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LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTORS OF THE AFRICAN CATFISH, *CLARIAS GARIEPINUS* (BURCHELL, 1822) IN MATTUPETTY RESERVOIR, SOUTHERN WESTERN GHATS, KERALA, INDIA

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Abstract: The present study discusses the Length-Weight Relationship, Condition factor (*K*) and Relative condition factor(*Kn*)of the aliencatfish *Clarias gariepinus*(Burchell, 1822)from Mattupetty reservoir, one of the premier reservoirs located at the high altitude terrains of Kerala. A total of 52 individuals were measured,size ranging from 16 to 63 cm (SL)and 60 to 2550 gm(Weight).Regression coefficient, 'b'for male, female and sexes combined were not significantly different from the isometric growth coefficient value,3.Correlation coefficient, 'r' for male and female were 0.9939 and 0.9852($p<0.0001$).The meancondition factor (*K*) for male,female and sexes combined during pre-monsoon, monsoon and post-monsoon were greater than one(*K*>1). The mean relative condition factor (*Kn*) for individuals at different seasons was not significantly different. Sexual differences have no significant effect ($p>0.05$) on length-weight relationship (ANCOVA).

Key words:*Clarias gariepinus*, Alien species, Mattupetty reservoir, Length-Weight relationship, *K* Factor, *Kn* Factor, Isometric growth.

INTRODUCTION

Length-weight Relationship of organism reflects their pattern of growth, habitat support, feeding behaviour, competition and survivability. Biomorphometric and meristic studies of endemic, threatened or alien species are more important, enabling to make out strategic stands against their vulnerability. Invasive alien species (IAS) are regarded as the second major cause for native and endemic species extinction globally (Wilcove *et al*., 1998), introduced mainly for improving fishery, ornamental fish trade ,bio-control of mosquitoes and sport fishing (Biju Kumar, 2000).The impact of invasive species on ecosystem is receivingmuch attention due to their detrimental ecological instability. The consequences of Aquatic Invasive Species are far reaching, including degradation of water quality, food-web disruptions, depletion of native biodiversity, as well as secondary economic impacts on fishing, tourism, and other related industries.

The Western Ghats is home to some of the world's most unique fauna, flora and fungi, as compared to the other biodiversity hotspots. The gene pool diversity of the freshwater ecosystems within the Western Ghats region is unique and has immense importance to livelihoods and economies. The Western Ghats have lost nearly 50% of forest cover since the early 1900s and has resulted in the extirpation of local populations of several species and groups of terrestrial and freshwater fauna (Molur, 2009). Majority of the Western Ghats freshwater fishes including endemic species are being enlisted in the threatened category of IUCN Red List (Dahanukar, 2011). Invasive alien species has a pivotal role to make dynamic, deleterious changes on biological diversity (Ciruna *et al*., 2004; MEA, 2005; Vié *et al.,* 2009), causing species endangerment and further into extinction in the freshwater ecosystem particularly (Claudi and Leach, 1999; Harrison and Stiassny, 1999; Sala *et*

al., 2000; Bijukumar, 2000).This study also looks into the Length- Weight Relationship(LWR) and condition factors of an alien catfish *Clariasgariepinus*, never been studied beforein Mattupetty reservoir.

MATERIALS AND METHODS

Study area

Mattupetty reservoir (10Ú 6 16 N 77Ú7 25 E) is a concrete gravity dam situated 15 km east of Munnar, a popular hill station at the humid tropical region (Koppen's classification)of the Southern Western Ghats (Fig.1). The reservoirhas a total surface area of 323.75 hectares, drains a catchment area of 105 sq. km. Further, it maintains the total capacity of 55.4 million m^3 of water at full reservoir level. Since, it is located at an altitude of 1700m above MSL,the region shows a mean annual temperature of 18ÚC and mean annual rainfall of 2012 mm (Thomas, 2012).

The collection sites were Echo-point, Puthukkudy and Santoz.The distance between Echo-point,Puthukkudy and Santoz is ~4 and~1.5 km respectively. The tail water from the reservoir drains to Ramasamy Aiyer Headworks at Munnar and to Pallivasal Hydro Electric Project and then to Shengulam reservoir and later drains after passing through a chain of reservoirs, intothe Periyar, a prominent river system of the Western Ghats.

