ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Morphometric Role on Length-Length and Length Weight Relationship of Sulphur goatfish (*Upeneus sulphureus, Cuvier, 1829)* From Mandapam Coast, Southern India.

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Manuscript Info

Manuscript History:

Received: 14 November 2015
Final Accepted: 22 December 2015
Published Online: January 2016

Key words:
: Morphometrics, length to length relationship, length weight relationship, *Upeneus sulphureus*

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Abstract

The length to length relationship (LLR) and length weight relationship (LWR) in fishes has a key role in estimation of biomass which is a basic and old age routine for assessment of fisheries. In the present study is engrossed on the morphometric aspects of *Upeneus sulphureus* from Mandapam coast. Thirty-four morphometric parameters were noted for LLR. All the morphometric parameters were extremely significant with head length and total length at 1 % with $p < 0.01$ in males but in case of females and juveniles not all the parameters were found to be significant they do have certain limitations in the LLR depending on the sex. The LWR equations are as follows Log W = -0.837 + 2.051 Log L, Log W = -1.544+ 2.712 Log L and Log W = 1.520 - 0.107 Log L in males, females and juveniles. While comparing the slope and elevations in linear regression between males and females was found to be non-significant. From our study it is evident that the LLR had a proficient role in understanding the different aspects with regard to the morphology dissimilarity among the different sexes which is a progressive tool for sex determination.

Introduction: -

Fishes play a chief role by providing essential and vital nutrients to human body which are enriched with proteins that are easily accessible and cheaper to any other protein source. Fish play a critical role in the frugality of the developing countries (Gharaei, 2012) Goat fishes are commercially essential benthic groups round the world that has an actively effective role in the ecosystem food webs and associated biota through stirring up and resuspension of the sediments due to their mixed scavenging habits (Rajan et al., 2012) Morphometrics and length weight relationship of the fish was a traditionally technique and a basic study in most of the fishery biological studies. Unlike in Molecular taxonomy, DNA Barcoding, gel documentation and other molecular studies morphometric data yield is simpler than any other applied morphological studies where the animal has to be sacrificed and is time taking and even costlier method. Morphometrics were considered as the linear measure of the whole or part of a body, it is the most basic employed technique in fisheries and morphometric ratios were reliable when the assessment was made between sexes and at different sizes as they show sexual dimorphism.

The length – length relationship in fishes was a dominant technique that is employed widely by the fishery biologists to assess the biomass estimation and population studies (Pavlova etal., 2014). The Morphometric characters and their length to length interactions in fishes are important in fishery biology and taxonomic studies (Ferdaushy and Alam, 2015). The length – length relationship has a significant role in understanding the length to length interaction which are useful in comparative growth studies and in stock assessment models (Moutopoulos and Stergiou, 2002). Morphometric information is essential for the conservation and management of fishes, length-weight relationship has an eminent role in fishery biology involving with the various trends with the life history of fishes (Ferdaushy and Alam, 2015). The length-weight and length-length relationships yields data which is used to interpret the biomass, condition and growth in fishes (Radkhah and Eagderi, 2015). In length weight relationship weight can be forecasted by length which can be used for assessment of biomass offering as a beneficial technique in the fishery biological studies (Moreyet al., 2003).

The length weight relationship is an effective technique that affords evidence on the reproductive history, health condition, spatial distribution of different ecologically different species and their historical comparisons among different populations (Kara and Bayhan, 2008). The knowledge on the length-weight and length-length relationships is a broader proficient tool in the management of fishery for studying the population dynamics, ecosystem interactions, taxonomic variations and metamorphic changes during developmental stages in the life history, maturity and stock management (Subba and Adhikaree, 2011). The length and length weight relation is a fundamental data for fishery biologists to enforce regulations for a sustainable management of fishery (Chaki et al., 2013). In the view of conservation and management of the fishery LLR and LWR plays a key role in regulating the mesh size for the suitable catch according to the marketable size and market demand which in turn increases the efficiency of the effort of catch by minimizing the probability of the bycatch or untargeted species.

Owing to the potential effort and hard word most of the workers don't address all the promising morphometric characters that have to be explained leaving a prospect blur view to understand the interfaces among the various length to length characteristics. Henceforth we have carried the present work as a challenging aspect with thirty-four morphometrics characters and their interactions to understand the prospect to be a legitimate biological study. Where the different morphometric parameters were established with dependent variables like head length and total length with the other independent variables to a coherence linear regression. Which have to be considered with all the distinguished effort to understand the length to length and length weight relationship for an efficient protracted management of the fisheries.

Materials and methods: -

The length – length relationship along with length – weight relationship of *Upeneus sulphureus* were studied. The fishes (n =149) were collected from fish mongrels from Mandapam coast, southern India. The morphometric characters like Head length, eye diameter, pre orbital length , post orbital length , Inter orbital length , head depth, occipital length , barbel Length, upper Jaw length and lower Jaw length, caudal peduncle length and height, 1st and 2nd dorsal Fin base, length and height, 1st and 2nd pre dorsal Length, Inter Dorsal Space, Pectoral Fin Base, Length and height, Ventral Fin Length and height, Anal Fin base, length and height, pre anal Length, total length, standard Length, girth length and body depth nearly thirty four Morphometric measurements were scrutinized for males, females and juveniles.

