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Biometry analysis, length-weight relationship and sexual dimorphism of the Spotted Scat, *Scatophagus argus* (Linnaeus, 1766) (Perciformes: Scatophagidae) from Gulf of Mannar, southeast coast of India

V.Gandhi[1], V.Venkatesan* and P.U. Zacharia
Central Marine Fisheries Research Institute, P.B. No. 1603, Kochi - 682018, India.
[1]Regional Centre of Central Marine Fisheries Research Institute, Mandapam Camp - 623520, India

*Correspondence e-mail: venkatcmfri@yahoo.co.in

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Original Article

Abstract

A total of 1,659 specimens of spotted scat were collected from commercial landings in Mandapam along Gulf of Mannar for studying biometry, length-weight relationship and sexual dimorphism. Biometry was carried out to analyse the growth rate of body parts in relation to the standard length. Fourteen morphometric characteristics were examined. The study revealed that the fastest growth rate was in depth of the body followed by pre-dorsal and pre-anal length and lowest in the eye diameter. The length-weight relationship was also carried out for 1,141 females ranging in TL from 140 - 340 mm and 518 males in the range of 50 - 117 mm. The equation of $W = 0.005373\ L^{2.842}$ and $W = 0.002152\ L^{2.479}$were derived for male and female respectively. The relationship revealed that the value of exponent ''b'' was considerably below 3, which might be due to the deep, strongly compressed body. Analysis of covariance revealed that there were significant differences ($P< 0.01$) between sexes. Male and female spotted scat could be differentiated by head shape and colour of body. Females were larger and heavier than males of the same length group.

Keywords: *Scatophagus argus, biometry, length-weight relationship, sexual dimorphism, Gulf of Mannar.*

Introduction

The spotted scat, *Scatophagus argus* (Linnaeus, 1766), (Perciformes: Scatophagidae) is a euryhaline teleost which is widely distributed throughout the near shore waters of Indo-Pacific region (Nelson, 1976). Because of its attractive pattern, this species is a popular candidate species in aquarium (Morgan, 1983) and is an important food fish in Southeast Asia (Musikasung *et al.*, 2006).

Morphometric and meristic characters are important to identify fish species and their habitat peculiarities as well as ecological criteria in any stream, lake or sea (Karatas, 2005). Length-weight relationship (LWR) is essential in stock assessment models and in estimation of the weight from length observations, as well as in an estimate of fish population condition (Moutopoulos and Stergiou, 2002) and comparisons among populations of the same species from different habitats or regions (Richter *et al.*, 2000). Sexual dimorphism study is of great significance as it is a preliminary step to distinguish the gender. The study on sexual dimorphism has been carried out only in few species of fishes in India (Jency *et al.*, 2008) No information on the biometry, LWR and sexual dimorphism of spotted scat in Indian waters are available in literature except the study of Jency *et al.*, (2008) on sexual dimorphism in the estuarine region of Kerala.

This study aims to contribute to a better knowledge of the biometry, LWR and sexual dimorphism of the spotted scat, collected from Mandapam waters along Gulf of Mannar. Biometric study is carried out to find out the relationship between various morphometric characters and standard length.

Material and methods

A total of 1,659 specimens were analyzed for the biometric characteristics, LWR and sexual dimorphism. Specimens for the study were collected from the fish landing centers in and around Mandapam region (09º16'43.1"N, 79º09'44.4"E) of the Gulf of Mannar, fortnightly for a period of one year from January to December, 1996. specimens of *S. argus* were collected by different types of nets such as shore seines, barrier nets, cast nets, gill nets, trawl nets and special drag nets locally called *Vidu valai*.

