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Morphometric variation studies on Cypriniformes fish of *Devario aequipinnatus* from selected rivers/streams of the Southern Western Ghats, Tamil Nadu, India

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Abstract

The morphometric variations were investigated on cypriniformes fish of Devario aequipinnatus from selected rivers of the Southern Western Ghats, Tamil Nadu. It was evaluated and compared with individual species and compared same in each study area. The samples were collected on both the rainy and summer from five sites as the selected rivers of Kalakkad Mudanthurai Tiger Reserve (KMTR) region (Kallar, Karaiyar, Manimuthar, Ramanathi) and other one at Kalikesam, Kanyakumari district). Their collected fish samples of morphometric characters are differentiated by various standard analyses of difference were carried out to examine the implication of morphometric variations among populations. The species wise and population wise descriptive statistics viz., minimum, maximum, mean, standard deviation; the coefficient of variation (CV) of all morphometric traits, the multivariate coefficient of variation (CVp) and the Principle Component Analysis were carried out. The detected phenotypical divergence between Devario aequipinnatus specimens revealed the fact of existing of five morphologically separated stocks within the samples may imply as a possibility a relationship among the extent of phenotypic heterogeneity and the geographic distance, shows limited combine into one among the populations. From this five populations of D. aequipinnatus were distinct with each other, their completely variation between the Karaiyar and Manimuthar river while compared with other three populations were distinct. This study suggests that the presence of morphometric variations among the evaluated site within same species.

Keywords: *Devario aequipinnatus,* morphometric traits, principal component analysis, tamiraparani river.

Introduction

Fish communities in relating the tropics streams are highly complex functional and structured constituents of running water are largely based on the system underlying, efficient incentive genesis and growth of those systems[1]. Ecological studies are leading well for environmental and also beneficial to the species[2-4]. The Western Ghats has extended the spatial location is considered as one of the most important bio-geographic zones of India and one among the hottest hotspots of biodiversity of the world. These mountain ranges with varied climatic conditions and diverse topography create a wide array of habitats that support rich fish diversity including many endemic species[5]. However, the rich biota is threatened by loss of pristine habitats due to poor management and abasement. Extensive sand mining in rivers has been affecting the breeding ground of fishes in the Southern Western Ghats Rivers. From that moreover dominant order of Cypriniformes can be characterized by webberian apparatus of super order[6]. Although the vertebrae of first four or five are called ossicles; connect the inner ear with the swim bladder. Therefore have been a number of classifications for the order Cypriniformes are most commonly order divided into two super families in which employed[7]. Cypriniformes group fishes are a morphologically diverse with globally distribution in a number of freshwater habitats. Interestingly, when quite species between various environments on most continents. These different habitats, matched with number of ecological challenges might have been played a major role in bringing about a number of evolutionary novelties that have seen between Cypriniformes and also the related otophysans. Among one of that *D. aequipinnatus* belongs to family Cyprinidae, it is commonly called giant danio. It is an extremely intelligent striped and active ornamental hill stream fish and has an extent value engage in the commercial promotion of ornamental fish market. It is native to India, Nepal, Sri Lanka and also widely distributed in Asia[8]. It had often found in hill stream and low land area[9]. However, these morphological characters according to environmental variability particularly change climate and habitat alteration, predominantly in freshwater fish species[10]. Also ichthyologists variation between species and populations within the species phenotypic variation has been used by environmental variability[11-13]. Effect of environmental factors on fish morphology also well documented[14-16].

Being inhabitants of a southern western Ghats, Tamilnadu freshwater ichthyofauna provide good examples to assess whether individual species are comprised of multiple evolutionary units. In this study, the hypothesis that different geographic samples may belong to a single homogenous population unit was tested for the cyprinid fishes *Devario aequipinnatus* using morphological characters. At last, typical characters for the discrimination between Cypriniformes morphotypes were distinguished, and the turnout of the traditional factor analysis of the morphometric data is equated with that found from the recent geometric methods is awaited to process of becoming larger the chances of finding the little morphometric variations that are expected at an intra-specific level[17]. Therefore, the present investigation of the fish *Devario aequipinnatus* individual morphometric variation would be analysis small difference in that character level.

