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Morphometric evaluation of an indigenous fish belong to genus Devario from three river systems of South Kerala

Sreelekshmi S*[1], Benno Pereira F G[2], Binil V Shijith[3]

[1,3]*Department of Aquatic Biology and Fisheries, University of Kerala, Kerala, India*

[2]*Department of Zoology, University of Kerala, Kerala, India*

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Abstract

Morphometric parameters, length-weight relationship and condition factor of indigenous fish belong to *Devario* genus, with great export and economic potential was evaluated from three different river systems of South Kerala, *viz*, Neyyar, Vamanapuram and Karamana river system. Since the taxonomy and nomenclature of many Cyprinids are being modified, morphometric evaluation of any Cyprinid is significant to reduce the ambiguity in taxonomy and systematics especially to delineate and document the population or habitat/environmental differences within species. A total of 19 morphometric parameters including length and weight of *D. species* was recorded from three river systems and compared statistically. Principal Component Analysis (PCA) was employed to delineate the habitat difference in the same species and elucidated head length as first principal component followed by snout length and pre orbital length were identified as second principal component and body depth as third principal component to distinguish three populations of the same species. Again morphometric comparison using ANOVA revealed that snout length, eye diameter and pre orbital length and pectoral fin length differed significantly between habitats within same species. Length weight relationship showed a negative allometric growth between rivers and condition factor showed fishes were in good condition with Fulton condition factor above unity.

***Corresponding Author:** S. Sreelekshmi ✉ susvshivam@gmail.com

Introduction

Freshwater fishes accomplish a wide range of ecological role necessary for the long term functioning of freshwater ecosystems all over the world. In India two families are most plentifully represented viz, the cyprinidae or carp family and the siluridae (Beavan, 1877). Meyers (1938) recognised that some group of freshwater fish (e.g. Cypriniformes, the most specious order of freshwater fish) have a little or no tolerance of seawater, either now or in their evolutionary history, describing them as primary division freshwater fishes.

The fish selected for the present study belong to *Devario* genus of family cyprinidae. Four species belong to this genus viz. *D.aequipinnatus, D.malabaricus, D.nelegiriensis, D.fraseri* are identified from water bodies of Kerala, even though ambiguity still exist among the identified. *Devario* species (unpublished data) is selected due to its ubiquitous occurrence in most of the lotic systems of southern Kerala. There are only a few studies on the morphometric evaluation (Edwinthangam *et al*., 2015) of *Devario* species. Many of the works are on the toxic effect of environmental acids on sperms, cytogenetic characterization, breeding and development, and helminth parasitic fauna (Dey *et al*., 2009; Sukham *et al*., 2013; Dey *et al*., 2014; Shine *et al*., 2015). Studies on morphometric measurements and statistical relationships are imperative for both fishery biology (Sparre *et al*., 1989; Mustafa and Brooks 2008) and taxonomic studies.

Morphometric studies and meristic counts are considered as easiest and authentic methods for taxonomic identification of specimen which is termed as morphological systematics (Nayman, 1965). Morphometric and meristic study are vigorous tools for measuring discreteness of the same species (Naeem and Salam, 2005). The length weight relationship serves the purpose of determining the type of mathematical relationship between two variables so that if one variable is known the other could be computed (Mir *et al*., 2012; Sarkar *et al*., 2013). Fish condition is defined as the robustness or well being of an individual fish (Le Cren 1951; Bulow *et al*., 1981; Blackwell *et al*., 2000) is an essential component of fishery biology used to assess the general health of populations (Gulland 1983; Sparre *et al*., 1989; Froese 2006). Condition factor is used for comparing the condition, fatness, or wellbeing (Mir *et al*., 2012) of fish, based on the assumption that heavier fish of a given length are in better condition. To the best of knowledge there are no previous studies regarding the mophometric evaluation, length weight relationship and condition factor of the species in Kerala. So as to fill the gap area, the present study is focusing on these parameters of *Devario* species from the three major rivers systems flowing through Trivandrum district viz: Neyyar, Vamanapuram and Karamana. Morphometric evaluation helps in identifying differences among populations which leads to proper identification and to adopt better conservation strategies for the species survival.

