilus triangularis* feeding predominantly on crustacean parts (22.09%). Result shows that the fish do not restrict themselves only to some particular food varieties. The food spectrum of *N. triangularis* showed that, most of the foods items present in the habitat fall within the ingestible size range were represented in their guts as well. This would suggest that there is little selection on the part of the fish. Similar results were observed on study of food and feeding in *Osteobrama belangeri* (Basudha and Vishwanath, 1999). According to Das and Moitra (1963), omnivorous fish feed on wide variety of food items. The presence of fish scales and sand particles in the gut along with other food materials indicated the bottom feeding tendency of the fish.

The structure of alimentary canal and its modification also has a direct bearing on the nature of diet consumed by the fish. The observed RLG value in *N. triangularis* ranged between 0.8 and 0.96. This implies that, the fish has omnivorous feeding habit, feeding predominantly on animal matter. Dasgupta (2004) 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. The present study revealed *N. triangularis* was omnivorous and bottom feeder in nature. The stomach fullness indices of the species showed a high feeding intensity in either pre spawning or post spawning period. The greater number of guts with food was attributed to good feeding strategy adopted by the specimens and probably

Table 2. Length - weight relationship of *N. triangularis* in different months during the study period

Group	Sample size (n)	Length range (mm)	a	b	SE (b)	r
Male	27	40 - 61	-1.4648	2.65427	0.1575	0.95
Female	23	38 - 62	-1.8247	2.86465	0.2220	0.94
combined	50	38 – 61	-1.6143	2.7413	0.1288	0.95