Material and Methods

Fish sampling: The sampling was collected during the wet and dry season between March 2012 to July 2013 from the selected tributes of KMTR region (Kallar, Karaiyar, Manimuthar and Ramanathi) and other one at Kalikesam, Kanyakumari district). This study site sampling localities and habitat type of rivers/streams are given in table-1. Fishes were sampled at each site by monofilamentous gill nets and cast net (8-12 mesh size). Fishes were identified in the field and then preserved in 10% formalin and stored at Sri Paramakalyani Centre of Excellence in Environmental Sciences, Manonmaniam Sundaranar University, Alwarkurichi, Tamil Nadu. The Morphometric characters of each fish were measured using aero space digital caliper range near 0.01mm. Individually imaged fish (with an mm scale) that was used to collect the data on standard length (^{L}S) and also 17 other morphometric characters of the fish, to the nearest 0.1mm holding characters values between samples. All the length measurement were take parallel to antero-posterior body within the named points as follow as the standard length is the distance between the anterior tip, the head length (LH) is from snout tip to the posterior operculam margin, its maximum body depth (MBD) is been measure perpendicularly at the dorsal fin origin, length of the pre dorsal (LPD) and length of the pre anal (LPA) were measured from the snout tip to the origin of each fin, post dorsa length (PDL) from the dorsal fin origin to the caudal fin origin, length of the pre pelvic (LPP) from snout to the pelvic fin origin, distance between the pectoral fin to the ventral (DPFV), distance between pectoral fin to ventral (DPFV), pelvic insertion to anal origin (PIAO), length of the dorsal fin base (LDFB) and the length of the anal fin base (LAFB) are between externally visible origin of first spine and the final ray of the respective fin bases, length of peduncle (LP), from anal tip insertion to caudal fin origin, peduncle depth (DP), distance between pelvic to ventral (DPV), length pectoral fin (LPF) which is from the base of the first fin ray and also the distal tip of the longest ray, depth of the head (HD) it is perpendicular to body axis between dorsal margins and the ventral margin of the head at laterally visible overlap of the isthmus, pelvic fin length (PFL) from pelvic fin origin to tip, caudal fin length (LCF) from caudal origin to tip[18].

Data analysis: The morphometric variables were transformed with natural logarithms and rectified as allometric variations for principal component analysis and the Size dependent variation for morphometric characters were excluded by using the formula[19].

$$M_{adj} = M\ (Ls/Lo)\ b$$

Where Madj is the sizing adjust measurement, M is the original morphometric measurement, Lo is the fish standard length, and the Ls is overall mean value of standard length of fish from all samples of each variable. Here the parameter b was estimated for each character from the discovered data as the slope of the regression of log M on log Lo using all samples. The efficiency of size adjustment transformations were assessing by examines the significance of correlations between transformed variables and standard length. Factor analysis of variance was carried out to examine the significance of morphometric difference among populations. The descriptive statistics viz., minimum, maximum, mean and standard deviation for morphometric characters were estimated using IBM SPSS (ver. 20.0).The coefficient of variation (CV) was computed for each one character using the formula[20].

Table-1
Sampling localities and type of rivers/streams in the study area

Study site	Habitat	Samples taken Depth (ft)	Altitude (m)	Latitude Nº	Longitude Eº	Stream order
Kallar	Cascade, Pools and riffle	2-4	265	08º47' 56.9"	77º 18' 07.3"	3
Karaiyar	Pools, runs and riffles	3.5-4.5	295	08º39' 24.7"	77º 19' 54"	3
Manimuthar	Cascade, riffles, runs and pools	2-4	310	08º39' 14.3"	77º 20' 11"	3
Ramanathi	Cascade, riffles, pools and runs	2-3	396	08º56' 49.2"	77º 29' 16.8"	3
Kalikesam	Runs, pools and riffle	2-3	276	08º35’ 78.4”	77º 35’ 17.7”	3