Freshly collected specimens were brought to the laboratory and utilized for the study. Total length, standard length, dorsal and anal fin length were measured to the nearest 1 mm using a regular fish ruler. The other morphometric variables were determined using digital calipers to the nearest 0.1 mm. Sex was determined through naked eye according to the appearance of the gonads. The colour pattern in sexes was noted in fresh condition itself. 14 morphometric features were measured for biometric study by following the method of McKay (1985). Snout length (LS), head length (HL), eye diameter (O), pre-orbital length (PO), post-orbital length (OLO), inter-orbital space (IO), pre-dorsal length (PD), pre-anal length (PA), depth of body (H), pectoral fin length (LP), ventral fin length (LV), 3rd dorsal spine length (L3DS), second anal spine length (L2AS) and depth at caudal peduncle (h) were taken into account for the biometric study. Abbreviations of the morphometric variables measured and their indications on the fish body are given in Fig.1. The power function $Y = aX^b$ was used to evaluate growth-related changes in morphology in relation to standard length (SL). The differential increase in allometric growth of each variable relative to SL was calculated from the function $Y=aSL^b$ using the first derivative with respect to the standard length $dY/dSL = a.b.SL^{b-1}$, where 'a' and 'b' are constants and Y is the morphometric variable (Minos *et al.*, 1995). Data were log (10) transformed and least-square regression analysis was applied to calculate the parameters of the allometric equation of each variable versus SL. The significance of the slope was tested by means of a t-test. The morphometric variables were then divided into three categories: positive allometry (+A), when the slope (b) was significantly higher than 1 and the variable increased relatively to SL; negative allometry (-A), when the slope was significantly lower than 1 and the variable decreased relative to SL; and isometry (I) when the slope showed a non significant difference from 1, indicating direct proportionality between the variable and SL. The analysis for the normal distribution features was carried out based on Pearson linear correlation coefficient (Minos *et al.*, 1995).

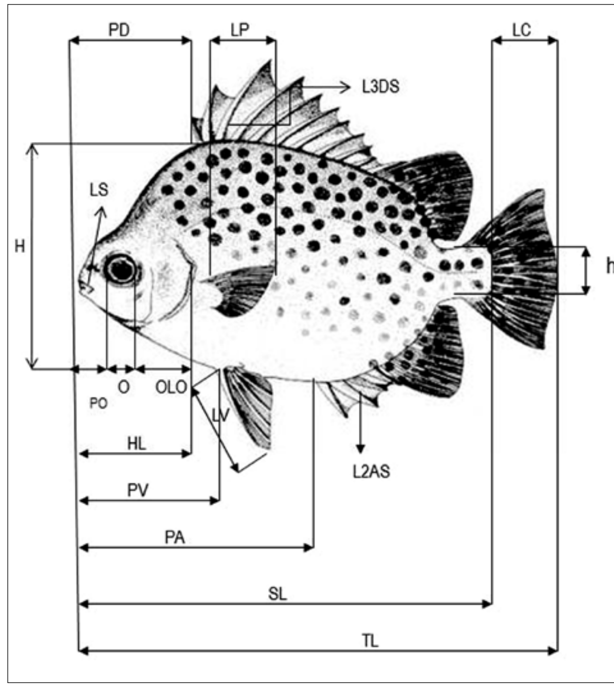

Fig.1. Morphometric characteristics of the Scatophagus argus: total length (TL), standard length (SL), Head length (HL), Snout length (LS) eye diameter (O), pre-orbital length (PO), post-orbital length (OLO), inter-orbital space (IO), pre-dorsal length (PD), pre-anal length (PA), depth of body (H), pectoral fin length (LP),ventral fin length (LV), 3rd dorsal spine length (L3DS), Second anal spine length (L2AS) and depth at caudal peduncle (h)

The LWR was calculated using the expression: $W = a L^b$, where W is the weight (g), L the total length (mm), 'a' the intercept of the regression and 'b' is the regression coefficient (Hayes *et al.*, 1995). Parameters 'a' and 'b' of the LWR were estimated by linear regression analysis based on logarithms: (Le Cren, 1951).

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

Analysis of covariance was carried out (Snedecor and Cochran, 1967) to test the equality of length-weight relationship between males and females. The significance of the slope was tested by comparing the slope with the expected slope of 3.0 under isometric growth using t-test.

Results and discussion

Data on fourteen morphometric characters of randomly selected fish samples were taken and these are presented in Table 1. The analysis of relation between SL and other morphometric characters revealed the highest correlation between: SL and H (b = 0.932) and SL and PA (b = 0.826).