Sampling and Analysis

Bimonthly sampling was carried out during November 2013 to October 2014at three different stations towards the upstream end of the reservoir *viz*., Echo point, Puthukkudy and Santoz. In addition to gill net (Fig. 2), fishing was conducted at morning (08-00-11-30) and evening (15-00-18-30) hours using hook & line, baited with flesh of sardine. The fatness or degree of well-beingof fishes was calculated using the formula, $K = 100\ W/L^3$(Fulton,1904),where *K*= Fulton's condition factor, W = total body weight (mg), L = standard length (mm). The Relative condition factor,*Kn* = W/^W, where W = observed weight, ^W = calculated weight derived from length-weight relationship.The Length-Weight Relationship (LWR) was measured by using the equation, $W=aL^b$ (Le Cren, 1951), where W=weight of the fish (mg), L= standard length of fish (mm), a= regression constant / intercept, b= regression coefficient / slope. The value of 'b' may vary from 2.5 to 4.0 (Hile, 1936 and Martin, 1949), but it is '3'in the case of an ideal fish (Allen, 1938).The equation was transformed into a logarithmic form,Log W= Log a+b Log L ('a'and 'b' were measured empirically).ANCOVA (Snedecor and Cochran, 1967) was employed to determine whether there were any significant differences in the length-weight relationship.

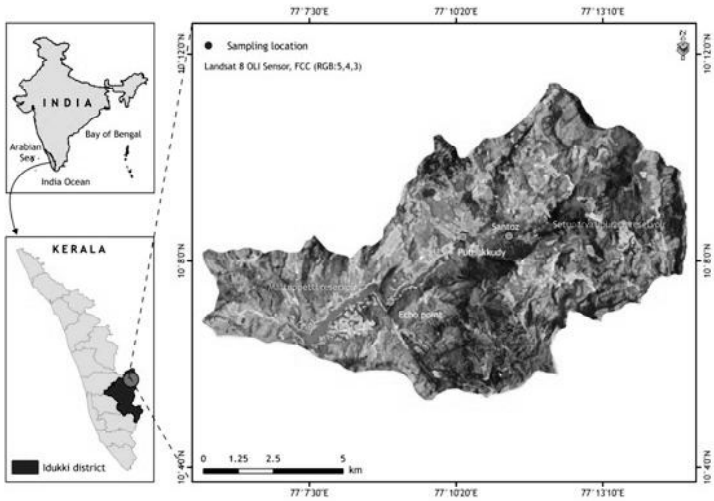

Fig. 1. Map of Mattupetty reservoir showing sampling stations.

Fig. 2. Gill netting at Puthukkudy station

The total length of fishes was measured to the nearest mm by using measuring board and the weight to the nearest gram by using a weighing balance. Statistical analysis of data for the estimation of Regression Coefficient(b), Pearson Correlation Coefficient(r) and ANCOVA(at 0.05 level of significance) were carried out with Microsoft Excel(2007) and SPSS 16.0.

RESULTS

A total of 52 individuals of *C. gariepinus* with standard length ranging from 160– 630(mm) were collected and measured from three sampling stations. Scatter diagram of Length-Weight Relationship was plotted separately for males (Fig. 3), females (Fig. 4) and combined sexes (Fig. 5).Regression coefficient, 'b' for male and female were 2.9614 and 2.9056 whereasCorrelation coefficient, 'r' for male and female were 0.9939 and 0.9852(Table 1). The t-test of found 'b' values were not significant ($p>0.05$) and hence the fish grows isometrically. Correlation coefficient, 'r' forlength and body weight ($p< 0.0001$) was linear and highly significant. Condition Factor (*K*) and the Relative Condition Factor (*Kn)* for male, female and sexes combined during pre-monsoon, monsoon and post-monsoon were calculated (Fig. 6). The mean '*K*' for males and females during all seasons recorded the values greater than one($K>1$). The highest mean values of '*Kn*' for males and females were found to be 2.45 and 2.5 during monsoon and post-monsoon whereas the lowest values of 1.99 and 2.28 for males and females were recorded during pre-monsoon.ANCOVA of length-weight relationship was not significant ($p>0.05$) between sexes.

DISCUSSION

C. gariepinus(Burchell, 1822), an alien catfish native to Africa (Jubb, 1967) reached the South Indian State of Kerala in 1993 or early 1994 (Middendorp, 1998) and now it expands indiscriminately to all aquatic realms of the State including the sub-terrain areas (Raghavan, 2011) due to the prevailing unlawful aquaculture practices and ineffective fisheries management.It is a fast growing animal and its growth rate depends on the nature of habitat and its ambient water conditions (Bruton and Allanson, 1980; Hecht and Appelbaum, 1987; Britz and Pienaar, 1992).Aquaculture has a leading role in further expansion of *C. gariepinus* globally (Cambray, 2005). In Kerala *C. gariepinus* has been observed from the river Periyar (Periyar Foundation, 2006; Sudhi, 2009), a major biodiversity hotspot and an excellent habitat for several endemic and endangered species. Kurup *et al*., (2004) reported the presence of *C. gariepinus*in the aquaculture farms of Kuttanad located along the Vembanad Lake, Gopi and Radhakrishnan (2002) reported their presenceat Manalur and then Krishnakumar *et al*.(2011) identified their occurrence in the Vembanad Lake, one of the Ramsar sites of Kerala.