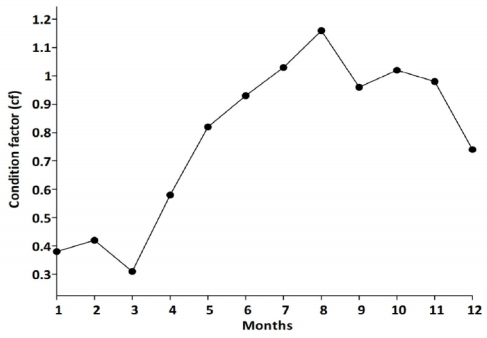

Fig. 3. Monthly variations in relative condition factor of in *N. triangularis*

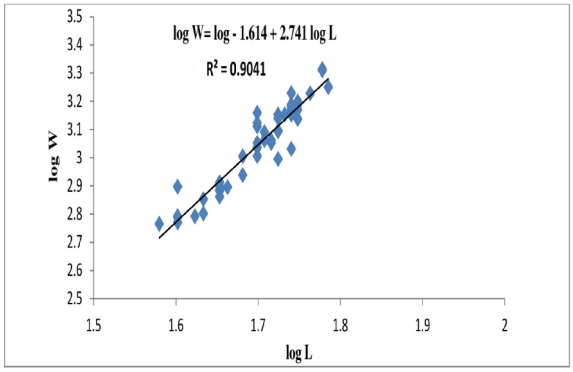

Fig.4. Length weight relationship of pooled data

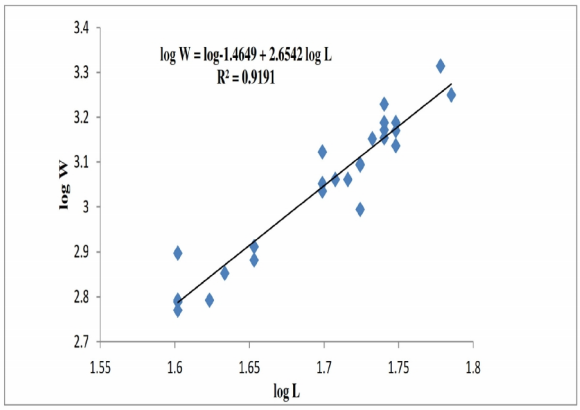

Fig. 5. Length weight relationship of male group

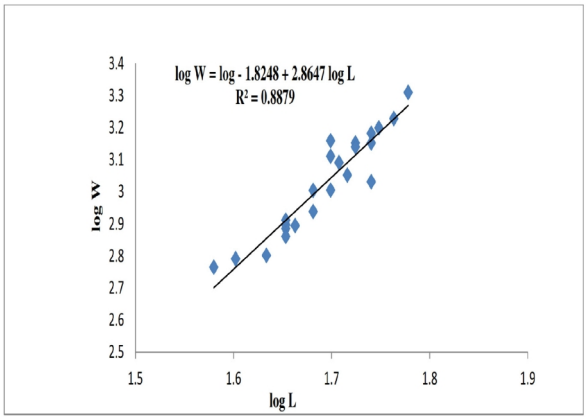

Fig. 6. Length weight relationship of female group

due to food abundance during the season (Haroon, 1998). The 'K' value showed that the species studied were in good condition. The species reproduce between February to April since they recorded the lowest 'K' at about this period. It confirmed that lowest 'K' values during the advanced stages of maturity might be due to the resource transfer to the gonads during the reproductive period.

The study of length-weight relationships of *N. triangularis* showed that the 'b' value (2.741) showed significant difference from the expected cubic values. It was assumed that for an ideal fish, the specific gravity of the fish remains constant throughout its life and probably due to this reason, in many cases the *'b'* values was found to be very close to 3 (Enin and Enidiok, 2002). The value of 3 indicating that a fish grows isometrically. In the present study *'b'* showed variation from the cube law, hence it was found that *N. triangularis* followed negatively allometric growth pattern.

The intercept 'a' was negative (-1.6143, SE= 0.2186) which indicated a perfect linear relationship between the variables. The regression value obtained was 0.904 which was greater than 0.5 which indicated that the regression value was highly significant ($p<0.001$). One of the reasons for this could be the specific habitat preference for the species that suited to the slow and fast moving riffle habitat of the stream. However, the changes in fish weight in general are actually greater than the changes in its length and the body shape of fish tends to change as the length increases. The energy expenditure of the species will be higher for mobility and benthic habitat of the fish in the torrential stream.

The difference in the '*b*' value for males and females was due to the gonadal maturity of the females. The study of allometric scale in growth and reproduction on *N. triangularis* revealed that the exponent *'b'* highest in pre spawning months and decreases substantially during the spawning period and least exponent was seen during the post spawning period. The exponent (*b*) was highest in the pre- spawning months. The results of maturation and spawning in *N. triangularis* indicated that the gonado somatic index showed four peak periods represented by four modes of varying intensity in January, March, May- June and September (Kumari and Nair, 1977). Thus it can be inferred that the testis remained active almost throughout the year. It was concluded that the gonadal maturity of females resulted in the increase of *'b'* value of female group of *N. triangularis*.

CONCLUSIONS

The well-known fact that the knowledge on fish biology particularly on morphometric, length-weight relationship, condition factor, reproduction, food and feeding habit etc are of utmost important not only to fill up the lacuna of the present day academic knowledge but also in the utility of the knowledge in increasing the technological efficiencies of the fishery entrepreneurs for evolving judicious fish culture

management. The fish selected for the present study was *N. triangularis* which belongs to family Balitoridae. Balitoridae family is one among the major hill stream fish families distributed in Kerala. Owing to its hardy nature, brilliant colouration and wide food spectrum, they were valued as an exciting indigenous ornamental fish of commercial value. The objectives of the present study were to find out the food and feeding habits and to determine the length-weight relationship of *N. triangularis*.

The study of food and feeding habits of N. triangularis revealed that the fish was omnivorous and bottom feeder in nature. Index of preponderance was found highest for crustacean parts. The RLG value suggests the omnivorous feeding habits of fish. The length weight relationship study concluded that the 'b' value of females (2.864± 0.22) was slightly higher than that of males (2.654± 0.1575), which could be due to gonadal maturity and resultant body size of females. The *'b'* value of pooled data (2.741±0.1288) showed that N. triangularis followed negatively allometric growth pattern since the 'b' value showed variation from the general cube law. Thus the present study formed a benchmark data on the food and feeding habits and length weight relationship of *N. triangularis*, an endemic fish of southern Western Ghats.

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