International Research Journal of Biological Sciences E-ISSN 2278-3202
Vol. **5(11),** 1-10, November **(2016)** *Int. Res. J. Biological Sci.*

Morphometry and Length - Weight Relationship of *Uranoscopus marmoratus* Cuvier, 1829 (Family: Uranoscopidae) from Palk Bay, India

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Available online at: www.isca.in, www.isca.me
Received 28th September 2016, revised 21st October 2016, accepted 2nd November 2016

Abstract

The study detailed the morphometry, meristic counts and length-weight relationship of Uranoscopus marmoratus along the coast of Pampan in Tamilnadu. Fish samples were examined having total length ranged from 172 to 301 mm with a coefficient of variation of 13.26%. The morphometric characters in the percentage of total length and head length showed a high value of correlation coefficient (r>0.84) and coefficient of determination (r2 >0.79) indicates that most of the characters exhibited a direct proportional growth to each other and a higher degree of homogeneity within the population. Between the ten morphometric characters in the percentage of head length, there were five genetically controlled, three intermediate and two environmentally controlled characters. In percentage of head length, one character was observed to be genetically controlled and the other three were environmentally controlled The fin formula of the fish can be written as D.I (4-5), II(11-12), P.13-16, V.5-7, A. 12-14, C. 12-15. The length-weight relationship of the fish is represented as Log W = - 4.2655 + 2.8147 Log L for male, Log W = - 4.3705 + 2.8556 Log L for female and Log W = - 4.3236+2.837Log L for pooled one. The correlation coefficient (r) was estimated as 0.93, 0.96 and 0.94 (P< 0.001) for male, female and pooled one while the regression coefficient for all the three cases were less than 3.0 indicating the negative allometry of the fish. It was evident that, both male and females showed a disparity in growth pattern which was clearly depicted from the regression of male and female (P<0.05). The present study generated data on the morphometrics, meristics, and length – weight relationship of U. marmoratus captured from the South Eastern coast of India (Palkbay) and forms the first reference for the species worldwide.

Keywords: Morphometrics, Meristics, Length-Weight relationship, Allometric, Palkbay.

Introduction

Uranoscopus marmoratus Cuvier, 1829 (Family: Uranoscopidae, Order: Perciformes, Class: Actinopterygii) is one of the stargazers occurred in the Eastern and Western Indian Ocean. The stargazers are purely marine, distributed throughout the world in deep and shallow waters, include about 50 extant and one extinct species in eight genera[1]. The fish is generally characterized by large head, dorsolaterally directed eyes, placed on the large flattened head, body and head dark brownish in colour with or without irregular whitish blotches on the back. Moreover, two large and four small venomous spines situated behind their opercles and above their pectoral fins. Spiny dorsals are blackish in colour. Stargazers were found for sale in some markets[2] and it is consumed in some countries after proper cooking because the venom present in the spines were not poisonous after cooking.

The backbone for taxonomic classification of organisms is to equate the anatomical features, which differentiate the stock as well as interrelated species, determined by using differences in body measurements (Morphometry) and in numbers of anatomical structures (Meristics)[3,4]. Morphological systematics is one of the simple and legitimate methods of fish stock identification from different regions[5]. The relationships between different morphometric characters of the fish can be used to determine the possible difference between unit stocks and the healthy status of individuals of the same species[6]. The essential requirement for taxonomic work is to study the statistical relationship among the morphometric measurements of fishes[7].

The length – weight relationship, is imperative to fish stock assessment models because it plays a critical role in assessment as well as conservation and management of fish population[8]. The mathematical representation of LWR derived for different fishes forms a base to estimate their weight from a range of length observations and also to describe the basic biological characteristics of fish[9,10] which in turn determining the general well-being of the fish[11]. Recently an emerging fishery of *U. marmoratus* established along the coast of Pampan in Tamilnadu forms the basis for the study. The present study would like to generate data on the morphometrics, meristics, and length – weight relationship of *U. marmoratus* specimens captured from the South Eastern coast of India (Palkbay) which forms the first worldwide reference for the species.