Materials and methods

Study Area

The sample for the study was collected from Neyyar (latitude: 8°31′N, longitude: 77°8′E), Vamanapuram (latitude: 8°42′N, longitude: 77°7′E) and Karamana (latitude: 8°39′N, longitude: 77°9′E). Study was carried out from October 2014 to February 2015. Fishes were collected using cast nets during morning hours. A total of 70 fishes were analysed for the study.

Morph metric traits

19 morph metric parameters was analysed namely weight of the fish, total length, standard length, fork length, body depth, body width, snout length, head length, eye diameter, pre orbital length, post orbital length, dorsal fin length, dorsal fin base length, pectoral fin length, pelvic fin length, anal fin length, caudal fin length, caudal peduncle length, caudal peduncle depth. All the values were recorded using digital calliper to nearest millimetre.

Length-Weight Relationship

Length of the fish was measured to the nearest mm using digital calliper and weight is measured using electronic balance to nearest milligram. The length weight relationship was determined by using the equation $W= aL^b$ (Pauly, 1984).

The value of constant 'a' and 'b' was estimated from logarithmically transformed value of length and weight, log W= log A+ B log l. Where b represent the slope of line and log a is a constant.

Condition factor

Condition factor is estimated by using the formula $K=W/L^{3*}$ 100. The coefficient of condition K was calculated using Fulton (1904), where W-the weight in gram, L-the total length in centimetre and 100 is a factor used to bring the value of K near unity.

Statistical analysis

Descriptive statistics namely mean and standard deviation were used for elucidating morph metric characters and condition factor. Regression analysis was used to depict the length weight relationship. ANOVA was employed to delineate statistically significant deviation among population between three river systems and for condition factor. To analyse the morph metric factors that differentiate three populations PCA were also estimated.

Results

Morphometric traits

Comparison of morph metric traits of populations of three rivers were represented in table (1). Parameters such as total length, standard length, fork length, body depth, body width, post orbital length, dorsal fin length, dorsal fin base length, caudal fin length, caudal peduncle length, caudal peduncle depth of population between rivers is not significant hence the p value greater than the significance level 0.05 ($p>0.05$). It shows that these parameters are more or less same in all the three rivers. But the parameters like head length, pelvic fin length and anal fin length showed significant difference at $p<0.05$. The head length was significantly higher in Vamanapuram (14.28±1.766) when compared to Neyyar and Karamana. Length of pelvic fin is significantly higher in Vamanapuram (9.712±1.271) and significantly lower in Neyyar (8.598±0.639) compared to Karamana (9.012±1.012). Length of anal fin is also significantly higher in Vamanapuram (10.02±1.308) when compared to Karamana (9.309±0.823) and Neyyar (9.030±1.020).

Snout length, eye diameter, pre orbital length and pectoral fin length showed significant difference at $p<0.01$. Snout length is significantly higher in Vamanapuram (4.352±0.565) as compared to Karamana (3.972±0.622) and Neyyar (3.315±0.591). Eye diameter is significantly higher in Karamana (4.531±0.555) and significantly lower in Neyyar (4.056±0.639) compared to Vamanapuram (4.384±0.372). Pre orbital length is significantly higher in Vamanapuram (4.352±0.565) than Karamana (3.927±0.622) and is significantly higher than Neyyar (3.315±0.591). Length of pectoral fin is significantly higher in Vamanapuram/914.98±1.085) compared to Karamana and Neyyar. Parameters showing significant variation are represented in Fig. (1).

Principle component analysis of 19 variables between the three sites population yielded three principle components. Weight of the fish as first principal component followed by snout length and pre orbital length as second principal component and body depth as third principal component to distinguish three populations of the same species represented in table (2). The percentage of variance of PC 1, PC2 and PC3 were 59.05%, 10.60%, 5.64% with an accumulative variance of 75.30%. The Eigen value for the first component is 11.22.