CV = (100× SD)/Xm,

Where, the standard deviation SD and Xm is mean of transformed measurements of the characters in each species. In each species' sample group, the morphological variance were estimate by multivariate generalization of coefficient of variation (CVp) using the formula[17]

$$CVp= 100 \text{ x } \sqrt{\sum Sx / \sum Mx}$$

Where Sx is the variance of each morphometric variable and Mx is the mean squared. To identify that whether there is any statistically significant deviations amoung the species/population for each character, one-way analysis of variance (ANOVA) were performed[21-23] using IBM SPSS software (ver. 20.0). In addition, the size adjusted data were standardized and submitted to principal component analysis (PCA) and the scatter plots and cluster analysis were generated using the paleontological statistics package of PAST 2.14 version software.

Results and Discussion

Morphometric traits: The species wise and population wise descriptive statistics *viz.*, minimum, maximum, mean, standard deviation; the coefficient of variation (CV) of all morphometric traits, the multivariate coefficient of variation (CVp) and and the Principle Component Analysis were carried out. The results are as follows.

Descriptive statistics of morphometric traits: Descriptive statistics for each of the morphometric variables of five sites populations of *Devario aequipinnatus* are represented in (table-2) respectively. Generally low coefficients of variation were obtained for the morphometric characters of sites five populations of *Devario aequipinnatus* are Kallar (1.51 – 10.60%), Karaiyar (1.08-10.09%), Manimuthar (1.45-9.28%), Ramanathi (1.16-10.53%) and Kalikesam (1.00-11.61%). The multivariate generalized coefficient of variation (CVp) in each Specimen from Kalikesam showed the highest CVp (5.18%) followed by Ramanathi (5.15%), Karaiyar (4.72), Manimuthar (4.36) and Kallar (4.35) with relatively low values; indicates minimal or very low intra-population variation.

When the five sites populations of *D. aequipinnatus* were compared (specimens from different sites combined together for each species) the univariate analysis of variance (ANOVA) showed significant differences at the p<0.0.5 and p<0.01 levels of significance in 18 morphometric characters. Univariate analysis of variance also showed that fish samples from different sited differed significantly (at p<0.05 and p<0.01 levels of significance) in 18 morphometric characters examined in *D. aequipinnatus* as (table-2) respectively, leading to rejection of the null hypothesis of 'no hetrogeneity in fish morphology among riverine populations' of these species. There were significant differences among samples of *D. aequipinnatus* and in *L*P, *L*PA, *L*AFB, DPFV, *L*PP and *L*CF populations from five sites shared several (but not uniform) of the morphometric characters that are significantly different from those in *D. aequipinnatus* with high F values.

In this respect, they have shorter PDL, PFL, *L*PF, *L*DFB PIAO and *L*PD. Moreover, larger mean *L*PA, *L*PD and HW identified *D. aequipinnatus* specimens of five sites populations.

Principle Component Analysis (PCA): Principle components analysis was carried out factoring the correlation matrix of the morphometric data, between the five sites populations *Devario aequipinnatus* respectively.

PCA between five sites populations of *D. aequipinnatus:* PCA of the 19 significant variables between five sites populations of *D. aequipinnatus* yielded 5 principle components accounting for 39.21% of total variation in the original variables (table-3).

