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LENGTH- WEIGHT RELATIONSHIP AND CONDITION FACTOR OF *Devario aequipinnatus* FROM BASISTHA RIVER, ASSAM

MOUBOROSHA HAZARIKA[1] AND KIMTY DAS[1*]

[1]Department of zoology, University of Science and Technology, Meghalaya, India.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Devario aequipinnatus is one of the most important food fish as well as a potentially important ornamental fish found in the high torrential water of river Basistha, Assam. As a measure of conservation certain aspects of the length- weight relationship and condition factor have been undertaken. On plotting the entire length- weight into a single data the relationship was found to be $W = 0.019L^{2.783}$. Three different data for fry, fingerling and adult the relationship was found to be $W=0.003L^{4.066}$, $W=0.252L^{1.185,}$ $W=0.132L^{1.801}$ respectively. 'b' value was found to be maximum in Fry (4.06) and minimum in Fingerlings (1.18). 'K' value showed higher range in case of fingerlings followed by fries and adults. The findings of present investigation on the length-weight relationship of *Devario aequipinnatus* indicated significant variation in 'b' value. The value of the exponent 'b' was significantly higher in the Fries compared to Fingerlings and Adults. The high values of condition factor (K) in different length groups of *Devario aequipinnatus* indicated well-being and adaptability of the fish in their habitat in Basistha River, Assam.

Keywords: Length–weight relatationship; *Devario aequipinnatus;* Basistha River; Guwahati; Assam.

1. INTRODUCTION

North East region of India is richly endowed with numerous hill streams, rivers and lakes that serve as congenial habitats for fishes. It is comprised of almost 25% of the Inland water system of the country and is considered as one of the hotspot biodiversity in the world (Kottlet and Whitten, [1]). Assam is the second largest state of the North Eastern Region of India. The state is divided into three geographical zones, viz., the Brahmaputra Valley, the Hill zone and the Barak Valley. The habitats that contribute to rich fisheries resources are in the form of rivers, floodplain wetlands (beels), swamps, and low-lying paddy fields.

**Corresponding author: Email: kimty_pory@rediffmail.com;*

Guwahati, the gateway to north east is endowed with different water bodies both in terms of rivers and wetlands. One such major river is Basistha River which is located in the southern part of the city. The river earlier was a home to a considerable number of fish fauna. But due to severe pollution and heavy erosion as well as human encroachment has leading to great depleting in its number especially in the lower part. Length-weight relationship studies of fishes are considered as an important tool for understanding of fish. Length is a linear measure (in centimeter) and the weight of a fish (in gram) is approximately equal to its volume (cubic centimeter). Hence, weight of a fish is a function of length. The relationship can be expressed by the hypothetical law $W=aL^3$. The value of exponent may considerably deviate from the value 3, as most fishes change their form or shape when they grow [2]. This variation from expected weight to the actual weight of individual fish is assessed by analyzing the length-weight relationship. It gives information about the growth pattern of the fish. The well being of a fish during the life cycle can be estimated by using the length weight relationship. The length- weight relationship is an important parameter for taxonomic characterization of a fish species. This relationship can be used for comparing the population over time and also to estimate the number of fishes landed in a landing site (Beverton and Holt, [3]). Variation from the general length-weight relationship is indicative of the overall condition and such changes in condition have been usually analyzed by means of a condition factor or coefficient of conditions or ponderal index (Hile, [4]). Le Cren [5] proposed the relative condition factor in preference to condition factor as the latter is influenced by many environmental and biological factors. Evaluation of the conditions at different body lengths can give valuable information regarding the maturation and spawning in the life span of the fish. *D. aequipinnatus* belongs to family Cyprinidae, is an active and brilliantly striped ornamental hill stream fish and has a great value in the ornamental fish market. This fish is commonly called giant danio. It is widely distributed in Asia and native to India, Nepal and Sri Lanka. The fish generally inhabits clear water and can adapt to aquarium conditions easily and thus regarded as a popular aquarium fish.

2. MATERIALS AND METHODOLOGY

Basistha River is a small tributary of the Brahmaputra River which flows through the heart of the city. The river Basistha is often termed as a rivulet as its dimension over the drainage area is meso-level. The study area is comprised of a part of the Basistha river continuing from the Basistha temple upto the pilot cut of the river reach near the Fatashil-Katabari region near the NH-37, from where, it joins the Mora Bharalu to from the Pamohi river which ultimately has its outfall in the Deepor Beel. The study area is bounded by 91°44´42´´E-91°46´45´´E longitude and 26°5´35´´N-26°6´40´´N latitude.