Material and Methods

About 150 specimens of *U. marmoratus* ranging from 172 to 301 mm total length were collected from Palkbay-Pampan, Tamilnadu during July 2015 to August 2016. The study location and the photograph of the fish were shown in Figure-1 and Figure-2. Fresh fish samples collected from the landing centres were brought to the laboratory without any physical damage by proper preservation in ice and all the direct measurements were taken with a digital verniercaliper to the nearest 0.01 mm. Fish were weighed to the nearest 0.1 g by a digital analytical balance. Twelve morphometric measurements were documented and the various morphometric characters in percentage of total length and in head length have been studied[12,13]. So in percentage total length, the proportion to total length vs Standard Length (SL), Head length (HD), Body depth (BD), Pre orbital length (PRL), Postorbital length (POL), Pre dorsal length (PDL), Pre pectoral length (PPL), Pre ventral length (PVL), Pre anal length (PAL), Caudal depth (CD) and in percentage head length, the proportion to head length vs Head depth (HD), Inter orbital length (IOL) Preorbital length (PRl), postorbital length (POL) were studied. All the measurements were calculated in the percentage of total length except those of head depth, inter-orbital length which was calculated in the percentage of head length. All the subsequent measurements calculated in percentage of total length and head length were subjected to statistical analysis chiefly mean, standard deviation, range, correlation and regression analysis. Based on the range and its difference, the different morphometric characters thus studied were then classified into genetically (<10%), intermediate (10 – 15%) and environmentally (>15%) controlled characters[14]. The correlation coefficient obtained for each character was used for assessing the relationship within the population and the linear regression equation were fit into the straight line equation ($Y= a+bX$), where Y is the dependent variable, 'a' is the intercept, 'b' is the slope of regression line and X is the independent variable. The length– weight relationship of the fish was calculated from the parabolic equation, $W= aL^b$ [15-19] and the linear regression between the length and weight can be evaluated by converting the equation to its logarithmic form. So this can be expressed in its logarithmic form as $\log W= \log a + b \log L$, where, W - weight, L - length, a - a constant or Y intercept known as initial growth factor, b- growth coefficient or slope of the regression line. The coefficient of L-W relationships was estimated by linear regression analysis and the degree of relationship between length and weight was calculated by coefficient of determination (r^2).