The variance explained by the five components was 20.98%, 19.62%, 11.01% and 5.96%, whose factor loadings are shown in table-4. The first component was mainly defined by measurements of head length (*L*H), length of peduncle (*L*PD), distance from pectoral fin to ventral (DPFV), Maximum body length (MBD), length of anal fin base (*L*AFB), length of peduncle (*L*P), depth of peduncle(DP), length of pectoral fin (*L*PF)length of caudal fin (*L*CF). These indicated that the above morphometric characters contributed the maximum to differentiate *D. aequipinnatus* populations. The second component was mainly correlated with measurements of post dorsal length (PDL), length of dorsal fin base (*L*DFB), head width (HW) and the third components was correlated with measurements length of pectoral fin (*L*PF), Length of pre anal (*L*PA), Length of pre pelvic (*L*PP). Similarly the fourth and fifth components was correlated with measurements of length of pre anal length (LPA), pelvic insertion to anal origin (PIAO) and head width (HW), length of peduncle (*L*P) on the fifth components measurements respectively (table-4). The bivariate scatter plot of component 1 and 2 was found to be sufficient to outline the morphological heterogeneity existing among *D. aequipinnatus* populations (figure-2). The samples collected from Kallar, Karaiyar, Manimuthar, Ramanathi and Kalikesam Rivers showed similarity, is depicted in the form of overlapping clusters analysis (figure-3).

From this five populations of *D. aequipinnatus* were distinct with each other, their completely variation between the Karaiyar and Manimuthar river while compared with other three populations were distinct.

Table-2
Descriptive statistics of transformed Morphometric variables, the coefficient of variation (CV) of each measurement, the multivariate coefficient of variation of each species (CV*p*) and F-values (derived from the analysis of variance) of five sites population of *Danio aequipinnatus*

Morpho metric characters	Kallar (n=10)		Karaiyar (n=10)		Manimuthar (n=10)	
	Mean±SD (Min-Max)	**CV**	**Mean ± SD (Min-Max)**	**CV**	**Mean±SD (Min-Max)**	**CV**
^{L} S	44.98±1.45(43.22-47.20)	3.22	46.10±0.98(44.76-47.21)	2.13	45.53±1.33(43.21-46.57)	2.92
^{L}H	25.18±0.85(24.05-26.15)	3.39	25.02±1.79(23.05-26.85)	7.16	25.42±1.00(24.15-26.35)	3.94
MBD	27.68±0.74(26.91-28.67)	2.69	27.55±0.92(26.81-28.97)	3.33	27.37±0.89(26.91-28.97)	3.26
^{L}PD	60.51±2.30(57.98-63.11)	3.81	61.43±2.85(58.74-64.91)	4.64	61.00±2.67(57.98-64.11)	4.37
PDL	41.45±1.47(39.87-43.78)	3.55	41.39±1.65(40.00-43.98)	3.98	41.35±1.54(39.67-43.98)	3.73
^{L}PP	47.70±0.72(46.82-48.50)	1.51	46.89±1.66(44.82-48.79)	3.54	47.40±1.12(45.82-48.50)	2.37
^{L}PA	64.82±1.15(63.60-66.08)	1.78	64.19±0.69(63.43-64.90)	1.08	64.52±1.15(63.01-66.08)	1.78
DPFV	37.34±0.86(36.02-38.07)	2.32	37.32±0.61(36.72-38.02)	1.62	37.30±0.54(36.72-37.92)	1.45
PIAO	17.38±1.08(16.26-18.75)	6.20	17.07±0.43(16.61-17.75)	2.51	17.13±0.75(16.36-18.15)	4.41
^{L}DFB	16.41±0.85(15.07-17.27)	5.20	16.51±0.89(15.67-17.97)	5.40	16.40±1.03(15.37-17.97)	6.27
^{L}AFB	21.48±1.08(20.20-22.58)	5.04	22.22±0.98(21.10-23.01)	4.41	22.19±1.15(20.20-22.98)	5.19
^{L}P	14.56±1.08(12.95-15.79)	7.39	15.19±0.74(14.15-15.99)	4.84	15.15±0.65(14.18-15.79)	4.27
DP	10.81±0.67(9.88-11.59)	6.22	10.97±0.96(9.59-11.97)	8.74	10.99±0.81(9.88-11.77)	7.35
DPV	13.83±1.47(11.52-15.19)	10.60	14.24±0.39(13.72-14.71)	2.71	1 3.71±1.27(11.52-14.61)	9.28
^{L}PF	23.81±1.29(21.53-24.52)	5.41	23.24±2.34(20.53-25.82)	10.09	23.93±1.27(21.73-24.82)	5.32
HW	50.72±1.06(49.24-51.98)	2.08	50.23±1.07(49.01-51.83)	2.13	50.64±1.16(49.64-51.98)	2.30
PFL	16.26±0.63(15.53-17.16)	3.86	16.44±1.39(14.93-17.76)	8.47	16.50±0.96(15.53-17.76)	5.84
^{L}CF	30.59±1.22(29.19-32.30)	3.98	30.88±2.55(28.19-33.90)	8.27	31.46±1.42(29.49-32.90)	4.52
CV*p*	4.35		4.72		4.36	