Morphometric characters were measured to the nearest centimeter (nearest ± 0.01cm) with the help of a measuring scale and a compass. The total weight of the fishes were weighed on a digital weighing balance to the nearest gram (nearest ± 0.001gm). The Total weight and total length of the fishes were logarithmically transformed before subjecting to the length – weight analysis.

To obtain the length - length relationship among the various parameter with dependent variables Total length (TL) and Head length (HL) was established with the formulae.

$Y= a + b X$

Where,

'Y' is the dependent variable, 'X' is the independent variable, 'a' and 'b' are constants which have to be determined by least squares method.

To obtain the length - weight relationship the total length and total weight of the fishes were measured and length weight relationship was established by using the formula.

$W = aL^b$ (Le Cren, 1951)

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

Where,

'W' is the weight of fish, 'L' is the length of fish, 'a' and 'b' are constants.

Analysis of covariance, linear regression and comparison of linear regression was carried out followed by (Snedecor and cochran, 1989). The fishes i.e. males, females and juveniles which are significant at 1% ($p < 0.01$) and 5 % (p <

0.05) with total length and head length were only plotted to prevent overlapping of the point and lines in the graphs. All statistical analysis was carried out using PRISM 6.0.

Results: -

All the morphometric parameters were extremely significant with head length at 1 % with $p < 0.01$ in males. But in females PTO, IO, HD, OPL, BL, TL, SL, UJL, LJL, BD and GL were extremely significant at 1%. Where as in juveniles PO and GL at 1%, HD, SL and BD were only significant at 5% with $p < 0.05$.

However, in males all the morphometric characters were extremely significant with total length at 1% with $p < 0.01$. But SL, GL, BD, CPL, CPD, 1DFL, 2DFL, 1DFH, 2DFH, 1DFB, 2DFB, IDS, 1PDL, 2PDL, PFL, PFH, PFB, PPL, VFL, AFB and PAL were extremely significant at 1%. AFL and AFH were significant at 5% in females. Where in juveniles AFL at 1 % and VFL at 5 % were only significant.

Length – length relationship with Head length:

A Stronger positive correlation was found between TL, PTO and GL with HL in males, females and juveniles **Fig 1, 3 and 5.** However Higher growth rates were observed in PTO, PTO and PO in males, females and juveniles **Table 1.** Considerably weaker correlation were observed in between IO and HL; PO and HL; BL and HL in males, females and juveniles. Slow growth rate was observed in TL, TL and BL in males, females and juveniles.

Length – length relationship with Total length:

A Stronger positive correlation was found between 2PDL, SL and AFB with TL in males, females and juveniles **Fig 2, 4 and 6.** Higher growth rates was observed in PFB in males, females and juveniles. Considerably Weaker correlation was observed in IDS, VFH and IDS with TL in males, females and juveniles. However slower growth rate was observed in CPD, VFH and IDS in males, females and juveniles.

Length and weight relationship:

Among all the fishes males and females were only found out to be extremely significant at 1% with $p < 0.01$. A Negative allometric growth pattern was observed in male and female fishes. The calculated length and weight relationship were as follows:

In Males $\quad \text{Log } W = -0.837 + 2.051 \text{ Log } L$

In Females $\quad \text{Log } W = -1.544+ 2.712 \text{ Log } L$

In Juveniles $\quad \text{Log } W = 1.520 - 0.107 \text{ Log } L$

However, from LWR females gained slightly more weight than in males **Fig 7, Fig 8** and **Fig 9.** However, from the linear regression by comparing the slope and elevations in males and females was found to be non-significant **Table 2.**

Discussion: -

The finding from this study shows that the length to length relationship has its own way of representing the fishes with head length and total length where sexual dimorphism is observed when a comparative study was carried. With our knowledge due to the absence of the previous reports on the LLR this report can be concluded as the 1st wider report on the LLR. A Negative allometric growth pattern was observed in all the fishes where females were found gaining the weight slightly than males. All the morphometric parameters were extremely significant with head length and total length at 1 % with $p < 0.01$ in males but in case of females and juveniles not all the parameters were found to be significant they do have certain limitations in the LLR depending on the sex. Our finding are similar to the finding of (Reuben et al., 1994) but we have observed a negative allometric growth and while comparing the regression lines no significant difference was observed in elevation or slope this might be due to the ecological difference in the study areas. (Ali et al., 1978) Had established separate equations for males and females in *U. Sulphureus* where males and females not following isometric growth and the cube law.