2.1 Recording of Fishes to Study the Length Weight Relationship and Condition Factor of Fish Species Found in Basistha River

2.1.1 Survey of landing site

Basistha Mandir, Biswamitra, Kanxi Ghuli and Bora Query these are landing sites of Basistha Stream Fishes. Local villagers, fisherman and tribal people of hill area usually used to catch fishes there. They use fishing gears like Boroxi, Sepa and Asora jal to catch fishes of the stream. During monsoon season catching is high and during winter catching is less. People also practice electric fishing in these areas which is very harmful for fishes. It can effect fish population and a fish species can be extinct from that area.

2.1.2 Collection and preservation of fish

Random sampling of fishes were done from August 2018 to April 2019 from Basistha Mandir, Biswamitra, Kanxi Ghuli and Bora Query.

- Fishes were collected in live condition. They were photographed in live condition.
- Collected live fishes were preserved in 10% formaldehyde solution for laboratory analysis of taxonomic characters. In the laboratory, fishes were later preserved in 6% formaldehyde solution for long term storage.
- Taxonomic identification of fish had been done with the help of existing literature, Kottelat, M. [1], Talwar and Jhingran [6], Nath and Dey, [7], Jayaram, [8]. Nomenclature of the fishes is verified from Fish Base (http//www.fishbase.org).
- Morphometric measurements were taken with dial vernier caliper nearest to 0.05mm.

2.1.3 Length-weight relationship

Length-weight relationship: The length-weight (log-transformed) relationships were determined by linear regression analysis and scatter diagrams of length and weight were plotted. The length-weight relationship of the experimented fish was worked out as per cube law given by Le Cren [5].

$$W = aL^b$$

Where, W=Weight of fish (g), L is observed total length (cm), 'a' is the regression intercept and 'b' is the regression slope.

The logarithmic transformation of the above formula is-

$$\text{Log } W = \log a + b \log L$$

iii. Fulton's condition factor (K): Fulton's condition factor (K) was calculated according to Htun-Han, [9] equation as per formula given below:

$$K = \frac{W \times 100}{L^3}$$

Where, W= weight of fish (g), L= Length of fish (cm).

The growth of fish length and weight is not proportionate or the relationship between length and weight is not linear. This means that when the length is increased the increase in weight is not proportionate to it. It is rather non-linear type of relationship. The estimation procedure for length-weight relationship is through linear regression. Since the above model of length-weight relationship is not linear it has to be transformed into linear type by applying logarithmic transformation.

If we take logarithm (natural logarithm with base e) the above model will become linear as

$$\text{In } (W) = \text{In } (a) + b \text{ In } (L) \text{ or } Y = A + b X$$

Where in (a) is the intercept and (b) the slope or regression coefficient.

2.2 Statistical Analysis

The analysis of covariance was performed to determine variation in 'b' values for each species following method of Snedecor and Cochran, [10]. The statistical significance of the isometric exponent (b) was analyzed by a function: $ts = (b-3) / S_b$ (Sokal and Rohlf [11], where ts is the't' student statistics test value, 'b' is the slope and S_b is the standard error of 'b'. The comparison between obtained values of t-test and the respective critical values allowed the determination of the 'b' values statistically significant and their inclusion in the isometric range (b=3) or allometric range (negative allometric; b<3). Statistical software SPSS 14 and PAST Ver. 1.8 used for analysing the data.

3. RESULTS AND DISCUSSION

During the investigation (August 2018 to April 2019) 126 numbers of fish of species of *Devario aequipinnatus* were collected. Of these fishes, number of fries were recorded to be 10, number of fingerlings 31 and the number of adults as 85. The Length-weight datasheet and Condition factor and also with Standard length (SL) of *Devario aequpinnatus* are depicted in the Table 1.