Length weight relationship

The regression analysis showing length weight relationship is shown in table (3). The scatter plot diagram of length weight relationship is illustrated in appendix (1). b value yielded from regression analysis between population ranged from 1.957 to 2.855 and for pooled data was 2.2. b values are significant as the corresponding p value is less than significant level 0.01. R^2 was reported to be 0.618 in Neyyar, 0.992 in Vamanapuram and 0.57 in Karamana and for pooled data was 0.66. The coefficient of correlation (r^2) in all cases was also found to be significant with $p<0.01$.

Condition factor

The condition factor between populations is shown in table (4). The result shows that the p value is greater than the significance level 0.05 the difference in condition factor between populations is not significant.

The table reveals that the condition factor is more or less same in Neyyar (1.150±0.206) Vamanapuram (1.056±0.041) and Karamana (1.222±0.359). Condition factor between rivers is represented in Fig. 2.

Table 1. Descriptive statistics of morphometric parameters of *Devario* species from three rivers.

Parameters	Neyyar		Vamanapuram		Karamana		P value
	Mean	SD	Mean	SD	Mean	SD	
Weight	3.877^{A}	1.027	4.260^{A}	1.604	4.278^{A}	1.234	0.922^{NS}
Total Length	69.43^{A}	6.041	72.95^{A}	9.402	70.61^{A}	7.553	0.904^{NS}
Standard Length	54.58^{A}	4.940	58.98^{A}	7.412	55.92^{A}	6.306	2.083^{NS}
Fork Length	62.74^{A}	5.473	65.50^{A}	9.749	63.27^{A}	6.926	0.619^{NS}
Body Depth	14.10^{A}	3.048	15.42^{A}	1.654	14.80^{A}	1.348	1.485^{NS}
Body Width	6.939^{A}	0.777	7.007^{A}	1.092	7.272^{A}	0.929	1.100^{NS}
Snout Length	3.315^{A}	0.591	4.352^{C}	0.565	3.927^{B}	0.622	14.110**
Head Length	13.18^{A}	1.061	14.28^{B}	1.766	13.03^{A}	1.238	3.840*
Eye Diameter	4.056^{A}	0.639	4.384^{AB}	0.372	4.531^{B}	0.555	5.250**
Pre Orbital Length	3.315^{A}	0.591	4.352^{C}	0.565	3.927^{B}	0.622	14.110**
Post Orbital Length	5.738^{A}	0.728	6.209^{A}	1.013	5.831^{A}	0.725	1.407^{NS}
Dorsal Fin Length	10.26^{A}	1.107	10.83^{A}	1.238	10.64^{A}	0.940	1.526^{NS}
Dorsal Fin Base Length	9.509^{A}	1.046	9.469^{A}	1.736	9.884^{A}	1.096	0.916^{NS}
Pectoral Fin Length	12.84^{A}	1.353	14.98^{B}	1.085	13.44^{A}	1.070	11.879**
Pelvic Fin Length	8.598^{A}	0.976	9.712^{B}	1.271	9.012^{AB}	1.081	4.242*
Anal Fin Length	9.030^{A}	1.020	10.02^{B}	1.308	9.309^{A}	0.823	3.816*
Caudal Fin Length	14.12^{A}	1.107	14.80^{A}	1.918	14.48^{A}	1.412	1.074^{NS}
Caudal pedunle length	8.121^{A}	1.304	9.351^{A}	1.260	7.971^{A}	2.185	2.474^{NS}
Caudal Peduncle Depth	5.596^{A}	0.846	5.830^{A}	1.117	5.396^{A}	0.704	1.124^{NS}

NS-Difference is not significant. Values with same letter showing no significance,

*Difference is significant at 0.05 level, **Difference is significant at 0.01 level.

Table 2. Principle Component Analysis.