A fairly high correlation was also noted for such pairs of features as: SL and PD, SL and HL, SL and OLO as well as SL and LV (the 'r' value is ≥ 0.5). This analysis also revealed that the depth of body (H) had the fastest growth rate followed by pre-anal (PA) and pre-dorsal lengths (PD). The head has been considered one of the most morphometrically variable parts of fish body (Gąsowska, 1973). Growth in 'PA' and 'PD' may directly derive from growth in 'H'. A small narrow head apparently favours the ingestion of small algae, zooplankton and nibbling of large macrophytes. Snout length (LS) grew faster than eye diameter (O). A close proximity of the eyes could be indicative that these organs are usually larger and closer to the mouth region, which is a clear advantage for detection of prey associated with the water column. Growth of snout is required because of its feeding habit. Kozikowska (1961) suggested that the values of the eye diameter might be influenced not only by the depth but also by the transparency of water. Head length (HL) showed better growth rate than pre-orbital length (PD), post-orbital length (OLO) and inter-orbital space (IO). Variations in 'IO' and 'OLO' may directly derive from growth in head length (HL). A comparison of the relative growth of fin revealed that pelvic fin (LV) grew faster than pectoral fin (LP). Gosline (1996) has already documented the importance of pelvic fins in batrachoidids fish. Costa *et al*. (1992) stated that the high development of pelvic fins seems to be a very helpful characteristic for the detection and capture of fast prey associated with the water column. Costa *et al*. (2003) observed that the pelvic fins are also important for a rapid projection of toadfishes in the water column when they are immobilised at the bottom. Third dorsal spine (L_3DS) grew better than 2nd anal spine (L_2AS). The diagnostic value of the measurements related to the body width (H) is of higher significance and probably dependent on the fish and environmental conditions.

In the present study, it was observed that snout to anal and ventral origin had slightly faster rate of growth compared to snout to dorsal origin. Gandhi *et al*. (1986) found the contrary in the Milkfish *Chanos chanos* that the snout to anal or ventral origin had the fastest growth rate while the snout to dorsal had the slowest. This morphological change could be related to the fact that Milkfish has an elongated body whereas spotted scat has a strongly compressed body. Morphometric relationships of all the characters with standard length had growth rates in the descending order (-A) (Table 1). All the morphological differences are possibly due to the variability of the habitats (Nicolsky, 1963). Our results show that the biometric measurements are different from each other for the same species. The biometric measurements vary geographically and could be related to abiotic and biotic factors in the habitat. In description of species, knowledge of its biometry is necessary especially because specimens from different areas differ in the growth rate of their body parts from one another in morphology.

A total of 1,659 fishes were used for studying LWR, of which 1,141 were females ranging in length from 124 - 340 mm and 518 were males ranging in length from 50-147 mm.

Table-1 Variations in morphometric measurements of spotted scat. Values given are from the equation Y= aXb. a, b, parameters of the equation; r2, coefficient of determination; r, correlation coefficient; SD, standard deviation; Slope patterns are: +A, positive allometry; - A, negative allometry; I, isometry

Dimension	a	b	r	r^2 (%)	Mean	SD	Slope(b)
LS	2.26	0.0803	0.377	0.142	12.29	5.07	-A
HL	5.63	0.2678	0.608*	0.370	39.07	16.06	-A
O	2.92	0.0570	0.306	0.094	10.04	3.63	-A
PO	-3.43	0.1314	0.408	0.166	12.97	7.77	-A
OLO	1.20	0.1429	0.512*	0.262	19.04	8.44	-A
IO	2.06	0.1389	0.423	0.179	19.40	8.27	-A
PD	8.20	0.4403	0.770*	0.593	63.17	26.05	-A
PA	-3.32	0.5119	0.826*	0.682	60.60	37.32	-A
H	3.25	0.6359	0.932*	0.869	82.64	38.28	-A
LP	4.42	0.1359	0.416*	0.173	21.01	8.59	-A
LV	5.73	0.2267	0.552*	0.305	34.04	14.07	-A
L3DS	4.99	0.1781	0.518	0.268	27.23	11.19	-A
L2AS	3.08	0.0989	0.407	0.166	15.43	6.16	-A
h	1.19	0.1395	0.426	0.181	18.61	8.24	-A