Table 1. Length-weight datasheet of *Devario aequipinnatus* with Condition factor

Fish Number	Standard Length (SL) (cm)	Fork Length (FL) (cm)	Total Length (TL) (cm)	Weight (g)	Condition factor ($K=W/L^3 \times 100$)	
					FL	TL
1	7.1	7.6	8.9	8.58	1.95	1.22
2	6.3	7.3	7.9	5.41	1.39	1.10
3	6.8	7.8	8.3	5.79	1.22	1.01
4	6.5	7.8	8.2	4.98	1.05	0.90
5	4.4	4.9	5.3	2.78	2.36	1.87
6	6.7	7.6	8.1	5.4	1.23	1.02
7	4.6	5.3	5.9	3.18	2.14	1.55
8	4.6	5.4	6	3.27	2.08	1.51
9	4.1	4.7	5.1	2.17	2.09	1.64
10	5.4	6.3	6.5	3.61	1.44	1.31
11	4.6	5.3	5.7	3.25	2.18	1.75
12	4.8	5.5	5.9	3.43	2.06	1.67
13	4.2	4.8	5.2	2.17	1.96	1.54
14	5.7	6.4	6.9	4.18	1.59	1.27
15	5	5.7	6.3	3.04	1.64	1.22
16	4.6	5.4	5.8	3.24	2.06	1.66
17	4.4	5.1	5.5	2.81	2.12	1.69
18	5.6	6.5	7.1	4.27	1.55	1.19
19	5.4	6.2	6.7	3.67	1.54	1.22

Fish Number	Standard Length (SL) (cm)	Fork Length (FL) (cm)	Total Length (TL) (cm)	Weight (g)	Condition factor ($K=W/L^3\times100$)	
					FL	TL
20	6.3	7.4	7.9	5.52	1.36	1.12
21	6.8	7.8	8.3	6.2	1.31	1.08
22	5	5.7	6.1	3.1	1.67	1.37
23	5.1	5.9	6.3	3.53	1.72	1.41
24	4.8	5.6	5.9	2.31	1.32	1.12
25	5.1	5.8	6.3	3.11	1.59	1.24
26	4.7	5.4	5.7	1.93	1.23	1.04
27	4.8	5.6	5.9	2.66	1.51	1.30
28	5.2	6.1	6.8	3.54	1.56	1.13
29	4.2	4.8	5.2	1.59	1.44	1.13
30	4.4	5.1	5.4	1.61	1.21	1.02
31	4.3	5	5.2	1.53	1.22	1.09
32	4	4.6	5.1	1.61	1.65	1.21
33	4	4.5	5	1.58	1.73	1.26
34	4.1	4.4	4.8	1.46	1.71	1.32
35	4.5	5.2	5.5	2.64	1.88	1.59
36	4.5	5	5.4	2.58	2.06	1.64
37	4.4	5	5.3	2.51	2.01	1.69
38	4.6	5.2	5.6	2.63	1.87	1.50
39	3.6	3.9	4.4	1.45	2.44	1.70
40	3.7	4	4.5	1.58	2.47	1.73
41	4.4	5	5.3	2.58	2.06	1.73
42	4.4	5	5.2	1.96	1.57	1.39
43	4.3	5	5.3	1.85	1.48	1.24
44	4.4	5.1	5.2	1.87	1.41	1.33
45	3.6	4	4.4	1.46	2.28	1.71
46	4.5	5.1	5.5	1.81	1.36	1.09
47	3.6	3.8	4.4	1.47	2.68	1.73
48	4.4	4.9	5.1	1.7	1.44	1.28
49	4.5	5.1	5.6	1.81	1.36	1.03
50	4.4	5.2	5.5	1.71	1.22	1.03
51	6.7	7.8	8.1	6.17	1.30	1.16
52	6.7	7.7	8	6.15	1.35	1.20
53	4.3	4.9	5.1	1.5	1.27	1.13
54	3.5	3.8	4.3	1.43	2.61	1.80
54	3.6	3.9	4.4	1.45	2.44	1.70
55	4.3	5	5.1	1.67	1.34	1.26
56	4.4	5.1	5.2	1.69	1.27	1.20
57	4.5	5.2	5.6	1.71	1.22	0.97
58	4.4	5	5.1	1.65	1.32	1.24
59	4.5	5.1	5.5	2.66	2.01	1.60
60	3.7	3.9	4.5	1.48	2.49	1.62
61	4.5	5.1	5.5	1.97	1.49	1.18
62	4.3	5.1	5.3	1.53	1.15	1.03
63	4.4	5.1	5.2	1.52	1.15	1.08
64	3.6	3.8	4.5	1.47	2.68	1.61
65	6.7	7.8	8.1	6.18	1.30	1.16
66	4.4	5	5.2	1.51	1.21	1.07
67	4.5	5.1	5.3	1.53	1.15	1.03
68	6.6	7.7	8.1	6.16	1.35	1.16
69	6.6	7.6	7.9	6.38	1.45	1.29
70	3.6	4.1	4.5	1.45	2.10	1.59
71	3.7	3.9	4.6	1.47	2.48	1.51
72	3.6	4	4.4	1.43	2.23	1.68