Parameters	Component 1	Component 2	Component 3
Weight of Fish	0.930		
Total Length	0.887		
Standard Length	0.863		
Fork Length	0.877		
Body Depth			0.865
Body Width	0.907		
Snout Length		0.855	
Head Length	0.747		
Diameter of Eye		0.722	
Pre-orbital Length		0.855	
Post-orbital Length		0.654	
Length of Dorsal Fin		0.688	
Length of Dorsal Fin Base	0.706		
Length of Pectoral Fin		0.792	
Length of Pelvic Fin		0.659	
Length of Anal Fin		0.725	
Length of Caudal Fin		0.648	
Length of Caudal Peduncle	0.739		
Depth of Caudal Peduncle	0.653		
Eigen values	11.22	2.014	1.073
% of Variance	59.05	10.60	5.649
Cumulative %	59.05	69.65	75.30

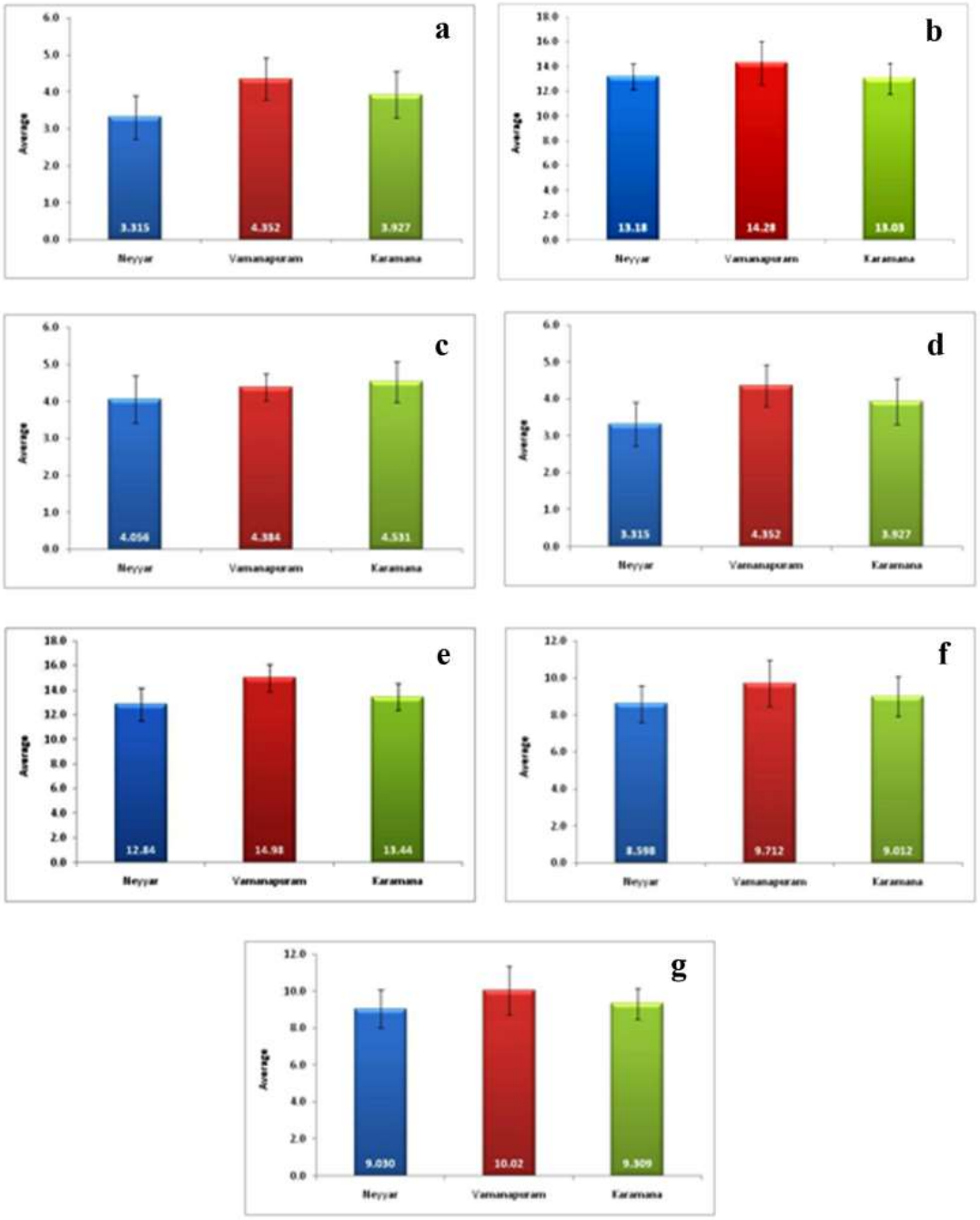

Fig. 1. Parameters showing significant variation between populations. a. Snout Length, b. Head Length, c. Diameter of Eye, d. Pre orbital Length, e. Length of Pectoral Fin , f. Length of Pelvic Fin, g. Length of Anal Fin.

