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Length-weight relationship, Relative length of gut and Gastro- somatic index of *Chanda nama* (Hamilton, 1822) and *Trichogaster lalius* (Hamilton, 1822) from Tripura, India

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Abstract
Length-weight relationship, condition factor, relative gut length and gastro-somatic index (Ga.SI) were calculated for 122 specimens of *Chanda nama* and 70 specimens of *Trichogaster lalius.* The b value for both the species was 3.08 which indicate isometric growth of the fish in existing scenario. The value of condition factor was 0.93 for *C. nama* and 1.94 for *T. lalius* indicates good condition of the fish. The relationship between total length and gut length was drawn using regression equation. The Relative length of gut (RLG) values revealed the feeding habit of *C. nama* as carnivorous and in *T. lalius* the values revealed that the juvenile shows carni-omnivorous feeding habit whereas in adult it is herbi-omnivorous. The Ga.SI value was used to determine feeding intensity and was found to be lowest in the month of July for *C. nama* and June for *T. lalius* which may coincide with the breeding season of the fish.

Keywords: length-weight relationship, condition factor, relative length of gut and gastro-somatic index

1. Introduction
Chanda nama (Hamilton, 1822) commonly known as elongate Glassy Perchlet used as aquarium fish for their transparent bodies [34]. This fish species has been exported from India to other countries as indigenous ornamental fish [15]. *Trichogaster lalius* commonly known as dwarf gaurami is an indigenous ornamental fish popular for aquarium fish hobbyist. It has high demand in the Indian and international market due to its brilliant colour pattern. It has also been considered as eatable fish due to their good taste in Northeast part of India and Bangladesh but it is generally categorised under weed fish [28].
Length-weight relationships and condition factors constitute one of the important aspects of fish biology used for determining the well-being of the individuals and possible differences among different stocks of the same species [21].
Food is the main source of energy and it is important in selecting fish species which utilize all the available resources of the water bodies without any competition and live in association with other fishes [6]. A comprehensive information on food and feeding habits of fishes is required for understanding their growth, breeding and migration [12]. Gastro-somatic index (Ga.SI) is the measure of gastric weight in relation to the body weight of fish. The feeding intensity of a fish can be determined by the Gastro-somatic index. The monthly fluctuation of Ga.SI indicates the variation in feeding intensity. The Ga.SI value in *Notopterus notopterus* inferred decrease in their feeding activity during the breeding season [17]. Relative length of the gut (RLG) is an index which provides information on the types of food consumed. It is used to find out the feeding habits such as herbivorous, carnivorous, omnivorous, herbi-omnivorous or carni-omnivorous [22]. A similar study in *Barilius bendelisis* and *Pethia ticto* revealed variation of RLG due to differences in types of food intake in different stages of their life [22]. Number of researchers have worked on the food and feeding habits and biology of *Chanda nama* [18,30,24,6] and genus *Trichogaster* of different species [9, 20] from different water bodies but no work has been reported from water bodies of Tripura. Furthermore, these fishes are exploited for trade and nutritive value. Therefore, it is imperative to know their feeding biology to improve its production both in captive as well as in wild. Thus recognising its economical importance, the present study focused on the biological parameters to provide proper

information on feeding biology and suitability of the environment of *Chanda nama* and *Trichogaste lalius* from rivers of Tripura.

2. Materials and Methods

In total, 122 specimens (Total length 3.58-9.39cm) of *Chanda nama* and 70 specimens (Total length 3.64-6.94cm) of *Trichogaster lalius* were randomly collected from Gomti river at Kemtali (Latitude: 23°49", Longitude: 91°18.14"), Rudrasagar lake (Latitude: 23°29'N, Longitude: 90°01'E) and Kemtali market of Tripura. The samples were collected by cast net, gill net and drag net during February 2018 to January 2019 for *Chanda nama* and April 2018 to March 2019 for *Trichogaster lalius*. The samples were preserved in 10% formalin and brought to the laboratory to study different biological aspects of the species. The specimens were brought to the laboratory to study the length-weight relationship. The total lengths (TL) to the nearest 0.01 cm were recorded using a vernier caliper and weights (W) of the fish specimens were recorded to the nearest 0.01 gm using an electronic weighing machine. Then the gut was removed from the fish and its length and weight was measured to the nearest 0.01cm and 0.01g. The length- weight relationship was determined using the formula:

$W=aL^b$ [23]

The equation expressed in natural logarithm as:

Ln W = Ln a + b Ln L

Where, W= weight of the fish (gm), L= Length of the fish (cm), a= intercept and b= regression coefficient.
Condition factor (K) was estimated using the formula:

$K = 100\ W/L^3$ [11]

Where, W = weight of fish in gram (gm) and L = length of fish (cm).
The Relative length of gut and Gastro-somatic index were calculated by the following formulae:

Relative length of gut (RLG) = Total length of the gut / total length of the fish [2]

Gastro-somatic Index (GaSI) = Weight of gut / weight of fish × 100 [5]

The linear regression equation Y = a + b X, where X = Total length (TL) and Y= gut length has been used to draw relationship between standard length and gut length. All statistical analyses were done using Excel (2007).

3. Results and Discussion

3.1 Length- weight relationship

The total length (TL) of *C. nama* and *T. lalius* ranged between 3.58cm-9.39 cm and 3.64 cm-6.94 cm respectively. The regression parameters for the relationship between total lengths (TL)-Weight (W) for both the species are tabulated in Table 1. The relationship between TL-W was presented in the form of a scatter diagram for both the species are shown in fig.1and 2. The relationships between ln TL-lnW showed a linear straight line.

Table 1: Basic statistics estimation of length- weight relationship of *C. nama* and *T. lalius*

Species	N	a	b	R^2	95% CL of b
C. nama	122	0.007987	3.08	0.94	2.94, 3.22
T. lalius	70	0.0000135	3.08	0.91	2.84, 3.33

a: Intercept, b: Regression coefficient, R^2: Coefficient of determination, CL: Confidence limit

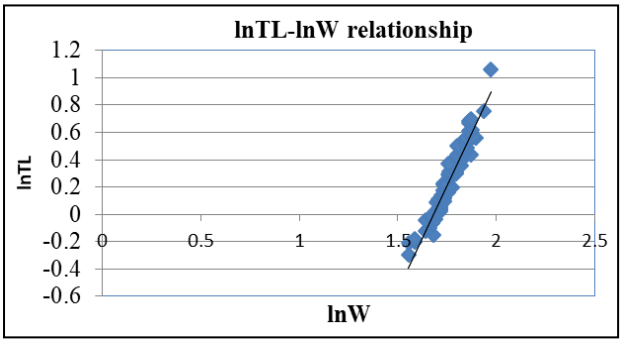

Fig 1: ln TL-lnW relationship of *Chanda nama*

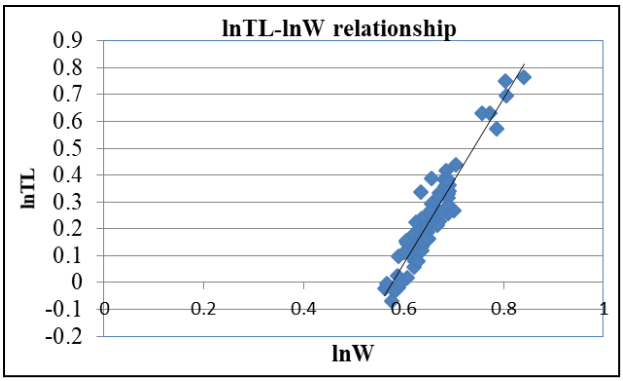

Fig 2: ln TL-lnW relationship of *Trichogaster lalius*

The relationship between length and weight of *C. nama* and *T. lalius* were established by linear regression of the natural logarithms. The relationship was found to be:
Ln W = Ln 0.007987+3.08Ln L (*C. nama*)
Ln W = Ln0.0000135 +3.08Ln L (*T. lalius*)

Fish are said to be isometric growth when the value of the exponent (b) is 3. The 'b' value different from 3 is said to be allometric growth. The 'b' value 3 is not restricted for all fishes because change of shapes are the cause of their growth [3]. The value of 'b' (regression coefficient) in the equation is 3.08 for both the species which is an indication of isometric growth following the cube law (b=3). The b values of *C. nama* reported by Sarkar *et al*. (2013) [30] from Ganga river (b=1.54), Gomti river (b=1.93) and Rapti river (b=1.71) is different from the present study. While the b values of genus *Trichogaster* reported by Paswan *et al*. (2012) [26] supported the present study of *T. lalius.* The variation in 'b' value is due to environmental factors, season, food availability, sex, life stage and other physiological factors [23]. The 'R^2' values showed variation of 94% in weight for *C. nama* while 91% in weight for *T. lalius* in relation to the variation in length (Table 1).