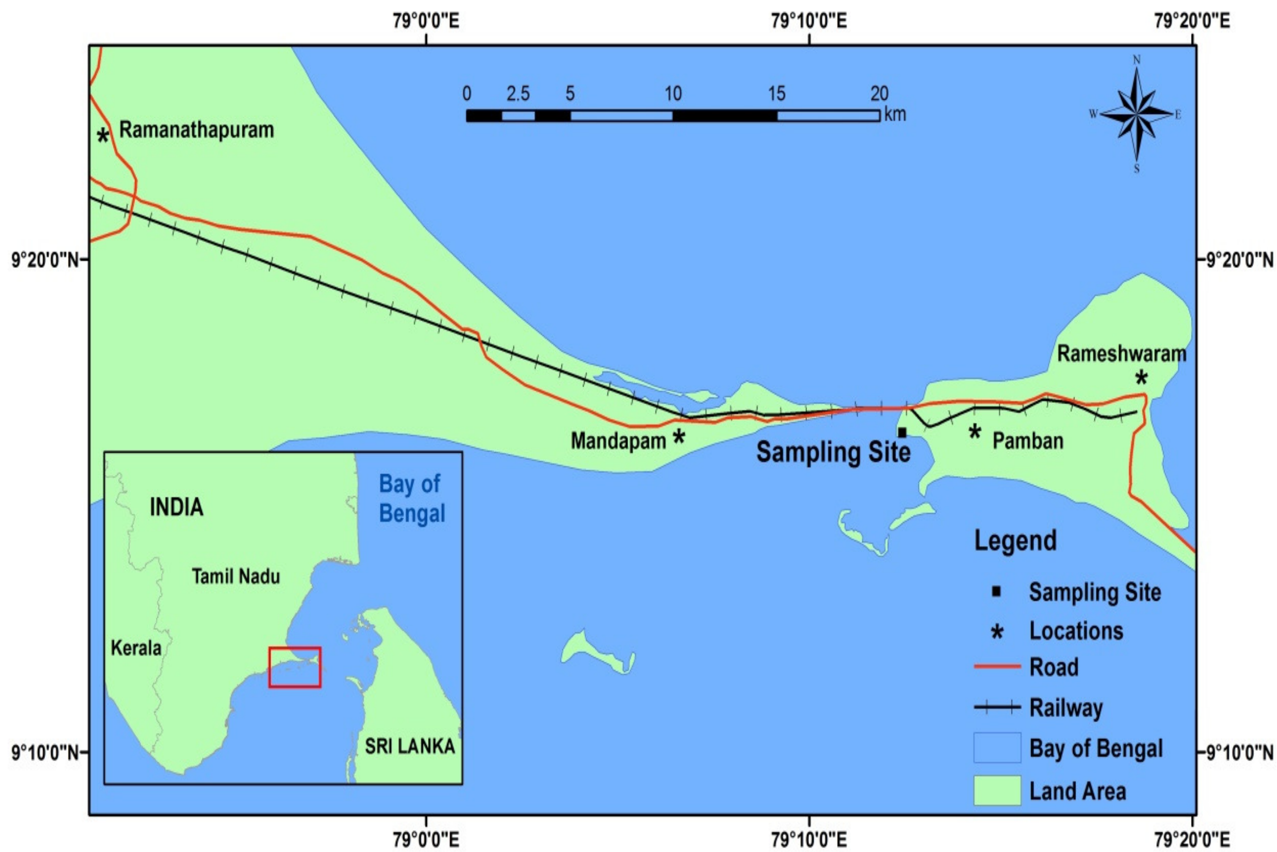

Figure-1
Location of the present study

Figure-2
Photograph of *Uranoscopus marmoratus* Cuvier 1829

Results and Discussion

During the present study, a total of 150 samples of *U. marmoratus* Cuvier, 1829 were collected from Pampan landing centre, Palkbay, Tamilnadu. The descriptive statistics of morphometric characters of *U. marmoratus* were given in Table-1. The maximum total length was recorded for a female specimen and the detailed statistical analysis of morphometric characters which are expressed in the percentage of total fish length and head length was given in Table-2. Linear regression of standard length, pre orbital length, post orbital length, pre dorsal length, pre anal length, pre pectoral length, pre ventral length, body depth and caudal peduncle depth against total length indicates allometric relationship and high degree of homogeneity within the population as also evident from the r^2 values (Table-2). The linear relationship between different characters was depicted in Figure-3. It has been observed that characters like standard length, pre orbital length, post orbital length, pre dorsal length, pre anal length, pre pectoral length, pre ventral length, body depth in the percentage of total fish length show the high value of correlation coefficient indicates the direct proportional increase in these morphometric characters. While the characters like head depth, pre orbital length, post orbital length and interorbital length in the percentage of head length show a little lower value of correlation coefficient, but a higher degree of homogeneity within the population evident from the r^2 values and depicts the allometric relationship. In *U. marmoratus*, all the characters exhibit allometric relationship, so the variations in the growth were evident [20] and found to be taxonomic interest[21], moreover the allometry can be used for studying intra and interspecific variations in fish species[22-24]. The linear relationship of various morphometric characters against Total length and Head length is shown in Figures-3, 4 and 5.

Table-1
Descriptive statistics of morphometrics of *U. marmoratus*

	Minimum	Maximum	Mean	Standard Deviation	Standard Error	Coefficient of variation (%)
Total length	172	301	266.8	35.38	8.58	13.26
Standard length	128	258	224.56	35.77	8.68	15.93
Head length	29.34	110.4	82.63	26.38	6.40	31.93
Head depth	23.2	57.9	49.48	9.07	2.20	18.340
Inter orbital length	4.2	20.1	14.61	4.31	1.04	29.49
Body depth	19.26	58.35	46.35	10.28	2.49	22.19
Pre orbital length	7.02	19.87	15.78	3.178	0.77	20.13
Postorbital length	11.32	39.97	30.51	7.35	1.78	24.09
Pre dorsal length	38.34	101.08	89.27	16.49	4.02	18.47
Pre pectoral length	23.45	88.08	75.67	16.43	3.98	21.71
Pre pelvic length	10.78	40.28	31.68	8.85	2.15	27.94
Pre anal length	59	121.54	113.96	19.29	4.68	16.92

Table-2
Mean, S.D., Correlation coefficient (r), Regression equation (Y=a+bX), Range and r^2 values between different morphometric characters of *U. marmoratus.*

	In percentage Total length					
	Mean	**Standard deviation**	**Correlation coefficient**	**Range, Range difference**	**Regression equation**	**r2**
Standard length	83.24	3.02	0.99	74.68-86.28 (11.6)	SL=-44.79+1.009TL*	0.99
Head length	30.18	2.56	0.97	17.05-35.93 (18.88)	HL=-19.81+0.721TL*	0.93
Body depth	17.17	2.47	0.91	11.19-20.05 (8.86)	BD=-22.97+0.25TL	0.79
Pre orbital length	5.85	0.57	0.97	4.08- 6.61 (2.53)	PR=-7.47+0.08TL*	0.94
Postorbital length	1.25	1.6	0.98	6.58-13.27 (6.69)	PO=-23.91+0.204TL*	0.96
Pre dorsal length	33.17	3.04	0.98	22.29-34.55 (12.26)	PD=-32.46+0.46TL*	0.95
Pre pectoral length	27.98	4.01	0.97	13.63-29.96 (16.33)	PP=-43.86+0.448TL*	0.93
Pre ventral length	11.61	2.09	0.98	6.26-13.42 (7.16)	PV=-34.35+0.247TL*	0.97
Pre anal length	42.49	2.88	0.95	34.30-46.05 (11.75)	PA=-25.22+0.521TL	0.91
Caudal depth	6.73	0.61	0.93	5.2-7.32 (2.12)	CD=-5.47+0.088TL	0.86
	In percentage Head length					
Head depth	61.13	2.06	0.84	51.09 -79.24(28.15)	HD=25.37+0.29HL*	0.91
Inter orbital length	18.64	1.05	0.89	14.98 – 35.01(20.03)	IO=5.92+0.105HL	0.91
Pre orbital length	20.11	2.36	0.91	16.65 – 25.42(8.75)	PR=6.64+0.11HL*	0.92
Postorbital length	38.14	1.09	0.93	32.25 -48.54(16.29)	PO=8.87+0.25HL*	0.95