(El-Drawany et al., 2013) Has evaluated separate equations for males and females in *U. pori* and isometric growth pattern was observed where females tend to gain more weight when compared to males. (Sabrah and El-Ganainy, 2009) Has established a combined equation for males and females in *U. vittatus* and *U. tragula* and observed isometric growth pattern. (Ozvarol et al., 2010) Also has derived a separate equation for *U.moluccensis* where females have shown slight gain in weight than in males showing an isometric growth pattern. (Pavlov et al., 2013) Has established a separate equation in *Parupeneus multifasciatus* where males and females had shown a similar pattern of growth showing an isometric growth pattern significant different in slopes were observed from the linear regression. A comparative study was made by (Pavlov et al., 2014) in *Upeneus tragula* where the fishes from the Nha Trang Bay has shown a negative growth pattern. But an isometric growth pattern was observed from the fishes from Ha Long Bay, However while comparing LWR in females from both the bays the slopes and intercepts were found to be not significant but in males the slopes were significantly different from both bays.

(Hamsa and Narayana Rao, 1997) Has derived a combined LWR equation for *Upeneus vittatus* where a negative allometric growth pattern was observed. (Jehangeer, 2003) has derived separate equations for males, females and unsexed fishes in *Mulloidichthys vanicolensis* where, females and unsexed fishes a negative allometric growth pattern was observed where in females isometric growth pattern is was observed. (Taskavak and Bilecenoglu, 2001) Has derived a combined LWR equation In *U.moluccensis* and *U.pori* where in *U.moluccensis* isometric growth pattern was observed and in *U.pori* a positive allometric growth pattern was observed. (Ismen, 2005) Has derived separate LWR equations for males and females In *Upeneus moluccensis* where an isometric growth pattern was observed in all the fishes. But, while comparing the regression lines no significant difference was observed. (Ismen, 2006) Has derived separate LWR equations for males and females in *U.pori* and an isometric growth pattern was observed in all the fishes. But, however while comparing the regression lines no significant difference was found.

These differences in the growth rate might be caused due to the probable dissimilarity in the diverse ecological niches. Therefore, it is concluded that the length – length relationship and length weight relationship of the fishes is an important technique to understand the biology where the interdependence of a morphometric character seems to be changing from one sex to other sex with head length and with total length henceforth can be used as an effective tool to determine the sexual difference without slaughtering the fish. LLR and LWR also have its proficient role in the conservation and management of the fishes where the mesh size can be regulated by knowing the marketable size and reproductive status of the fishery. Further research needs to carry out in the length – length relationship and length weight relationship of the fishes to have a wider acquaintance and promising perceptive for an appealing biological study.