Fish Number	Standard Length (SL) (cm)	Fork Length (FL) (cm)	Total Length (TL) (cm)	Weight (g)	Condition factor ($K=W/L^3\times100$)	
					FL	TL
73	3.5	3.7	4.2	1.39	2.74	1.88
74	3.5	4	4.4	1.4	2.19	1.64
75	3.5	4.1	4.4	1.41	2.05	1.66
76	6.5	7.5	7.9	6.16	1.46	1.25
77	4.4	5	5.2	1.91	1.53	1.36
78	3.6	4.1	4.4	1.48	2.15	1.74
79	3.7	3.8	4.6	1.47	2.68	1.51
80	6.6	7.5	7.9	6.29	1.49	1.28
81	3.6	4.1	4.3	1.47	2.13	1.85
82	3.6	4	4.2	1.43	2.23	1.93
83	3.6	4.1	4.3	1.32	1.92	1.66
84	3.6	3.9	4.6	1.33	2.24	1.37
85	3.5	4.1	4.2	1.3	1.89	1.75
86	3.6	4.1	4.5	1.33	1.93	1.46
87	6.5	7.4	7.8	6.17	1.52	1.30
88	6.5	7.4	7.9	6.19	1.53	1.26
89	3.5	3.6	4.1	1.39	2.98	2.02
90	3.5	4	4.3	1.34	2.09	1.69
91	6.6	7.7	8	6.21	1.36	1.21
92	4.2	5.1	5.4	1.7	1.28	1.08
93	4.3	5.3	5.5	1.72	1.16	1.03
94	4.2	5.1	5.4	1.69	1.27	1.07
95	4.6	5.2	5.4	2.22	1.58	1.41
96	4.4	5.1	5.2	2.1	1.58	1.49
97	3.4	4.1	4.5	1.19	1.73	1.31
98	5.4	6.1	6.5	4.51	1.99	1.64
100	6.8	7.9	8.2	5.03	1.02	0.91
101	6.6	7.7	8	5.03	1.10	0.98
102	6.7	7.8	8.2	5.41	1.14	0.98
103	6.8	8.1	8.7	6.27	1.18	0.95
104	6.5	7.7	8.1	5.59	1.22	1.05
105	5.7	6.5	6.9	3.21	1.17	0.98
106	5.4	6.3	6.5	3.14	1.26	1.14
107	5.6	6.7	6.9	3.31	1.10	1.01
108	4.9	5.8	6.1	2.39	1.22	1.05
109	4.7	5.7	6	2.22	1.20	1.03
110	4.9	6.1	6.5	3.03	1.33	1.10
111	5.1	6.2	6.7	4.11	1.72	1.37
112	4	4.6	4.9	2.36	2.42	2.01
113	4.4	4.9	5.4	2.78	2.36	1.77
114	4.7	5.2	5.8	3.16	2.25	1.62
115	4.1	4.5	5.2	2.75	3.02	1.96
116	4.9	5.5	5.9	4.01	2.41	1.95
117	1.9	2.4	2.7	0.14	1.01	0.71
118	2.1	2.6	2.9	0.21	1.19	0.86
119	2.6	3.1	3.3	0.49	1.64	1.36
120	2.6	3.1	3.2	0.31	1.04	0.95
121	2.2	2.6	2.8	0.3	1.71	1.37
122	2.5	2.9	3.1	0.33	1.35	1.11
123	2.7	3.2	3.5	0.47	1.43	1.10
124	2.5	3.1	3.4	0.45	1.51	1.14
125	2.5	3.2	3.3	0.37	1.13	1.03
126	2.4	3.1	3.4	0.48	1.61	1.22

The logarithmic value for fries, fingerlings and adults were also calculated and shown in Tables 2,3 and 4 respectively.