Table 3. Regression analysis showing the relationship between weight and length in Neyyar Vamanapuram and Karamana rivers.

	Neyyar		Vamanapuram		Karamana		Pooled	
	Constant	Total Length	Constant	Total Length	Constant	Total Length	Constant	Total Length
Beta	-0.718	2.333	-1.708	2.855	0.001	1.957	-0.558	2.251
SE		0.786		0.996		0.756	0.362	0.196
t – value	-1.126	6.733	-10.027	31.189	0.001	6.104	-1.541	11.478
p - value	0.270	0.000	0.000	0.000	0.999	0.000	0.128	0.000
R-square	0.618		0.992		0.571		0.660	

Condition Factor

Table 4. Condition factor of fish between rivers.

River	Mean	SD	F – value
Neyyar	1.150[A]	0.206	
Vamanapuram	1.056[A]	0.041	1.507[NS]
Karamana	1.222[A]	0.359	

NS ➔ Difference is not significant, Values with same letter showing no significance.

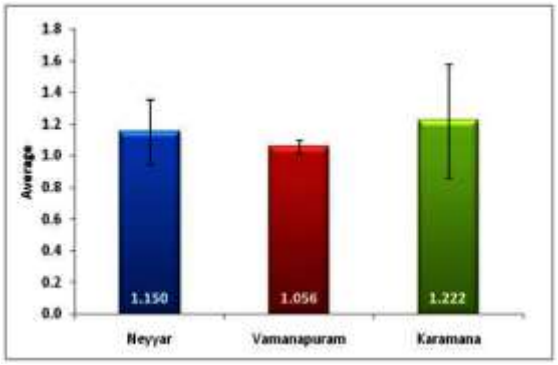

Fig. 2. Condition factor of fish in Neyyar, Vamanapauram and Karamana.

Discussion

The study mainly aimed to investigate the difference in morph metric parameters, length weight relationship and condition factor of populations of *Devario* species from three river systems. The studied sample exhibit morph metric difference, while all the three rivers are originating from the southern part of Western Ghats. Previous report on the morph metric variation studies on Cypriniformes fish *Devario aequipinnatus* from Tamil Nadu (Edwinthangam *et al.*, 2015) suggest the presence of morph metric variation among the evaluated site within the same species.

In the present study out of the seven variables which showed heterogeneity among populations of the species, river Vamanapuram showed higher significance in 6 variables, snout length, head length, pre orbital length, pelvic fin length, pectoral fin length and anal fin length. Fishes of Karamana River showed higher significance only in one variable, eye diameter. Heterogeneity in these characteristics may be due to the difference in habitat which they live. Jenning *et al.*, (2001), King (1995), Bagenal (1978) reported that variation occur in meristic and morph metric characteristic among similar species of fish from different geographic location to be influenced by the environmental variables.

Difference in snout length, pre orbital length and head length may be associated with feeding habit of the fish. The phenotypic plasticity helps the fish to adapt themselves to the existing environment and thus the physiological and behavioural modifications leads to changes in external morphology.

Length weight relationship of *Devario* species from three rivers showed negative allometric growth with b value less than 3 (b<3) and the population did not followed the cube law completely. Report on the length weight relationship of cyprinid fishes showed that many of them strictly follow cube law while there are many in which weight of fishes either tend to increase or decrease in proportion to the cube of length. When the b value is less than three the fish experience a negative allometric growth (Pervin and Mortuza, 2008 and Thomas *et al.*, 2003). When the b value of three populations is compared, population of Vamanapuram River showed relatively higher b value (2.855) than river Neyyar (2.333) and Karamana (1.957). Tesch (1971) also reported that the length weight relationship in fishes can be affected by habitat and area besides other factors such as seasonal effect, degree of stomach fullness, gonad maturity, sex, health, preservation technique and difference in the observed length ranges of the specimens.