3.2 Condition factor

Condition factor or K value indicates its general appearance and fat content. Generally if the K value is less than 1, it indicates that fish is poor, long and thin and more than 1

indicates the state of fish health as good [13]. The mean condition factor (K) for *C. nama* and *T. lalius* were 0.93 and 1.94 respectively. The condition factor of *C. nama* was slightly less than 1 whereas *T. lalius* had more than 1, indicates good health condition of both the species. The present study on K value of *C. nama* is found similar with K value (0.95) reported by Manjural *et al*. (2014) [24] and varied with the value (1.41) reported by Hossain *et al*. (2012) [18].

Table 2: Month wise condition factor of *Chanda nama*

Month	Condition factor
February	0.87
March	1
April	1.08
May	0.91
June	0.9
July	0.95
August	0.91
September	0.86
October	0.87
November	0.91
December	0.92
January	0.93

Table 3: Month wise condition factor of *Trichogaster lalius*

Month	Condition factor
April	2.38
May	1.95
June	1.92
July	2.04
August	1.63
September	1.75
October	2.03
November	2.2
December	1.72
January	1.86
February	1.79
March	1.98

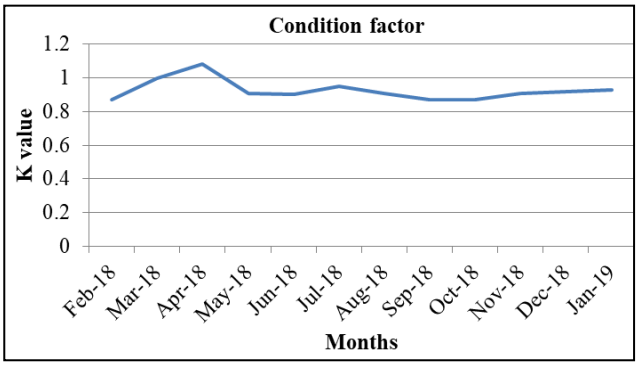

Fig 3: Month wise condition factor of *Chanda nama*

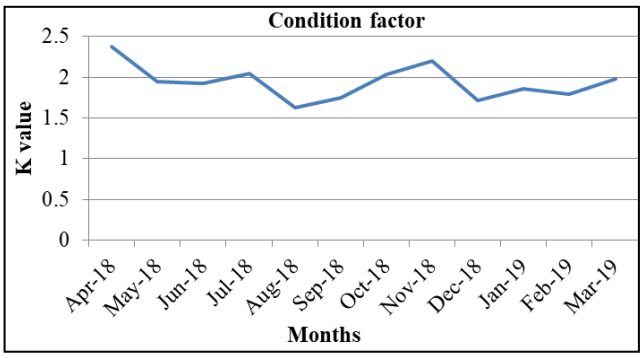

Fig 4: Month wise condition factor of *Trichogaster lalius*

Month wise Fulton's condition factor was computed for both the species which are shown in Table 2&3 and Fig.3&4. In *C. nama*, the lowest K value was found in September (0.86) and the highest in April (1.08) with mean of 0.93 whereas, in *T. lalius* the lowest K value was found in August (1.75) and highest in April (2.38) having mean value of 1.94. Monthly changes of condition factor (K) showed the feeding activity and breeding season of the fish. The K value is high prior to spawning season and declined subsequent to spawning season. The lower K value from May to September (*C. nama*) and August to September (*T. lalius*) may result because of post-spawning period and decrease in feeding activity. In females, declined in K value indicates more developed gonadal stages due to transfer of resources to the gonads during the reproductive period [33]. In present study, based on K value the reproduction period was found in between May to September in *C. nama* and June to September in *T. lalius*. Condition factor is influenced by the biotic and abiotic environmental factors and the index can be used to assess the status of environment in which fish live [4].

3.3. Relative length of gut (RLG) and Gastro-somatic index (Ga.SI)

The coefficient b, coefficient of determination R^2 of *Chanda nama* and *Trichogaster lalius* were analysed (Table 4). The RLG of different size groups and Ga.SI of different months for these two species were analyzed and plotted graphically (Fig.5-8).

Table 4: Regression parameters of total length-gut length relationship

Species	N	a	b	R^2	95% CL of b
C. nama	122	0.0539	0.425	0.65	0.32, 0.52
T. lalius	70	0.00312	2.70	0.63	1.8, 3.5

a: Intercept, b: Regression coefficient, R^2: coefficient of determination, CL: Confidence limit

The regression equation for *Chanda nama* and *Trichogaster lalius* was obtained as Y= 0.0539+0.425TL and Y= 0.00312+2.70TL respectively which depict that a unit increment in the size TL increase the gut length by 0.425 and 2.70 (Table 5) in both the species. The extent of variation in gut length was 65% and 63%.