Length-weight relationship of fishes offers a couple of information including their pattern of

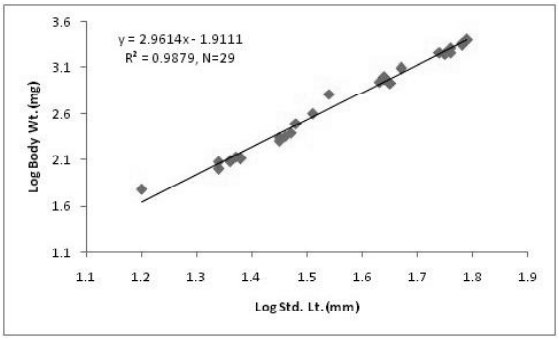

Fig. 3. Length- Weight Relationship of *Clarias gariepinus* (Male).

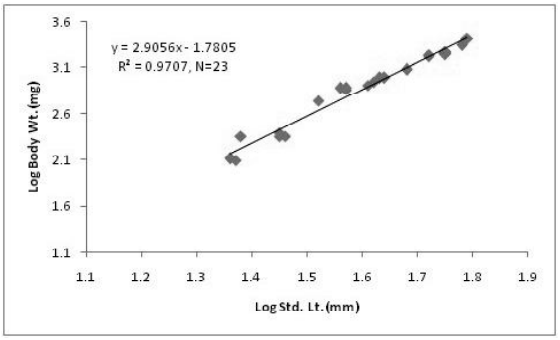

Fig. 4. Length- Weight Relationship of *Clarias gariepinus* (Female).

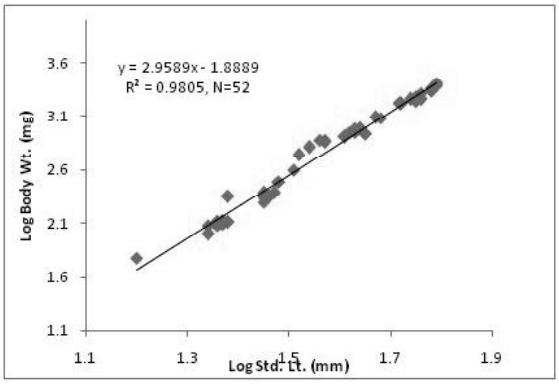

Fig. 5. Length- Weight Relationship of *Clarias gariepinus* (Combined).

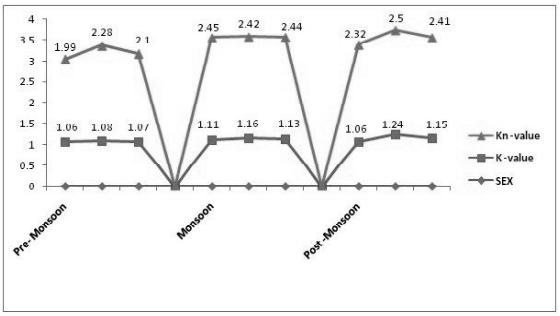

Fig. 6. Line graph showing Mean Condition Factor(K) and Mean Relative ConditionFactor(Kn) of male, female and combined sexes of *C.gariepinus* individuals during three seasons.

Table 1. Regression analysis and for males, females and combined sexes of *C. gariepinus*.

SEX	N	SL. (cm) min.-max.	TBWT.(gm) min.-max.	Mean *'K'*	Mean *'Kn'*	b	r
Male	29	16-62	60-2480	1.08	2.27	2.9614	0.9939
Female	23	23-63	125-2550	1.16	2.43	2.9056	0.9852
Combined	52	16-63	60-2550	1.12	2.34	2.9589	0.9902

growth and stages of life cycle. This statistical data is often important to determine their population structure and their interaction with the habitat where they are living. Notable observations of Clay (1979),Eyo and Mgbenka(1992), Anyanwu *etal*.(2007), Akinwole and Faturoti(2007),Davies *et al*.(2013), Yusuf *et al*.(2013), Kembenya *et al*.(2014) and Keyombe *et al*.(2015) illustrates the LWR and condition factor and biology of *C. gariepinus* globally. LWR of *C. gariepinus* in Mattupetty reservoir justifies itssound biological status and hence it makes the reservoir a unique aquatic ecosystem with vulnerable condition.The 'b'value of males, females, and sexes combined was 2.9614, 2.9056 and 2.9589 and hence the values were not significant ($p>0.05$) in the t- test analysis. But 'b' values obtained from this study is not significantly different from '3'

(Isometric coefficient value), hence fish grows isometrically. Isometric growth generally refers to increase in body weight with increase in length, whereas b>3 orb<3 indicates positive or negative allometric growth respectively. The 'b' value is directly linked with the weight affected by various factors including ecological and biological conditions (Ricker, 1973).Thevalue of 'r'for combined sexes with SL(mm) ranged between160-630 was 0.9902. Hence the relationship was linear and significant.