The condition factor for all the population of *Devario* species was higher than unity with values 1.150, 1.056 and 1.222 respectively for Neyyar, Vamanapuram and Karamana. Condition factor of river Karamana was higher when compared to the other two rivers. It indicates the well being of the fish population in Karamana River. The k value is known to be strongly influenced by both biotic and abiotic conditions and can therefore be used as an indicator of the aquatic ecosystem health (Anene, 2005). Oni *et al.*, (1983) observed that the condition factor is a useful measure to understand the health of the fish as well as monitor feeding intensity, age and growth rates.

Conclusion

The present study delineates the difference in morph metric parameters between populations of the same species from the three river systems. And thereby we can say fishes are very sensitive organisms and adapt themselves to the existing environment by making changes in their morph metric traits. The regression coefficient b revealed that the growth pattern of fish populations show a negative allometric growth. And the fishes from the three rivers were in good condition with Fulton condition factor above unity.

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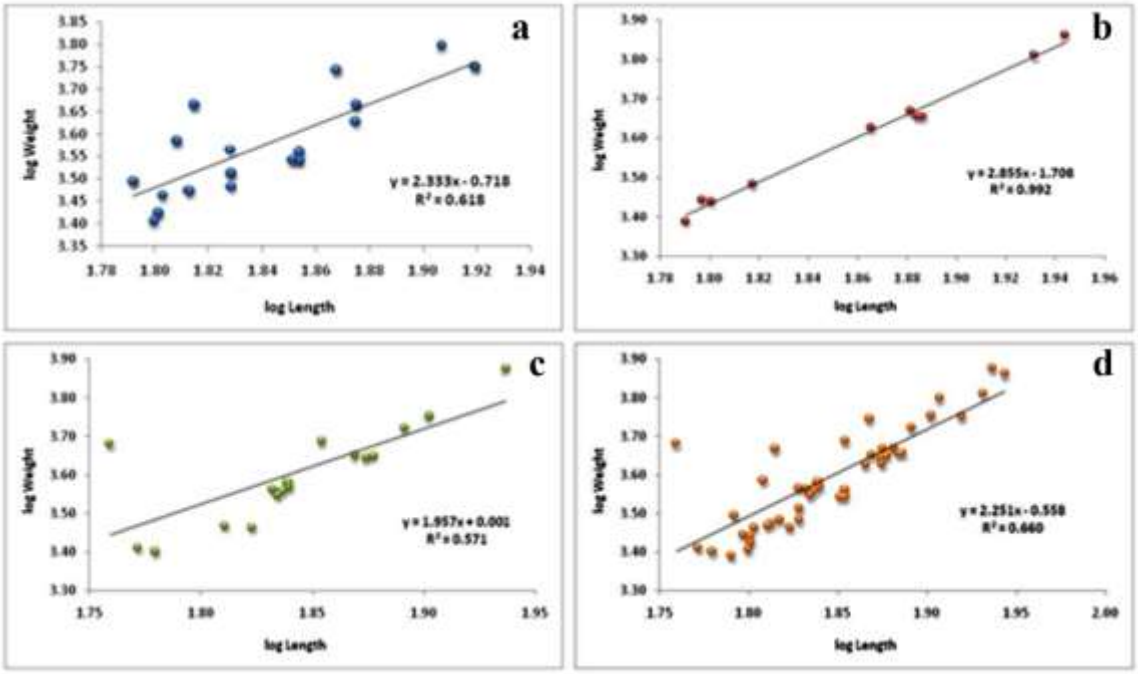
Appendix 1. Scatter plot showing the length weight relationship of population from three rivers and pooled data.



a. Neyyar, b. Vamanapuram, c. Karamana, d. Pooled. Weight was measured in grams and Length in centimeters.