*Significant (P<0.001)

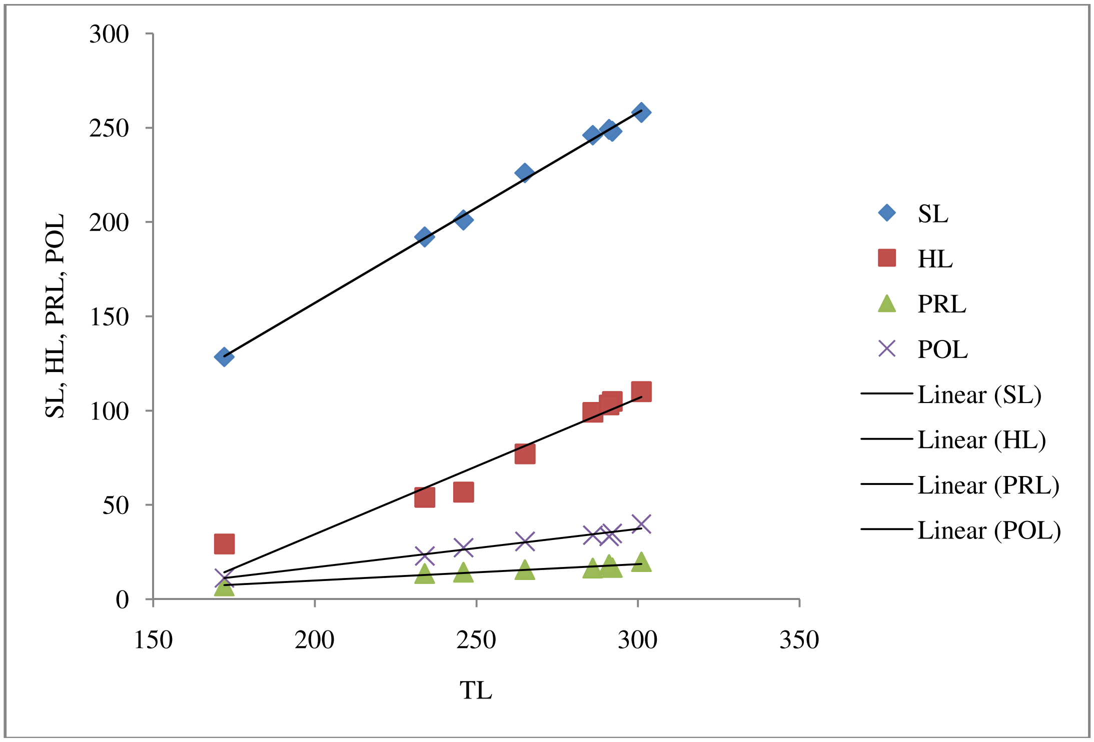

Figure-3
Linear relationship of Total length (TL) against Standard length (SL), Head length (HL), Pre orbital length (PRL) and Post orbital length(POL)