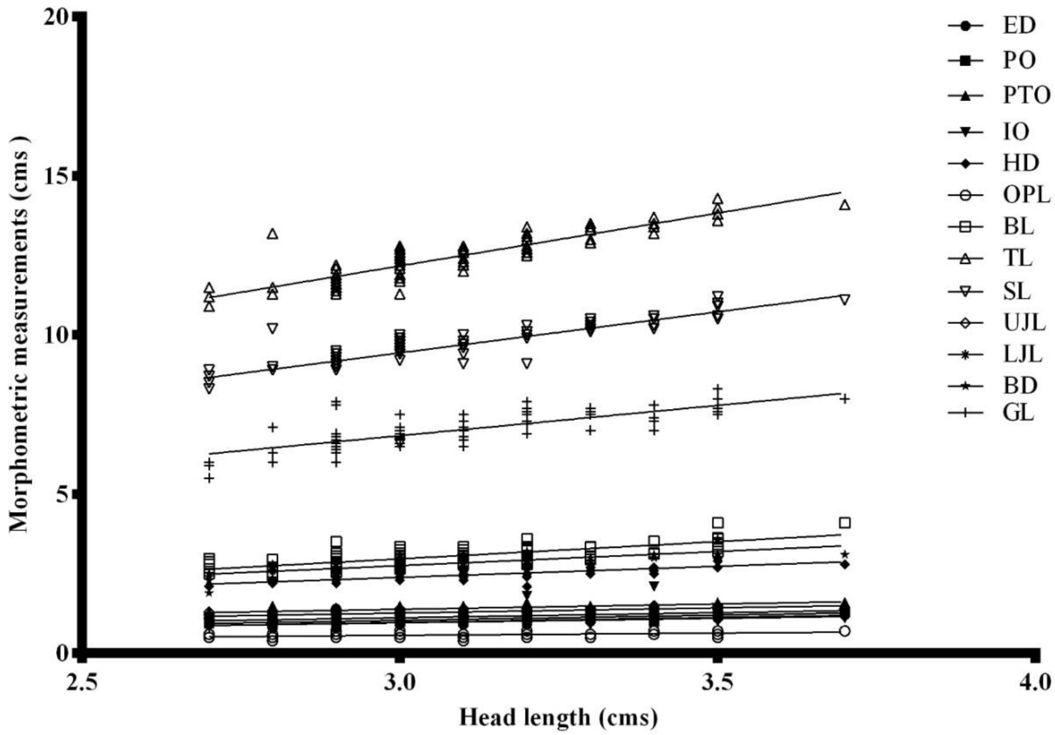

Figure 1

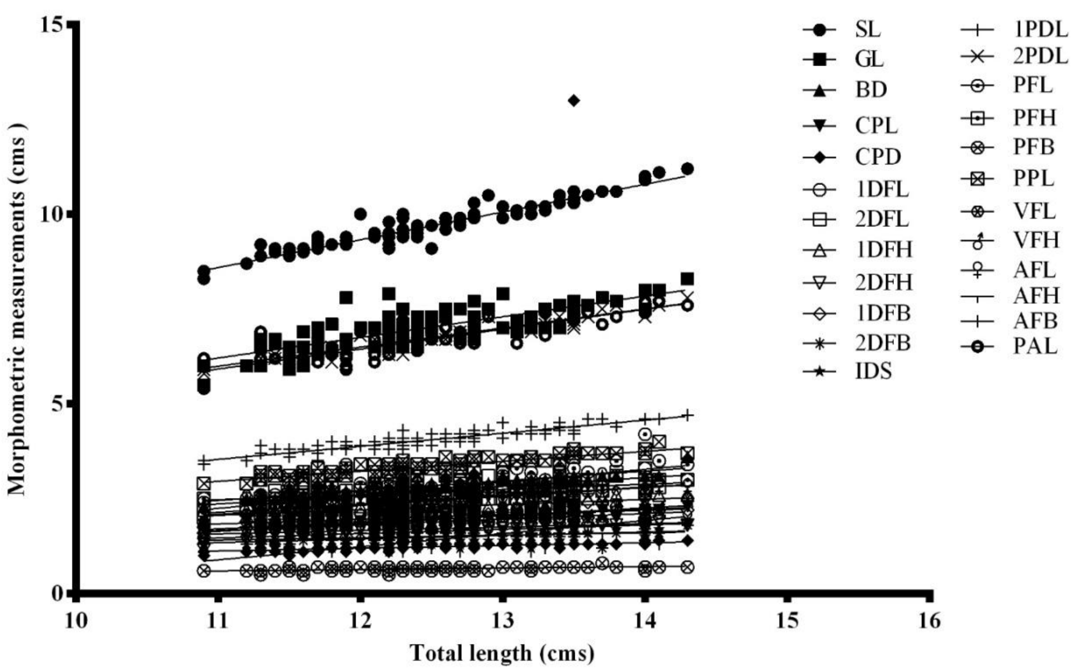

Figure 2

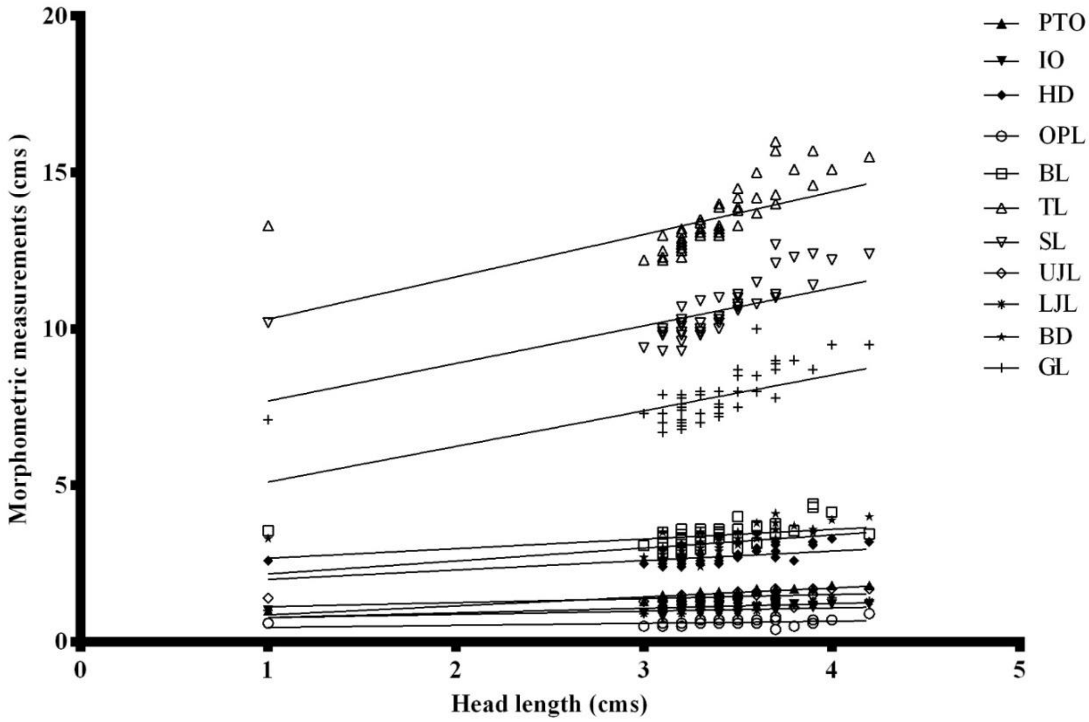