* the spearman rank correlation coefficient

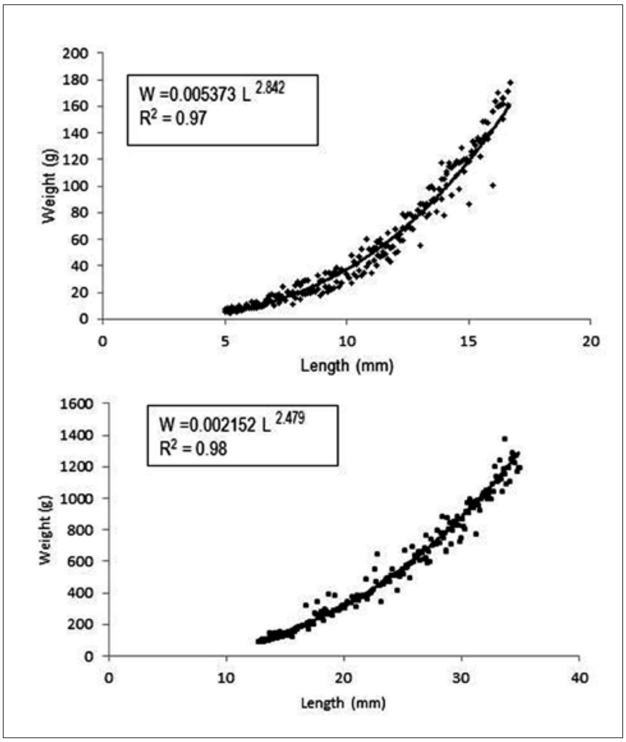

Fig. 2. Scatter plot of length vs. weight of *Scatophagus argus* for male (upper graph) and female (lower graph) in the Gulf of Mannar.

The relationships between the total length and weight were estimated for each sex separately (Fig. 2). The ANCOVA showed significant difference ($P < 0.01$) between sexes hence, the following equations were established for respective sex.

Male : $W = 0.005373\ L^{2.842}$ ($r^2 = 0.97$, $n = 518$)

Female : $W = 0.002152\ L^{2.479}$ ($r^2 = 0.98$, $n = 1141$)

Regression equation revealed that the value of $b = 2.842$ (♂) and 2.479 (♀) are significantly different from 3, indicating that LWR of this species depart significantly from isometry (t-test, $P < 0.05$). The 'b' values of spotted scats were quite similar to that observed by Barry and Fast (1992) for the same species in southern coastal waters of Anay Island, Philippines. The value of 'b' may range between 2.5 and 3.5 (Pauly and Gayanilo, 1997). The slopes (b) of the regressions were less than 3 for both the sexes, hence growth in the individual sex was found to be negative allometric which might be due to the deep, strongly laterally compressed body of spotted scat. Negative allometric growth ($b<3$) as noted in the present study was also observed in other fishes of laterally compressed body (Vaitheeswaran and Venkataramani, 2008 in *Odonus niger*; Wassef and Abdul-Hadry, 2001 in *Siganus canaliculatus*). Wootton (1992) stated that allometric growth is negative ($b<3$) if the fish gets relatively thinner as it grows larger, and positive ($b>3$) if it gets plumper as it grows larger.

Several earlier workers (Day, 1878; Munro, 1982; Carcassion, 1977) described the body colour of the species, but did not differentiate colour based on sex. Male and female butterfishes can be differentiated by head shape and colour of body. The male has a concave curvature of the head above the eye and darker olive green colour body, whereas the head profile ascends at a constant slope in female and it has a lighter olive green colour body. These findings are in conformity with that of Barry and Fast (1992). The tip of the ventral fin is black in female while in male such coloration is not noticed. In mature female, body with basal portion of all fins except first dorsal fin, pectoral and pelvic fin are tinched with pale greenish blue colour whereas in male, it is pinkish tinge. Females are larger and heavier than male of the same length group. These observations were supported by Jency *et al*., (2008) while studying the same species. Females tend to have larger gonads than males with large yolk rich eggs, whereas males have much smaller gonads that produce numerous smaller sperms (Andersson, 1994). Reimchen and Nosil (2004) stated that sexual dimorphism can be influenced by sex-specific natural selection resulting from ecological differences between sexes. Minos *et al*. (2008) while studying in red porgy stated that the dimorphic characters may reflect the adaptation of males and females to different social or/ and reproductive roles rather than different niche utilization.

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