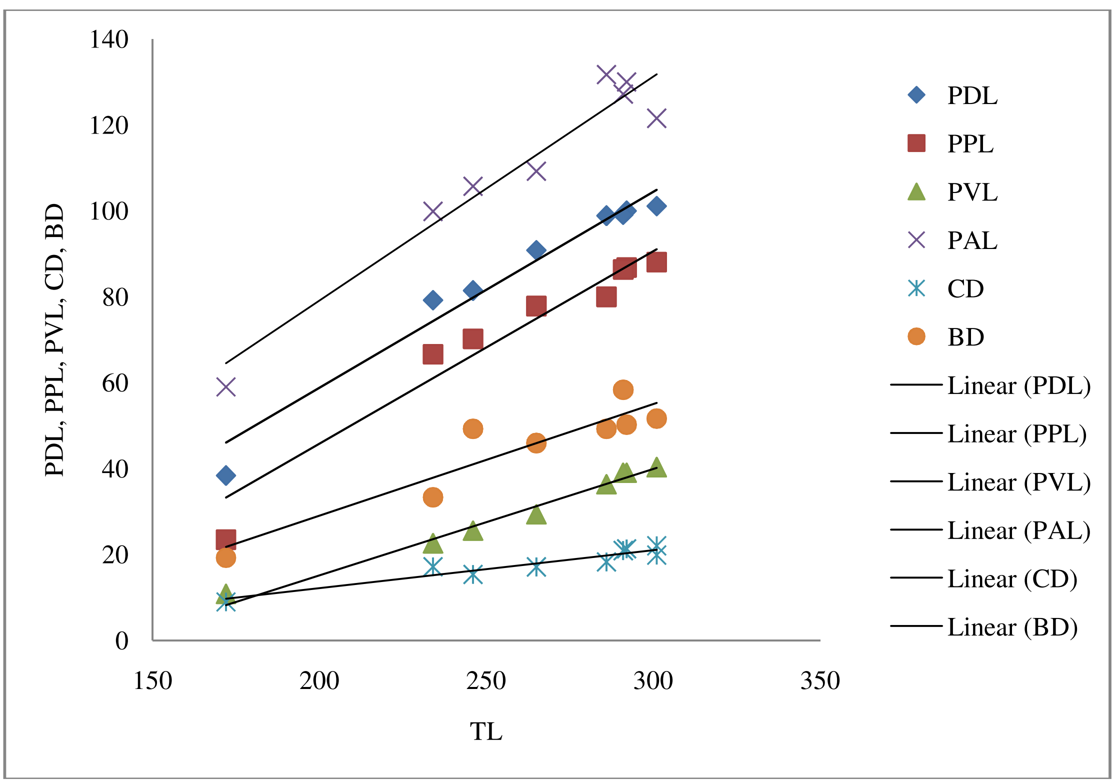

Figure-4
Linear relationship of Total length (TL) against Pre dorsal length (PDL), PRE pectoral length (PPL), Pre ventral length (PVL), Pre anal length (PAL), Caudal depth (CD) and Body depth

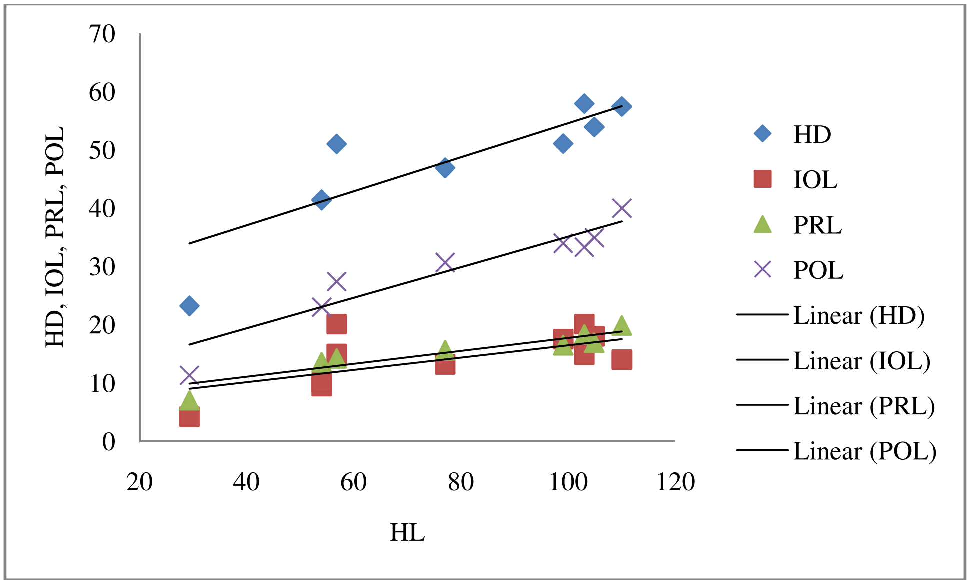

Figure-5
Linear relationship of Head length against Head depth (HD), Interorbital length (IOL), Pre orbital length (PRL) and Post orbital length(POL)

Fishes are very keen to environmental distortion and quickly acclimate themselves to change in body measurements. It is a well-known factor that the phenotypic plasticity of fishes was too high and quickly adapt to the stressed situation by modifying their physiology and behaviour. Several workers were opined that there was a high pliancy in the morphological characters of fish in response to differences in environmental conditions, such as food abundance and temperature[25-27]. This kind of modifications and adaptations ultimately change their morphometric systematics. Moreover, the fish undergo finer variations in morphological traits both within and between populations than any other vertebrates and are more responsive to environmentally induced morphological variations[27,29]. The morphometric characters studied in the percentage of total fish length from which five characters were genetically controlled, three characters were intermediate and two characters were environmentally controlled. In percentage of head length, one character was observed to be genetically controlled and the other three were environmentally controlled. So the study accentuates on the taxonomic interest of fish and revealing the interspecific variations of the morphometric characters and pinpointed that, the ecosystem disturbance to the fish and its acclimatisation to the same were curious and even remarkable. Since this is the first reference of the morphometry of *U. marmoratus* worldwide, no comparative discussion about the morphometric characters of the same is possible.