Morphometric characters	Ramnathi (n=10) Mean±SD (Min-Max)	CV	Kalikesam (n=10) Mean±SD(Min-Max)	CV	F-Value
^{L}S	44.41±2.36 (40.78-46.37)	5.31	44.37±1.34 (42.17-45.57)	3.03	1.13**
^{L}H	24.94±1.08 (23.57-26.25)	4.34	24.88±1.33 (23.05 -26.35)	5.33	0.15*
MBD	27.19±1.00 (26.0l-28.77)	3.66	27.31±0.80 (26.31-28.27)	2.91	0.25**
^{L}PD	60.49±3.33 (55.88-64.11)	5.51	60.03±2.96 (56.98-63.51)	4.93	0.18*
PDL	41.10±1.79 (38.87-43.88)	4.36	41.12±1.64 (39.17-43.38)	3.99	0.05*
^{L}PP	47.52±1.41 (45.82-49.32)	2.97	47.32±1.01 (45.82-48.58)	2.14	0.31**
^{L}PA	64.21±0.74 (63.01-64.96)	1.16	64.24±1.35 (62.60-66.06)	2.11	0.33**
DPFV	36.84±0.78 (35.95-37.92)	2.12	36.90±1.32 (35.22-38.44)	3.57	0.41**
PIAO	17.12±0.64 (16.41-18.15)	3.73	16.98±0.84 (16.11-17.98)	4.94	0.19*
^{L}DFB	16.25±0.89 (15.22-17.47)	5.49	16.25±0.72 (15.37-17.17)	4.41	0.08NS
^{L}AFB	21.50±1.39 (19.90-22.98)	6.46	21.27±0.96 (20.16-22.78)	4.49	0.76**
^{L}P	14.30± 1.41(12.45-15.79)	9.88	14.24±1.38 (12.05-15.69)	9.68	0.88**
DP	10.53±1.04 (8.88-11.77)	9.92	10.53±0.96 (9.18-11.77)	9.12	0.32**
DPV	13.55±1.43 (11.12-14.51)	10.53	13.65±1.56 (11.02-14.89)	11.61	0.24**
^{L}PF	23.57±1.19 (21.73-24.82)	5.07	23.49±1.80 (20.53-24.91)	7.66	0.14*
HW	50.30± 1.05 (49.13-51.73)	2.08	50.28±0.50 (49.74-51.08)	1.00	0.26**
PFL	16.18±0.87 (15.13-17.26)	5.36	16.16±1.04 (14.93-17.06)	6.44	0.11*
^{L}CF	30.41±1.42 (29.49-32.90)	4.68	30.25±1.76 (28.19-32.80)	5.81	0.38**
CV*p*		**5.15**	**5.18**		