Table 2. Log table and length-weight calculation for fry

Fish number	Total length (TL) (cm)	Weight (g)	log10_TL	log10_WT
1	2.7	0.14	0.431364	-0.85387
2	2.9	0.21	0.462398	-0.67778
3	3.3	0.49	0.518514	-0.3098
4	3.2	0.31	0.50515	-0.50864
5	2.8	0.3	0.447158	-0.52288
6	3.1	0.33	0.491362	-0.48149
7	3.5	0.47	0.544068	-0.3279
8	3.4	0.45	0.531479	-0.34679
9	3.3	0.37	0.518514	-0.4318
10	3.4	0.48	0.531479	-0.31876
Length-Weight	a'	B	a	
Calculation	-2.50386115	4.0668404	0.003	

Table 3. Log table and length-weight calculation for fingerling

Fish Number	Total Length (TL) (cm)	Weight (g)	log10_TL	log10_wt
1	5.1	1.61	0.70757	0.206826
2	5	1.58	0.69897	0.198657
3	4.8	1.46	0.681241	0.164353
4	4.4	1.45	0.643453	0.161368
5	4.6	1.47	0.662758	0.167317
6	4.2	1.39	0.623249	0.143015
7	4.3	1.47	0.633468	0.167317
8	4.5	1.33	0.653213	0.123852
9	4.1	1.39	0.612784	0.143015
10	4.9	2.36	0.690196	0.372912
Length-Weight	a'	B		
Calculation	-0.598306659	1.185381		

Table 4. Log table and length-weight calculation for adults

Fish number	Total Length (TL) (cm)	Weight (g)	log10_TL	log10_WT
1	8.9	8.58	0.94939	0.933487
2	7.9	5.41	0.897627	0.733197
3	8.3	5.79	0.919078	0.762679
4	8.2	4.98	0.913814	0.697229
5	8.1	5.4	0.908485	0.732394
6	6	3.27	0.778151	0.514548
7	6.5	3.61	0.812913	0.557507
8	5.7	3.25	0.755875	0.511883
9	5.9	3.43	0.770852	0.535294
10	6.9	4.18	0.838849	0.621176
Length-Weight Calculatioin	a'	b	a	
	-0.87965004	1.801736	0.132	

In cases of all fishes of *Devario aequipinnatus*, the 'b' value was recorded to be 2.783 which is smaller than 3, therefore it indicates that the growth of the species is isometric. For Fries the 'b' was recorded to be 4.066, for fingerlings 'b' value was (1.185 and for adults 'b' value was 1.801 respectively. Now according to 'b' values; the growth of the fries is showing positive allometric because 'b' value is greater than 3. But for fingerlings and adults 'b' value is found to less than 3 therefore the growth in these

two cases is isometric. This shows that the average condition of health of the recorded fishes of *Devario aequipinnatus* is not so bad because the 'b' value is almost near to 3. Morato et al., [12] suggested that variations if any, in the exponent values of juveniles and adults may be due to their varied food habits. Further fish generally does not retain its normal body shape of the body through their life span and the relationship may depart from ideal 'b' value. It was also reported [13], Ozaydin et al. [14] that 'b' value may vary seasonally, between habitats and even daily. The condition factor (K) of a fish reflects physical and biological circumstances and fluctuations by interaction among feeding conditions and physiological factors (Anibeze, [15]) and with the system of environment [16]. This also indicates the changes in food reserves and therefore an indicator of the general fish condition. In the present findings it showed significant variation in the condition factor. Fluctuations in the condition factor may be due to differences in the weight of food content in the stomach, different stages of maturity or spawning on the part of the female [17]. Even among the members of one population sampled on a single date, there may be considerable variation in the 'K' values with length [12]. However in almost all the species of *Devario aequipinnatus* studied during the investigation the 'K' value was recorded to be greater than 1 which showed the well being of the fish.

Length-Weight Relationship: The entire length-weight relationship of *Devario aequipinnatus* was pooled into a single data and was presented as follows:

$$W = 0.019\ L^{2.783}$$

When observed length was plotted against observed weight a parabolic graph was obtained (Fig. 1).

Length-Weight Relationship in Different Life Stages: The length-weight relationship of different life stages of *Devario aequipinnatus* had been calculated as followes:

Fry- The length-weight relationship of fries had been depicted as follows:

$$\text{Log } W = -0.003 + 4.066 \text{ Log } L$$

When observed length was plotted against weight a parabolic graph was obtained (Fig. 2).

Fingerling- The length-weight relationship of fingerlings had been depicted as follows:

$$\text{Log } W = -0.252 + 1.185 \text{ Log } L$$

On plotting observed length against observed weight a parabolic graph was obtained (Fig. 3).