The study also enlightens, seven meristic characters of the fish i.e., a number of dorsal fin rays, pectoral fin rays, anal fin rays, ventral fin rays, caudal fin rays, post opercular spines and branchiostegal spines. Meristic characters have a distinct number and count, keep on variation under some specific range. The meristic traits of *U. marmoratus* were given in Table-3. The fin formula of the fish is D.I (4-5), II(11-12), P.13-16, V.5-7, A. 12-14, C. 12-15. The variation in meristic counts of *U. marmoratus* was observed in different size groups and are keep on changing while increasing or decreasing the body length and weight. Several workers reported the similar kind of variations in the meristic characters of fishes such as *Megalapsiscordyla*[30], *Sphyraenaobtusata*[31] etc.

Table-3
Meristic counts of *U. marmoratus*

Meristic characters	Range
Dorsal spiny ray	4-5
Dorsal soft ray	11-12
Pelvic fin ray	5-7
Pectoral fin ray	13-16
Post opercular spines	3 pairs
Anal fin ray	12-14
Caudal fin ray	12-15
Branchiostegal spines	2 pairs

The length weight relationship of male and female, *U. marmoratus* were computed from the linear regression analysis and the mathematical relationship between the length and weight were written as follows: Log W = -4.2655 + 2.8147 Log L for male, Log W = - 4.3705+2.8556Log L for female. Their corresponding parabolic equations can be expressed as $W = 0.2146L^{2.7985}$ for male and $W = 0.1975L^{2.8909}$ for female. There is a good correlation, perfect relationship and high degree of association between length and weight in both sexes, which is evident from the correlation coefficient 'r', 0.91 for male and 0.95 for female and was found to be significant ($P< 0.001$) in both cases. The linear regression analysis between length and weight of the fish in both sexes determined the regression coefficient which was found to be significant in both instances (Table-4). The regression coefficient value of both the sex of *U. marmoratus* is less than 3.0 indicates the allometric growth especially, a negative allometry, that is to say, at a particular length fish becomes lighter when it increase in size[32]. The logarithmic regression equation of both the sexes (pooled) is given as Log W = - 4.3236+2.837Log L also gave a negative allometric growth ($b<3$). Since, the difference between the slopes of the regression of male and female was significant ($P<0.05$), it reflects a disparity in growth pattern in both the sexes. The study of LWRs of fish in the present study determined that the rate of increase in body length is not proportional to the rate of increase in body weight ie the growth of fish is not isometric. Several other workers also opined that, there are a lot of factors which attributed to the deviation from the isometric growth of fishes including the habitat, sex, gonad maturity, stomach fullness, physiological changes, ecology, number of specimens examined etc.[33]. Geographical variations were also be documented for many fishes by various workers 11. The calculated curve for the LWR is presented in Figure-6, 7 and 8. So the present study of Length- Weight (L-W) relationships of *U. marmoratus* and the mathematical equations representing the relationship forms a base to estimate weight for length classes of fish, when the length frequency distribution is known[34,35,] and specially in tropical fisheries due to the lack of availability of age data this can be used in stock assessment models, to predict age of fishes which in turn determine the condition indices, growth, mortality and maximum sustainable yield of resources[36,37]. This is also applicable to compare life history and morphology of populations from different locations[35].

Table-4
Regression statistics of LWRs of *U.marmoratus*

Regression statistics			
	Male	**Female**	**Pooled**
Correlation coefficient	0.930041	0.968118	0.943753
Regression coefficient (b)	2.7925	2.8945	2.83567
R Square	0.864977	0.937252	0.89067
Adjusted R Square	0.863991	0.936477	0.890173
Standard Error	0.081088	0.016731	0.023544