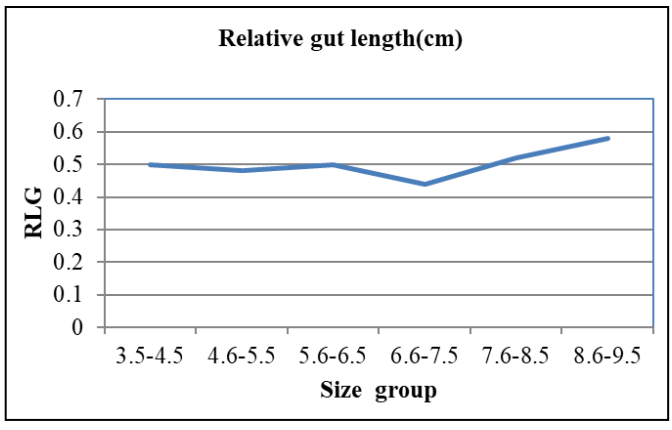

Fig 5: RLG at different size group base on TL of *Chanda nama*

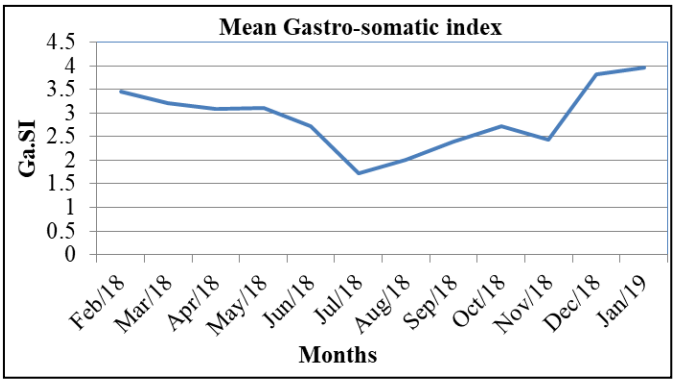

Fig 6: Month wise Ga.SI of *Chanda nama*

In *Chanda nama*, the RLG values were varied from 0.44 to 0.58 with mean value 0.5. The lowest and highest value was observed in the size group 6.6-7.5 cm TL and 8.6-9.5 cm TL respectively (fig.5). The RLG value was revealed by Das and Moitra (1963) [8] for carnivorous (0.4-0.8), omnivorous (2.3-3.3) and herbivorous (9.5-12) fishes. The observation on RLG values in the present study depicted the carnivorous feeding habit of *Chanda nama*. The RLG values have not shown any significant difference with the different size groups which indicate no significant change of feeding habit along with growth in this fish species. The absence of significant difference in relative gut length index of juveniles and adult specimens indicated that growth does not involve shift in carnivorous habit of fish. The present results were found similar with earlier findings in carnivorous fish like *Mastacembelus armatus* and *Macrognathus aral* [22, 10].

The observation on feeding intensity was based on Gastro-somatic index (Ga.SI) taken on monthly basis (Fig.6). Mean monthly values of Ga.SI varied from 3.97-1.72 in *Chanda nama*. The values of Ga.SI were observed to become high during December to February and started to fall from June to September. Low Ga.SI value indicated low feeding activity and breeding season of the fish species. The poor feeding during breeding season may be due to the development of gonad which occupies the major space of the abdominal cavity [25]. Further, availability of food in the environment and nutrient requirement stage might also influence the feeding activity of the fish [25]. The personal observation also found that the ovary was developed during the month of July and August. Therefore the breeding season of this species is found from June to August based on its Ga.SI value and personal observation which is similar with some researchers. Some workers [16, 19] have reported its breeding season from June-August and April-May in India while another [14] have reported March-July as its breeding season in Western Ghat, Tamil Nadu, India.