Adult: The length-weight relationship in adult had been depicted as follows:

$$\text{Log } W = -0.132 + 1.801 \text{ Log } L$$

On plotting observed length against observed weight a parabolic graph was obtained (Fig. 4)

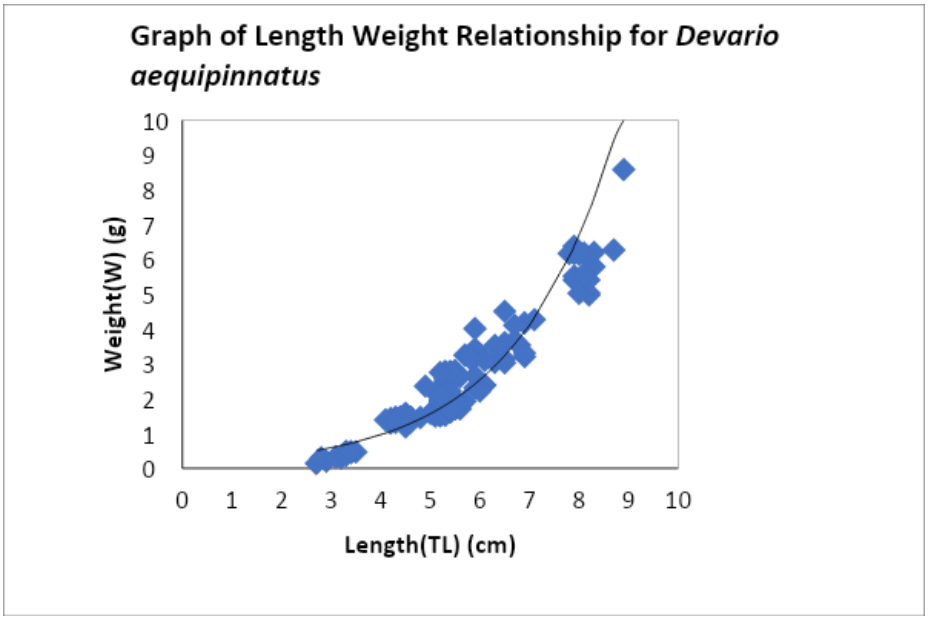

Fig. 1 Overall Parabolic graph between length-weight for *Devario aequipinnatus*

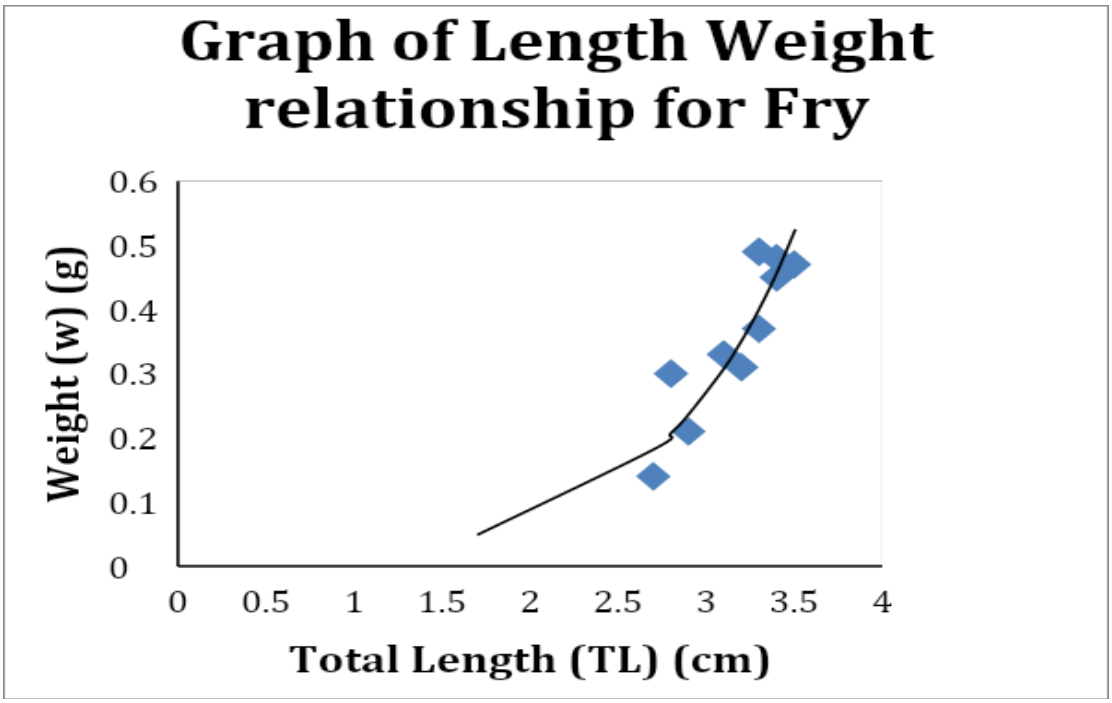

Fig. 2 Parabolic graph between length-weight in fry