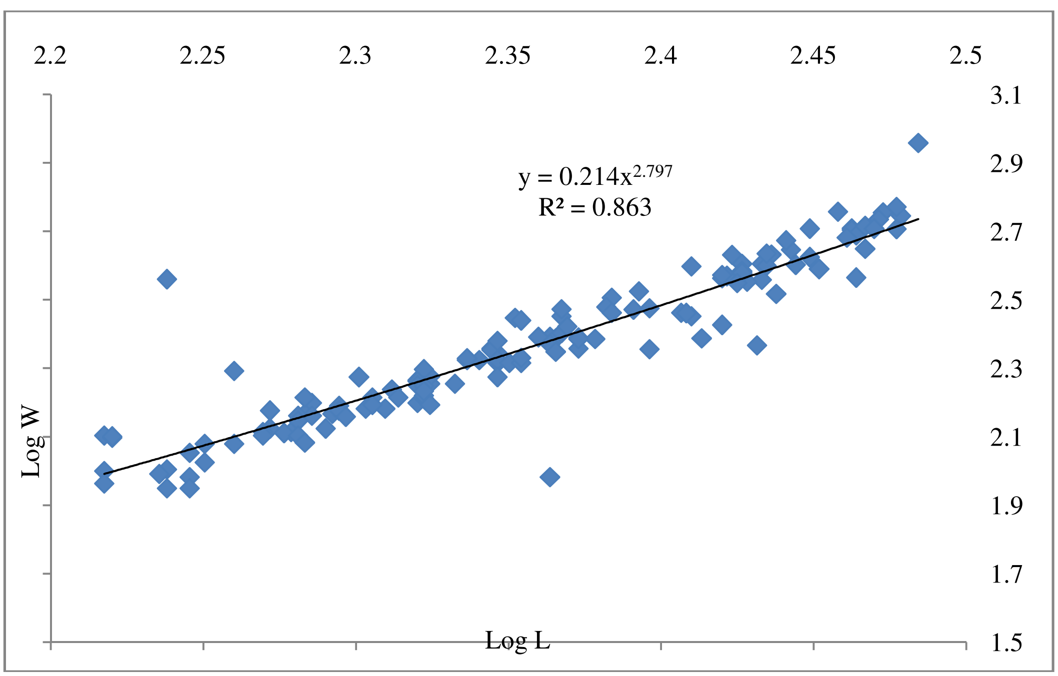

Figure-6
LWRs of Male *Uranoscopus marmoratus* Cuvier, 1829

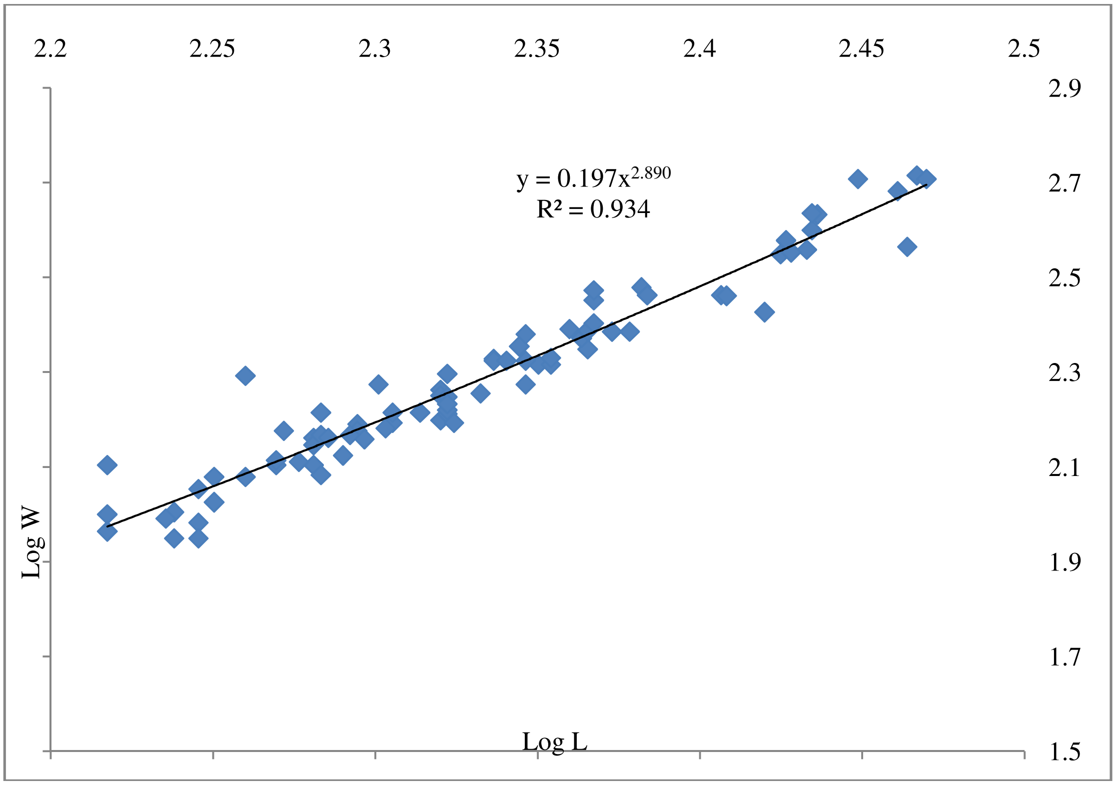

Figure-7
LWRs of female *Uranoscopus marmoratus* Cuvier, 1829

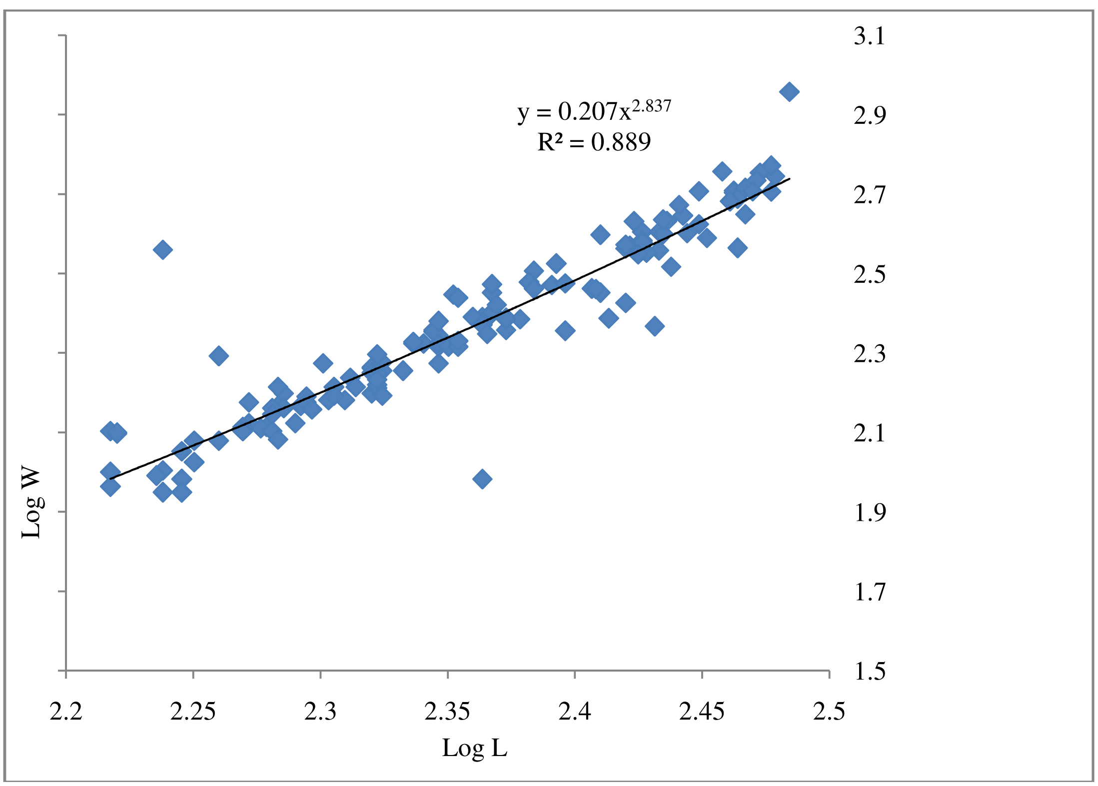

Figure-8
The pooled LWRs of *Uranoscopus marmoratus* Cuvier, 1829

U. marmoratus was mostly caught by gillnet as bycatch along with other species such as *Lactarius lactarius, Lutjanus argentimaculatus, Lethrinusspp, Aphareusrutilans, Epinephelus diacanthus, Siganusspp*, and other demersal fishes. The fish was landed at Pampan Light house (Palk bay) by the fibre boat (locally called as vallam) with a LOA of 8 M, 60 HP China engine and the speed of about 15 – 20 knots. No.4 gillnet is utilized for the particular fishery, characterised by 105 mm mesh size and length of about 1000 M. Since there was no established fishery of *U. marmoratus*, and the ambiguity about the marketing creates dilemma in fishers initially, later knowing the demand of fishes which was served in hotels in the neighboring districts, they started marketing after proper skinning. Three species of Stargazers were identified from the catch and it includes *Ichthyoscopuslebeck, Uranoscopus marmoratus and Uranoscopus sulphureus.* The fishes were sold as individual pieces and the cost varies from Rs. 40/- to Rs. 240/- depending upon the weight of fishes (the weight varies from 250 g to 800g). The emergence of new fishery always encourage the fishers to expand their fishing to unexplored Indian Exclusive Economic Zone (EEZ) and to bring a lot of commercially important fishes which in later forms one of the lucrative fisheries. The scope of similar studies from the Palk bay is to the higher side because of the rich diversity of fishes existing in the area.

Conclusion

The present study of morphometry and length weight relationship of *U. marmoratus* revealed that there is an allometric relationship between various morphometric characters and exhibited a negatively allometric growth pattern respectively. Most of the morphometric characters studied in percentage of total length and head length were genetically controlled and few were environmentally controlled. The ecosystem flexibility and adaptations exhibited by the fish in the morphometry was also quite remarkable. The fin formula of the fish was drawn from the various meristic counts and variations in the number of meristic characters were observed depending on the length, weight and sex of the fish. Negative allometry shown in the LWRs of both the sexes and pooled one revealed that the rate of increase in body length is not proportional to the rate of increase in body weight and thereby showing a deviation from the isometric growth pattern. The study envisaged the detailed morphometry, meristics and LWRs of *U. marmoratus*, from Palk Bay India, forms the first reference to the species worldwide.

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