Figure 3

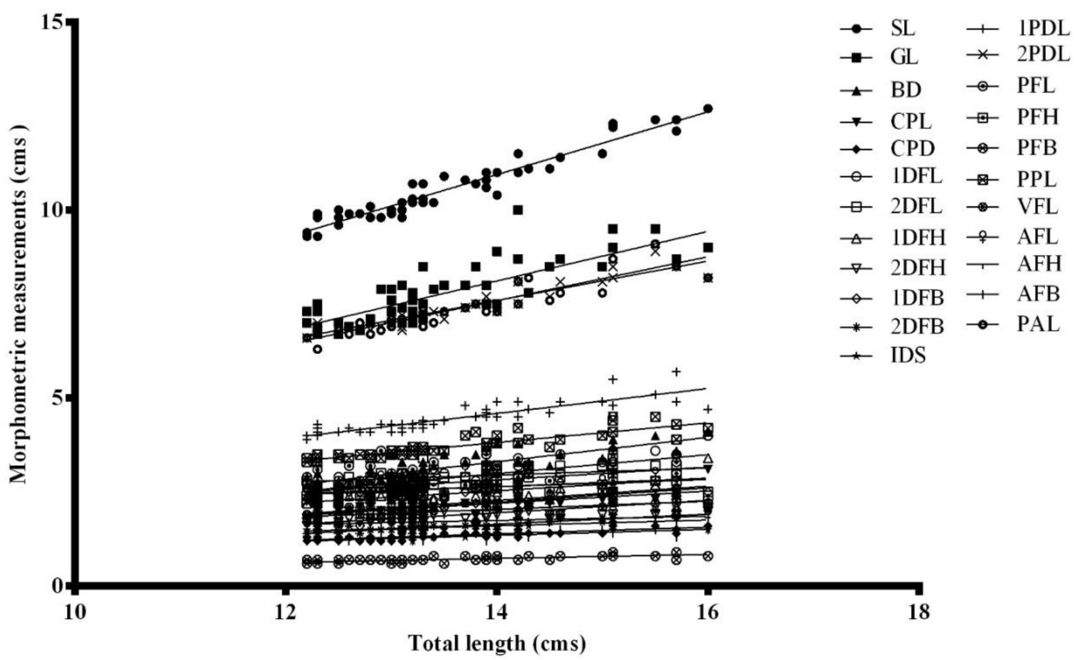

Figure 4

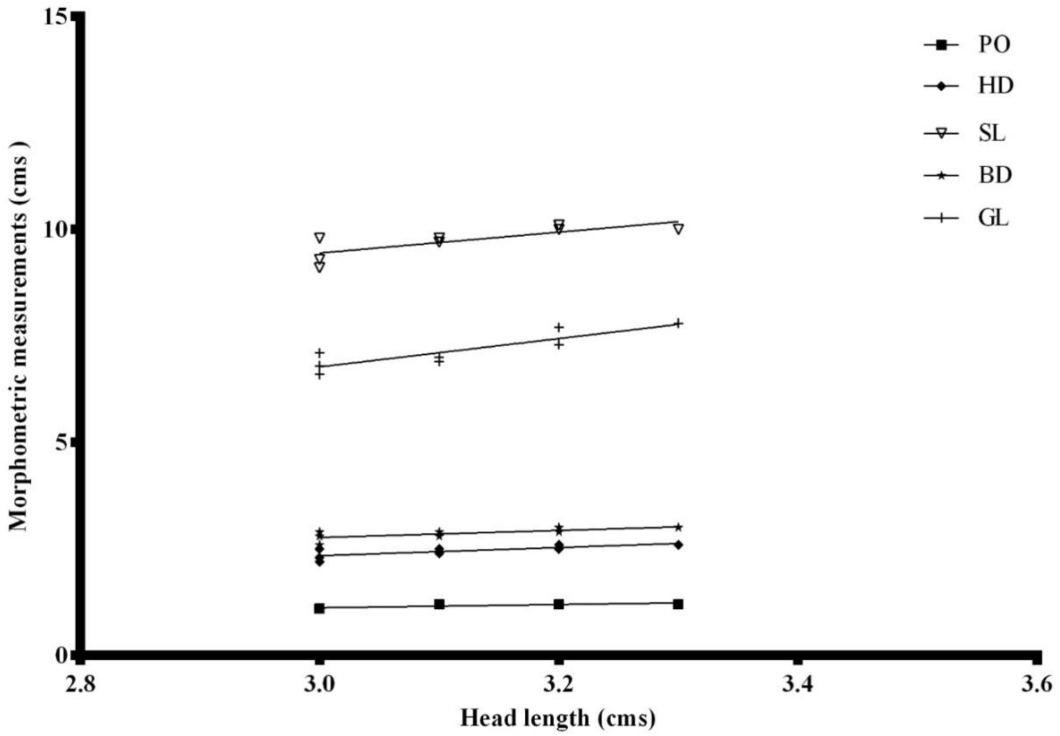

Figure 5

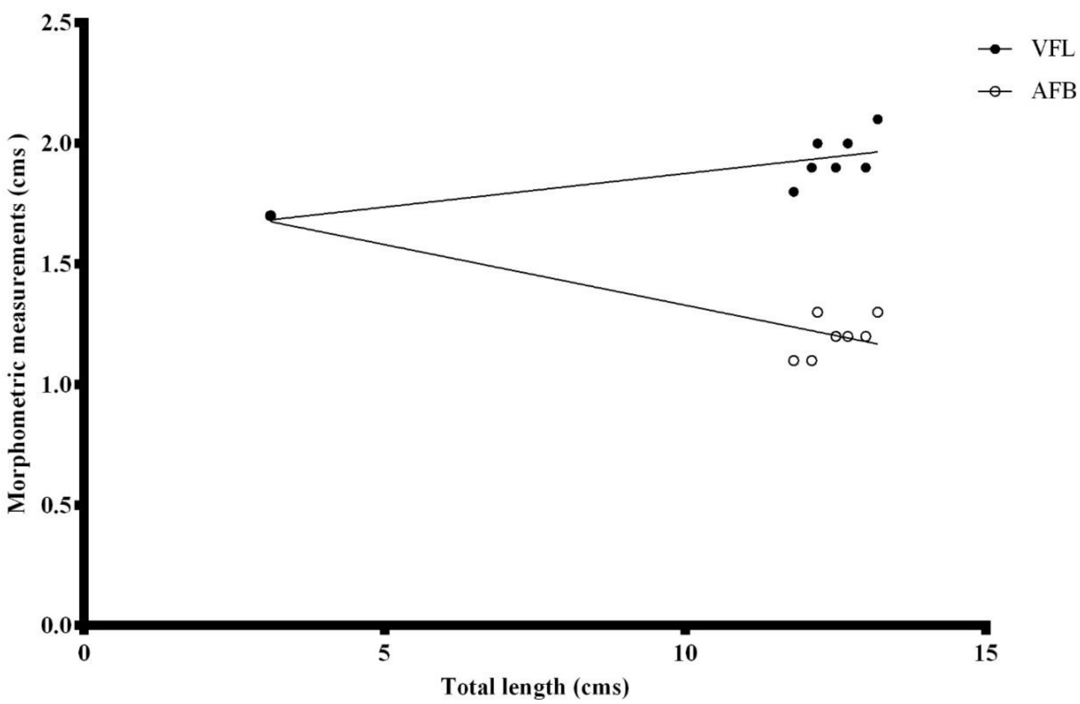