*=P< 0.05; ** = P<0.01; NS= Not significant; SD= Standard deviation

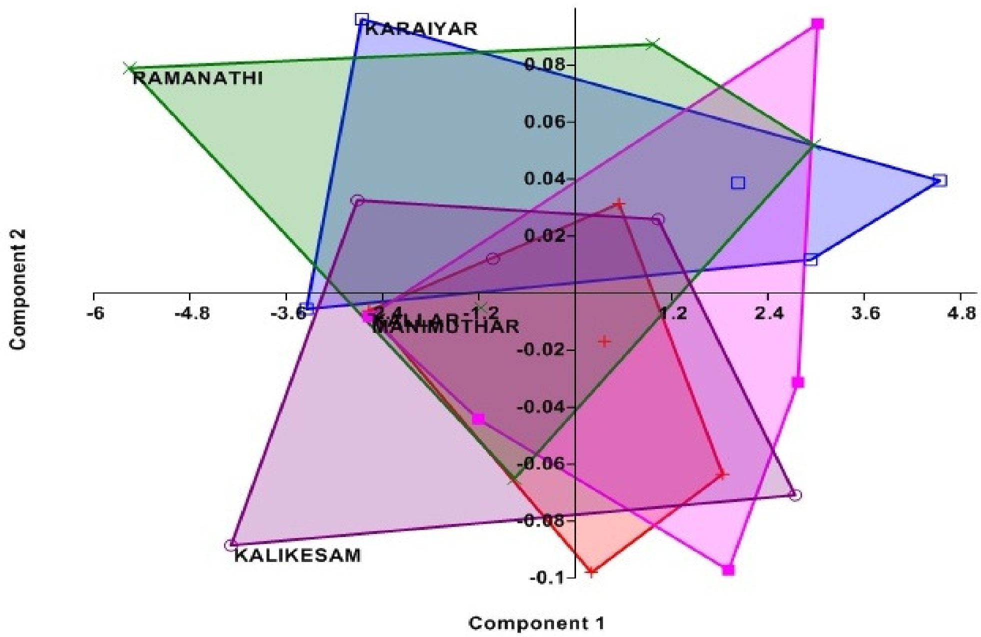

Figure-1
Scattered Diagram for *D. aequipinnatus* (Green cross – Ramanathi, Square Blue – Karaiyar, Pink filled square – Manimuthar, Red cross –Kallar, Purple circle – Kalikesam