Condition factor (*K*) is a useful measure to determine the well-being of the fish as well as other variables such as growth pattern, reproductive maturation, ecosystem health, climatic variations etc.The mean '*K'* value of sexes combined during pre-monsoon, monsoon and post-monsoon was 1.07, 1.14 and 1.15.Higher '*K'* value (*K*>1) of *C. gariepinus*individuals indicates that the environmental conditions in the reservoirare conducive for their growth.The slight difference in the mean '*Kn'* during the seasons may be due to the process of gonadal maturation and spawning strain. Gonadal maturation in *C. gariepinus* is usually associated with monsoon (Safriel and Bruton, 1984; Davies *et al*., 2013). The variations in '*Kn'* value accompanied with the size ranges were noticed.The individual female fish with size class 63cm-2550gm recorded the highest '*Kn'*(2.96)during the post-monsoon while the lowest '*Kn'*(1.33) for male(16cm-60gm) was recorded during pre-monsoon. The fluctuations in the '*Kn*' values not only related to reproductive cycle but directly or indirectly linked with various other factors including feeding , rhythm(Hile, 1936; Quasim,1973a; Blackburn,1950) and due to growth rate reduction etc. In *C.gariepinus*the growth rate of females decreases after attaining 3 years (Skelton, 2001).Forinstance, in this case it is clear that the variations in '*Kn'* values for both sexes at different seasons are not significantly different, indicating that the metabolic strain experienced by males as well as females is almost same.Analysis of covariance, ANCOVA showed that the differences in length of *C. gariepinus* have significant impact ($p<0.05$) on the total body weight of the fish while the sexual differences have no such statistically significant influence ($p>0.05$) on length and weight of the fish.

An array of unratified reasons supports the occurrence of *C. gariepinus* in Mattupetty reservoir, since it regarded as a major aquaculture and ecotourism destination of the State of Kerala. It might be due to the flooding and following escape of reared individuals from aquaculture farms or artificial ponds situated along the catchment area, ignorance on handling live specimens by sellers/ buyers or sometimes, a deliberate release by locals. The authors have also observed the live fish trade in the premises of the reservoir.The drain outwater from the reservoir during the late premonsoon might be another cause for the occurrence of this alien species at downstream water bodies particularly in the adjacent reservoirs and canals and also throughout the Periyar River System.Sport fisherscarrying live specimens of *C. gariepinus*for introduction in their distant natural water bodies,expecting high commercial benefits is another dreadful aspect to be discussedand debated,if we serious about the conservation of indigenous gene pools.

.The mechanism to curtail the impact of this alien species in our ecosystems has not been thought of adequately and the uncontrolled spread of the alien species is a tribute to our poormanagement practices.The effective way to eradicate this species is the use of degenerative chemicals (Omitoyin, 2006),which is undesirable, due to its long reaching impacts and effects on non target organisms.Attempting the eradication of this population by ensuring the assistance of local people during the dam draining period, can be a feasible intervention.The catastrophic aquaculture practices of Kerala, mismanagement of reservoir fisheries, illiteracy of the public on the need for conservation of natural resources and lack of inter departmental co-ordination in resource management etchave to be examined.In addition to the stringent implementation of the existing aquaculture legislations and awareness programmes for the stakeholders and public; the adverse ecological impact of exotic species introduction has to become the priority of planners and policy makers for any feasible solution to this malice. If not, we will have to preserve the photographs of our endemic fishes for oncoming gen

erations. Scientifically designed risk assessment procedures, prior to the introduction of invasive alien species, enables one to ascertain whether the introduction is desirable or not, with emphasis mainly on prevention better than cure (CBD, 2001).

Even though *C. gariepinus* is a wide spread alien species in Kerala, only limited case studies have been reported so far. Absence of ideological and interventional harmony between the Forest, Fisheries and Electricity Departments of the State is the real enigma which hampers the studies and management of reservoir fisheries, contributing to the depletion the fish diversity. We hope that the present study could be a reference tool to those who are desirous of carving out comprehensive conservation policies.

CONCLUSION

The data obtained from this study reveals that *C.gariepinus* has already established a feral population inMattupetty reservoir. The statistical inferences on length-weight relationship and condition factors presented here provide important information about their well-being and isometric growth pattern and also give a testimony to the mismanagement in reservoir fisheries and associating ecological uncertainties.

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