Figure 6

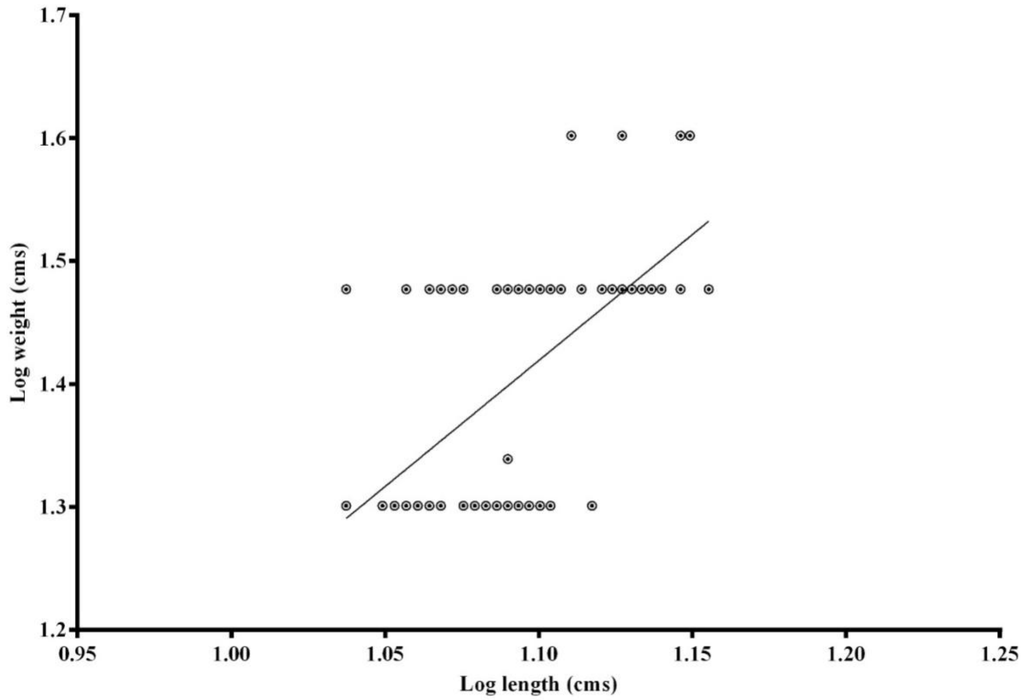

Figure 7

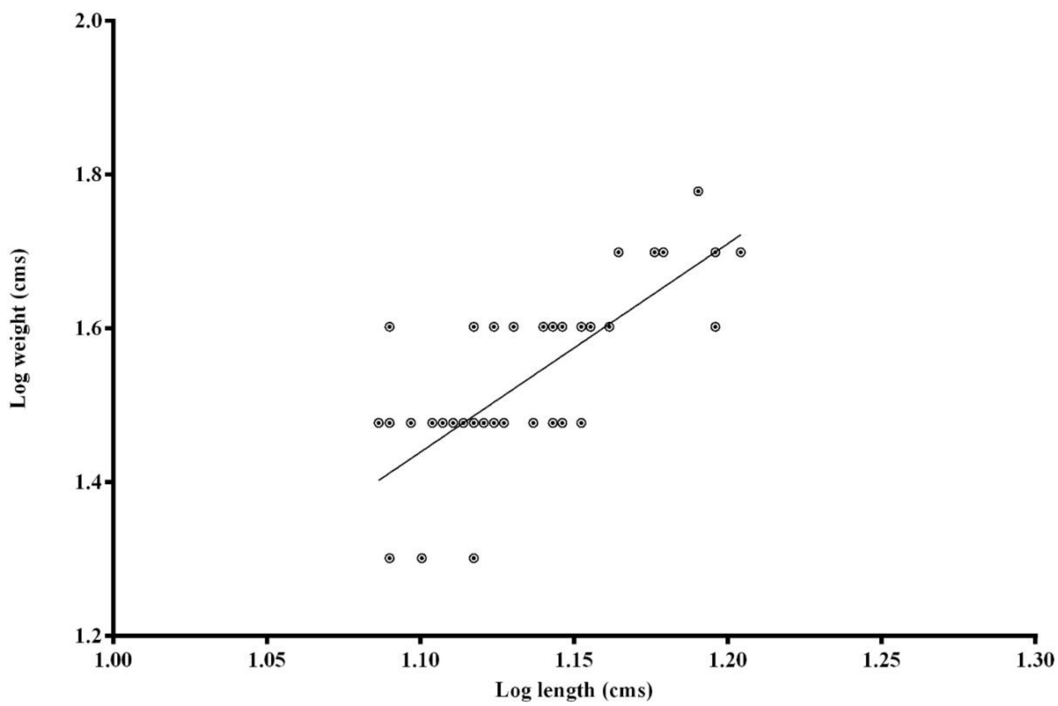

Figure 8

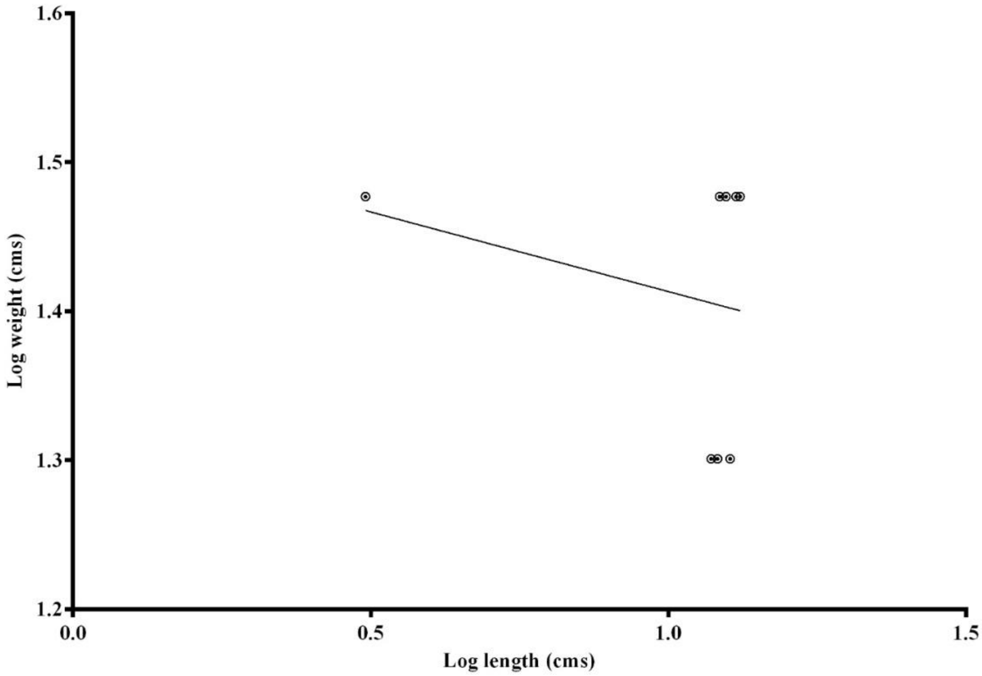

Figure 9

Table 1 Regression values for various morphometric characters (y) as function of head length and total length in *Upeneus sulphureus.*