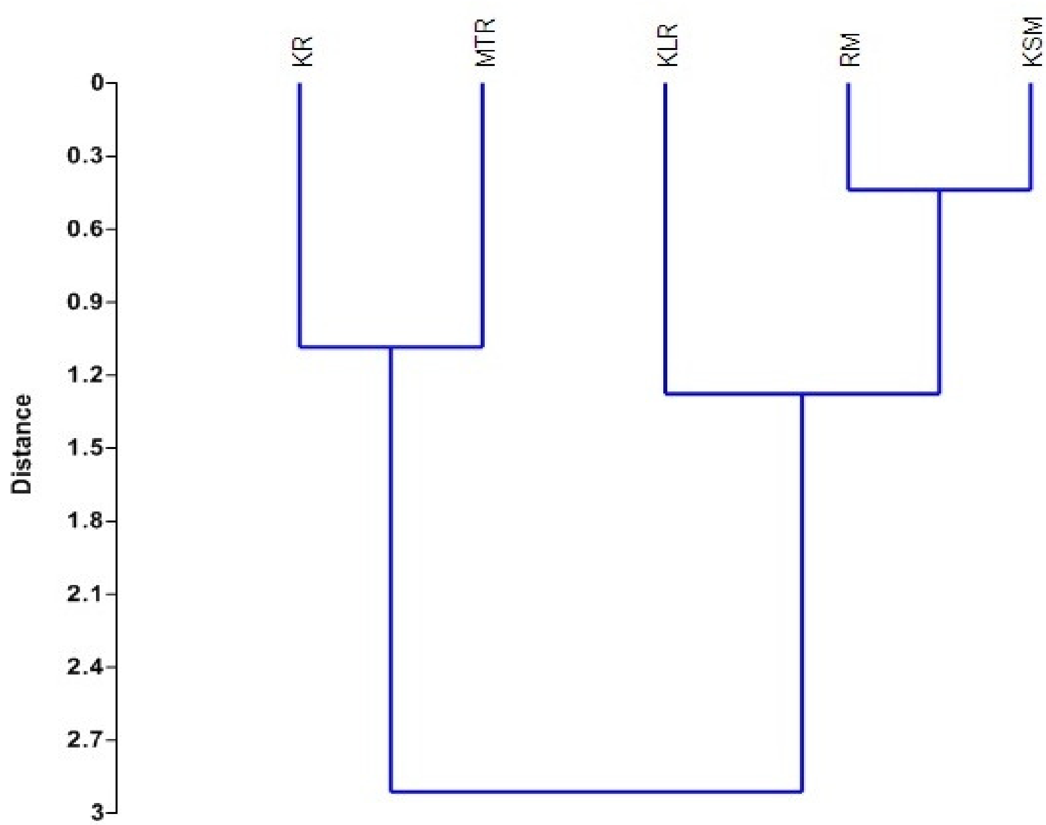

Figure-2
Cluster Analysis for *Danio aequipinnatus* populations

Table-3
Summary of principal component analysis (PCA) for the morphometric variables of *Danio aequipinnatus* populations

Components	Eigen values	% of Variance	Cumulative %
1	7.058	39.209	39.209
2	3.776	20.979	60.188
3	3.532	19.621	79.809
4	1.983	11.014	90.823
5	1.072	5.955	96.778
6	.215	1.193	97.971
7	.156	.868	98.839
8	.085	.471	99.310
9	.043	.240	99.550
10	.026	.144	99.694
11	.020	.112	99.806
12	.013	.070	99.876
13	.008	.043	99.919
14	.006	.035	99.954
15	.004	.021	99.975
16	.003	.014	99.990
17	.002	.010	100.000
18	.005	.000	100.000

Discussion: The observed phenotypic divergence amoung among *Devario aequipinnatus* samples revealed the existence of five morphologically differentiated stocks viz., the Tamiraparani River population (including the Kallar, Karaiyar, Manimuthar and Ramanathi sampling sites) and the Kalikesam River population. The distinction amoung the samples may suggest a relation between the extent of phenotypic heterogeneity and geographic distance, showing the limited intermingling within the population of the four tributes in Tamiraparani Rivers (Kallar, Karaiyar, Manimuthar and Ramanathi) and Kalikesam River. *Devario aequipinnatus* samples from the five sites were morphometrically similar to each other; the extent of overlapping between the populations of Karaiyar, Ramanathi and Kalikesam could have sufficient to prevent morphometric variation between the samples. According to Menon A.G.K.[24] while *Devario aequipinnatus*, is distributed in several east flowing rivers of Tamiraparani and Kalikesam River, Tamilnadu. In the present study, samples of *Devario aequipinnatus* collected from Tamiraparani River and the samples from Kalikesam River showed similarity in morphology characters.

Morphometric characters differentiation between five sites populations of *Devario aequipinnatus:* Morphometric analysis showed a clear morphologic heterogeneity existing among five sites populations of *Devario aequipinnatus* as mentioned, the size and body characters of *D. aequipinnatus* population's differences between Kallar, Karaiyar, Manimuthar, Ramanathi and Kalikesam were readily noticeable. From that the *D. aequipinnatus* and in *L*P, *L*PA, *L*AFB, DPFV, *L*PP and *L*CF samples from five sites shared several (but not uniform) of the morphometric characters that are significantly different. The larger mean *L*PA, *L*PD and HW identified *D. aequipinnatus* specimens of five populations. Although the morphometric characters variation due to environmental factors may be able change to some stage for the possible phenotypic discreteness of tilapia collections, the discovered practice of differences show that there is some imperceptible between populations[25].

Multivariate analysis between five sites populations of *Devario aequipinnatus:* The multivariate generalized coefficient of variation (CVp) in each Specimen. The coefficient of variation observed in the present study was comparatively lower ranging from 4.35% (Kallar) and higher from 5.18% (Kalikesam) of *D. aequipinnatus* populations. In fishes, the coefficients of variation within populations are usually far greater than 10%[26]. The lower coefficient of variation indicates the minimal or very low intra-population variation. Similar results were obtained[27] in seven populations of red mullet[28] (*Mullus barbatus*) and in four populations of Silver perch (*Leiopotherapon plumbeus*).