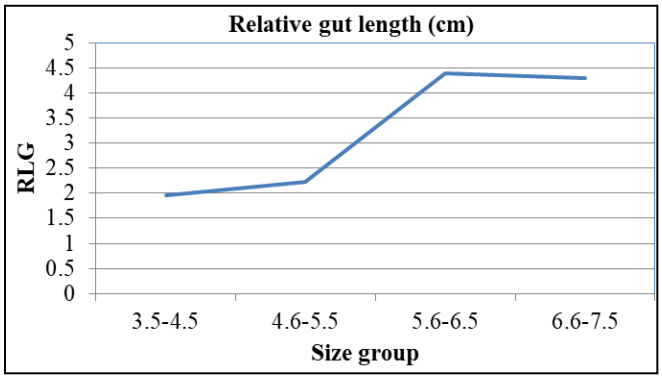

Fig 7: RLG at different size group base on TL of *Trichogaster lalius*

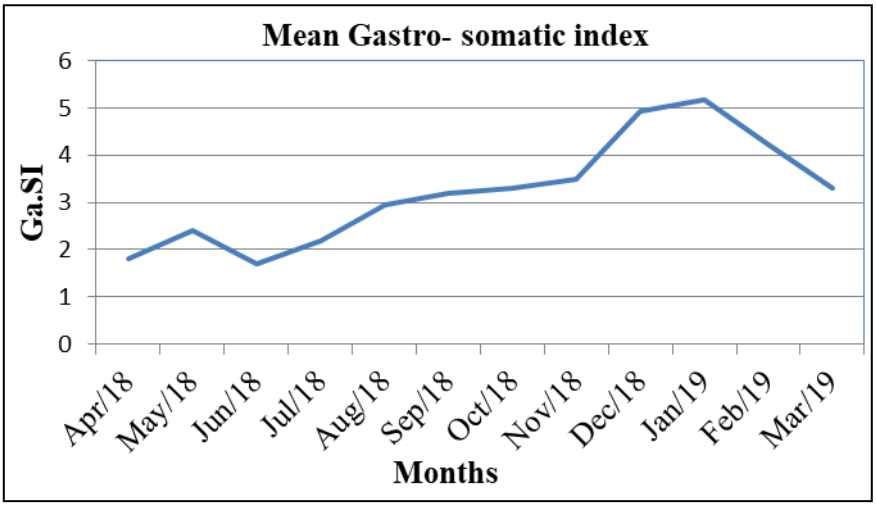

Fig 8: Month wise Ga.SI of *Trichogaster lalius*

The Relative Length of Gut (RLG) in *Trichogaster lalius* (Fig.7) was found to vary between 1.96 and 4.4cm with mean value 3.22cm. The lowest and highest peak was observed in the size group 3.5-4.5 cm TL and 5.6-6.5 cm TL. It was observed that RLG increase gradually from 3.5-4.5 cm TL size group and increase rapidly from 4.6-5.5 cm TL to 5.6-6.5 cm TL size group. The slight decrease in largest size group 6.6-7.5 cm TL was noticed which may be due to its maturity stage. The same opinion has been revealed by several workers [7, 31, 29, 1]. The variation of RLG values in different size groups depicted carni-omnivorous feeding habit in smaller size group and herbi-omnivorous in larger size group. Thus the present study showed the change in feeding habit from smaller to larger size group. The similar observation has also been reported by several workers [22, 29]. The RLG values reported by Dasgupta (2004) [9] for *T. fasciata*, *Puntius sarana*, *P. javanicus* and *Cyprinus carpio* from West Bengal are 3.1, 2.89, 2.82 and 1.36. Further, he reported that the value increased with more intake of vegetable matter and decreased with more animal matter in the gut.

In *Trichogaster lalius*, mean monthly values of Gastro-somatic index (Ga.SI) were determined and its value ranges from 1.7-5.18. The values of Ga.SI were observed to become low during April to August then started to increase from

September to February. The highest value was recorded during the month of January (5.18) and lowest during April (1.8) (Fig. 8). The high Ga.SI value during January to February indicates high feeding intensity and low during monsoon season indicates spawning periods of the species. The food requirement is more before and after the spawning season [27]. Some workers [20] studied Ga.SI of *Trichogaster fasciata* and reavealed the highest value for male and female in the month of December (3.055) and September (4.232), whereas the lowest value was recorded during the same month, July for both male(1.806) and female (0.916) which differ from the present study.

4. Conclusion

In present study the 'b' value for *C. nama* and *T. lalius* was found to be 3.08 which indicate isometric growth of the species. Based on the observed RLG values, the feeding habit of *C. Nama* is revealed as carnivorous whereas *T. lalius* changed its feeding habit from carni- omnivorous to herbi-omnivorous with the increase in size of the fish. The feeding intensity was found to be lowest in the month of July for *C. nama* and June for *T. lalius* which coincides with the breeding season of the fish.

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