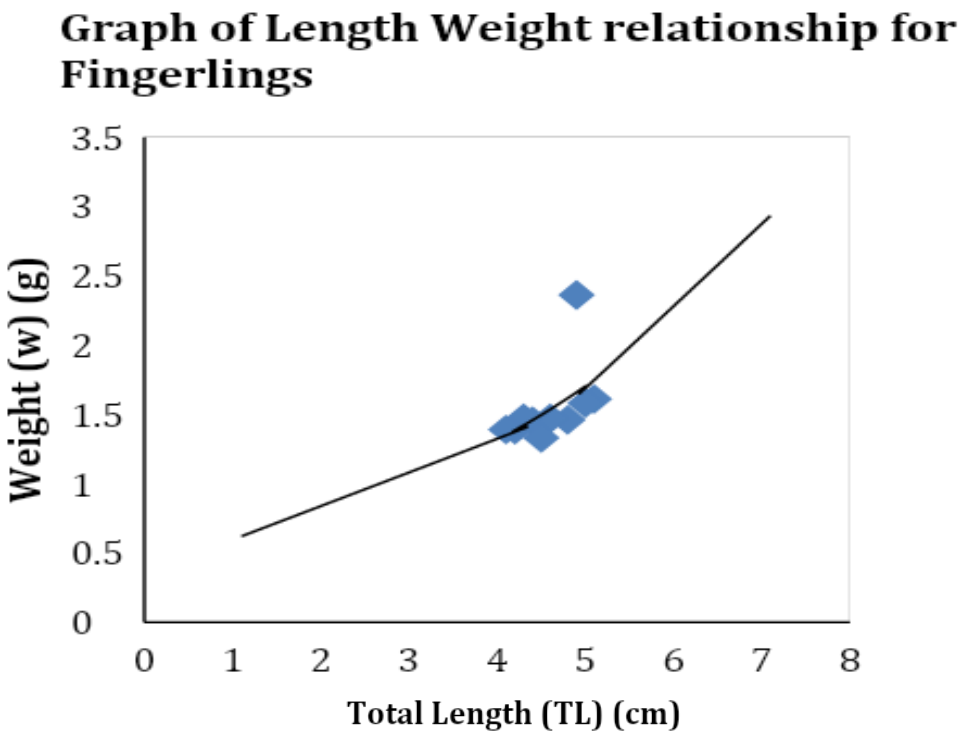

Fig. 3. Parabolic graph between length-weight in fingerling

The findings of the present investigation on length – weight relationship of *D. aequipinnatus* from Basistha River shows applicability of the cube low. In the present investigation the regression co-efficient shows variation in the same population. Similar results were also found by Pathak [18] and Biswas [19].