Principal Component Analysis between five populations of *Devario aequipinnatus:* The Principal Component Analysis has clearly demonstrated an intraspecific morphological variation among the populations of *Devario aequipinnatus*from five different sampling sites systems of the Southern Western Ghats of India. The variations observed are related to measurements of like *L*P, *L*PA, *L*AFB, DPFV, *L*PP and *L*CF. Measurements of these characters were the most discriminating variable in this study. Accordingly, Ramanathi and Kalikesam population of *D.aequipinnatus* was further confirmed by the Principal Component Analysis. The bivariate scatter plots represented that the populations from Kallar, Manimuthar and Karaiyar were in overlapping, while the populations from Ramanathi and Kalikesam were in separate clusters. This clustering suggests closer morphological similarity between populations from Kallar, Manimuthar and Karaiyar whereas; Ramanathi and Kalikesam populations were morphometric well distinct. As related studies reported earlier *Puntius dorsalis*[29]*Puntius bimaculatus*[30] genus *Puntius*[31]. Hence, the study of five site populations of *Devario aequipinnatus* were morphologically variation between different their characters. These environmental factors may affect morphological characters. In some studies, environmental conditions, particuraly temperature which prevail during some sensitive developmental stages have been shown to have the greatest influences in morphological characters[32-33]. Lindsey C.C.[34] explained the effect of temperature on morphological characters based on the study in Paradise fish (*Macropodus opercularis*). The observed patten of the phenotypic discreteness also suggests a direct relationship between the extent of phenotypic divergence and geographic separation, indicating that geographic separation is a limiting factor to migration amoung stocks. It will know that the morphological characteristics can show high plasticity in response to differences in environmental conditions. This rises the possibility that phenotypic may itself be adaptive, allowing stocks to shift their appearance to match their ecology circumstances[35]. The phenotypic plasticity of fish allows them to respond adaptively to environmental change by modifications in their physiology and behavior, which lead to changes in their morphology, reproduction or survival, which mitigate the effects of environmental change[36]. Therefore the examined could be found out the morphometric variation differences between some characters of same species from different site populations.

Table-4
Factor loadings for the first five principal components formed from the morphometric variables of *Danio aequipinnatus* populations

Morphometric variables	PC1	PC2	PC3	PC4	PC5
^{L}S	.747	.066	-.587	.166	.225
^{L}H	.900	.052	.381	-.129	-.105
MBD	.441	.839	-.086	.251	-.109
^{L}PD	.832	-.481	-.028	.169	-.162
PDL	.526	.812	-.092	.048	-.208
^{L}PP	.367	-.236	.814	.163	-.109
^{L}PA	.102	-.001	.753	.546	.217
DPFV	.599	-.588	-.053	.496	.129
PIAO	-.344	-.252	-.260	.781	.278
^{L}DFP	.082	.898	-.189	.343	.041
^{L}AFB	.830	.091	-.400	-.280	.194
^{L}P	.521	-.099	-.440	-.485	.510
DP	.930	-.180	-.218	.126	.062
DPV	.666	-.218	-.537	.353	-.299
^{L}PF	.602	.025	.769	-.145	.015
HW	-.174	.690	.392	.122	.551
PFL	.821	.490	.206	-.051	-.152
^{L}CF	.749	-.297	.461	-.232	.238
Explained variance (%)	39.21	20.98	19.62	11.01	5.96

Conclusion

Devario aequipinnatus were morphologically variation between different their characters in the examined five localities of the Southern Western Ghats. It found out the same species of some characters morphometrically unlike in nature. It may become a habitat structure changes from nature and human specific behavior. Also habitat alteration their aquatic environment causes modifies their characters changes of fish species. From this furthermore studies were carrying out for if there is any genetic variation in specific individual species.

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