Regression	Males (n= 89)			Females (n=52)			Juveniles (n=8)		
	(a)	(b)	(r)	(a)	(b)	(r)	(a)	(b)	(r)
HL ED	1.838	1.266	0.597**	2.668	0.682	0.150	2.891	0.227	0.179
HL PO	1.287	1.569	0.706**	2.947	0.307	0.100	1.020	1.800	0.827**
HL PTO	0.481	1.845	0.788**	-0.832	2.725	0.884**	2.191	0.652	0.371
HL IO	2.552	0.530	0.409**	1.309	2.010	0.455**	1.800	1.400	0.643
HL HD	0.832	0.920	0.801**	0.616	1.011	0.553**	1.625	0.607	0.763*
HL OPL	2.361	1.248	0.421**	2.211	1.856	0.348**	2.975	0.250	0.119
HL BL	1.666	0.462	0.707**	1.904	0.426	0.362**	3.122	-0.003	0.007
HL TL	0.021	0.246	0.903**	0.057	0.244	0.575**	3.183	-0.006	0.186
HL SL	0.672	0.249	0.802**	0.312	0.289	0.589**	0.695	0.249	0.780*
HL UJL	1.146	1.499	0.702**	1.397	1.368	0.421**	1.968	0.864	0.680
HL LJL	1.863	1.148	0.615**	1.499	1.645	0.493**	3.259	-0.136	0.107
HL BD	1.172	0.675	0.774**	1.802	0.492	0.452**	1.335	0.621	0.718*
HL GL	1.069	0.287	0.740**	0.910	0.313	0.597**	1.438	0.234	0.882**
TL SL	3.211	0.956	0.837**	1.114	1.774	0.964**	40.167	-2.966	0.312
TL GL	4.677	1.109	0.777**	5.653	1.008	0.815**	35.102	-3.325	0.420

TL BD	4.975	2.642	0.825**	6.772	2.139	0.832**	12.349	-0.358	0.014
TL CPL	4.319	4.043	0.700**	7.218	2.944	0.753**	3.798	3.563	0.132
TL CPD	12.253	0.127	0.208*	3.976	7.093	0.802**	45.480	-27.600	0.426
TL 1DFL	6.925	2.064	0.528**	8.283	1.821	0.678**	23.313	-4.340	0.218
TL 2DFL	8.006	1.643	0.617**	9.996	1.278	0.466**	-4.043	5.939	0.384
TL 1DFH	4.630	3.448	0.697**	6.490	2.860	0.695**	39.124	-11.957	0.457
TL 2DFH	5.987	3.791	0.585**	11.498	1.069	0.418**	9.926	0.783	0.015
TL 1DFB	7.995	2.281	0.621**	8.025	2.582	0.649**	20.259	-4.412	0.251
TL 2DFB	8.494	2.624	0.412**	4.965	5.397	0.845**	20.025	-6.000	0.166
TL IDS	10.497	1.309	0.348**	11.340	1.377	0.324**	11.581	-0.176	0.012
TL 1PDL	2.978	2.345	0.899**	3.230	2.320	0.876**	57.146	-11.210	0.487
TL 2PDL	0.836	1.727	0.933**	1.147	1.685	0.940**	50.545	-5.800	0.505
TL PFL	8.868	1.302	0.667**	11.518	0.681	0.254**	3.281	2.912	0.217
TL PFH	5.293	2.944	0.832**	5.801	2.973	0.575**	6.605	1.897	0.047
TL PFB	8.333	6.317	0.484**	6.567	9.792	0.724**	-9.080	30.800	0.475
TL PPL	2.748	2.904	0.875**	2.355	3.024	0.892**	31.442	-5.917	0.326
TL VFL	7.098	2.758	0.752**	9.366	2.077	0.472**	-27.321	20.207	0.751*
TL VFH	3.901	4.552	0.825**	13.289	0.095	0.135	-29.657	21.429	0.226

TL AFL	8.632	1.545	0.585**	11.066	0.936	0.299*	8.706	1.139	0.077
TL AFH	5.783	4.085	0.681**	11.108	1.391	0.276*	23.700	-7.500	0.169
TL AFB	5.281	5.841	0.651**	3.310	7.801	0.797**	30.659	-15.314	0.877**
TL PAL	2.719	1.456	0.874**	2.827	1.461	0.922**	18.731	-1.112	0.126

** Significant at 1% $p < 0.01$,

* Significant at 5% $p < 0.05$.

	df	∑X2	∑XY	∑Y2	Reg Coeff.	Deviations from Regression		
						df	SS	MS
With in								
1 Males	88	0.0622	0.128	0.8097	2.051	87	0.5478	0.006
2 Females	51	0.0498	0.1350	0.6257	2.712	50	0.2597	0.005
3						137	0.8075	0.006
4 Pooled , W	139	0.112	0.263	1.4354	2.564	138	0.8178	0.006
5			Difference between slopes			1	0.0103	0.0103
6 Between, B	1	0.0414	1.5634	5.3219				
7 W + B	140	0.1534	1.8264	6.7573		139	0.8394	
8			Between adjusted means			1	0.0216	0.0216

Comparison of slopes: F = 0.0103 / 0.006 = 1.7167 (1,137) not significant

Comparison of elevations: F= 0.0216 / 0.006 = 3.6 (1,138) not significant

Table 2 length weight relationship comparison of regression lines in Males and females in *Upeneus sulphureus*.

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