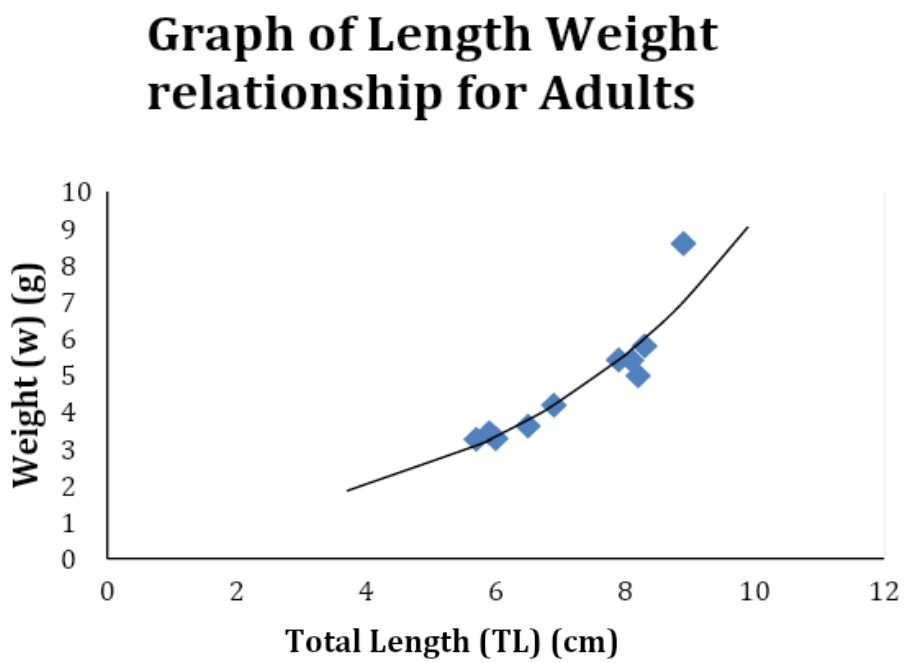

Fig. 4. Parabolic graph between length-weight in adults

4. CONCLUSION

It can be concluded from the present finding that length-weight relationship of *Devario aequipinnatus* shows variations from the cube law. The b value for fry was recorded to be more than ideal value 3 and that of fingerlings and adults were recorded to be less than 3. The condition factors (K) were recorded to be more than 1 for all the species of *Devario aequipinnatus* which shows well being on the part of the fish. However The use of water of Basistha River for bathing, throwing of wastes above water which is a cause for pollution and over fishing like electric fishing equipments causing a major threats to the River especially in the lower reaches which directly affecting the fish growth and diversity leading to declining in population.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kottelat M, Whitten T. Freshwater biodiversity in Asia with special reference to fish. World Bank Tech. Paper no. 343. The World Bank, Washington DC. 1996;17-22.
2. Frost WE. The age and growth of eels (Anguilla anguilla) from the Windermere catchment area. J. Anim. Ecol. 1945;14:106-124.
3. Beverton MA, Holt SJ. On the dynamics of exploited fish populations, U.K. Ministry of Agriculture and Fisheries; Fisheries Investigation Series. 1957;2 (19):1-520.
4. Hile R. Age and growth of the *Ciscoleucichthys artedt* (Le Sueur) in the North Eastern high lands , Wiscosin. Bull. U.S. Bur. Fish. 1936;48:211-317.
5. Le-Cren ED. The length – weight relationship and seasonal cycle in gonad –weight and condition in the perch (*Perca flueviatilis*) J. Anim. Ecol. 1951;20:201-219.
6. Talwar PK, Jhingran AG. Inland fishes of india and adjacent countries. Oxford and IBH Co., Pvt. Ltd., New Delhi. 1991; I & II:1158.
7. Nath P, Dey SC. Fish and Fisheries of Northeastern India. Arunachal Pradesh. 1997;I: 140.
8. Jayaram KC. The Freshwater Fishes of the Indian Region. Narendra Publishing House, Delhi. 1999;551.
9. Htun-Han M. The reproductive biology of the dab *Limanda limanada* (L.) in the North Sea: gonadosomatic index, hepatostomatic index and condition factor, J Fish Biol. 1978;13(1): 351-377.

DOI:10.1111/j.1095 8649.1978.tb03443x

10. Snedecor GW, Cochran WG. Statistical methods. 6th Edition, Ames, Iowa, the Lowa State University; 1967.
11. Sokal RR, Rulf FJ. Introduction to biostatistics. 2. New Work: Freeman publication; 1987.
12. Morato T, Afonso P, Loirinho P, Barreiros JP, Sanstos RS, Nash RDM. Length- weight relationship for 21 coastal fish species of the Azores, North-eastern Atlantic. Fish Res. 2001; 50:297-302.
13. Goncalves JM, Bentes SL, Lino PG, Ribeiro J, Canario AVM, Erzini K. Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. Fish. Res. 1997; 30:253–256.
14. Ozaydin O, Taskavah E. Length-weight relationships for 47 fish species from Izmir Bay (Eastern Agean Sea, Turkey). Acta Adviatica. 2007;47:211-216 .
15. Anibeze CIP. Length-weight relationship and relative condition of *Heterobranchus longifilis* (Valencienness) from Idodo River, Nigeria. Naga, The ICLARM Quarterly. 2000;23:34-35.
16. Gomiero LM, Braga FMS. The condition factor of fishes from two river basins in Sao Paulo Stae, Southeast of Brazil. Acta Scientiae Maringa. 2005;27:73-78.
17. Das K, Biswas SP. Length-weight relationship and conditionfactor of a hillstream fish *Garra gotyla gotyla* (Gray) from Noa- Dihing River, Arunachal Pradesh, IJETSR. 2016;3(6).
18. Pathak SC. Length- weight relationship, condition factor and food study of *L. calbasu* (Ham.) from Loni reservoir (M.P). J. Inland. Fish. Soc. 1975;8:58-64.
19. Biswas SP. Studies on certain aspects of the biology of *Labeo pangusia* and L. dero from North Eastern India. Ph.D. Thesis, North-Eastern Hill University, Shillong; 1982.