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Truss morphometry in the Asian seabass - *Lates calcarifer*

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Abstract

Truss network analysis was carried out using data of the Asian seabass *Lates calcarifer* sampled from five different locations along the Indian coast, in an effort to examine the stock differences based on juveniles/ pre-adults. Principal Components Analysis was carried out on the multivariate morphometric data. Shearing was done in order to obtain a size-free shape component. It was observed that the first factor loadings were positive and nearly of the same magnitude indicating that PC I is a measure of size. A few truss measurements contributed to the shape differences among the stocks. As far as the shape differences are concerned, the Kakdwip stock was different from the rest of the stocks. A similar trend was discernible in the Chennai stock. However, there were no shape differences among the Chilka, Kakinada and Goa stocks.

Keywords: Asian seabass, truss morphometry, *Lates calcarifer*

Introduction

The Asian Seabass *Lates calcarifer* belongs to the family Centropomidae and is distributed along the East and West coasts of India. In the East coast, it is abundant in West Bengal, Orissa, Andhra Pradesh and Tamil Nadu. In the West, it is found in parts of Kerala, Goa and Maharashtra. It is euryhaline and catadromous, the adults spawning in estuarine waters. It is a protandrous hermaphrodite. The larvae are found in estuaries for sometime, after which they migrate to the sea.

Before going in for a breeding programme, a fish breeder is ought to know the genetic make-up of the stocks as it would help in identifying the traits for which the stocks may be superior or inferior. In fish, morphometry has been used as a tool for measuring traits, especially related to body form. Usually, the morphometric studies have been restricted to the conventional measurements and their analyses. However, there has been a lot of debate concerning the appropriateness of their use (Atchley *et al.*, 1976; Corruccini, 1977; Mosimann and James, 1977; Hills, 1978; Dodson, 1978; Albrecht, 1978; Atchley and Anderson, 1978 and Atchley, 1978).

The Truss Network Analysis overcomes the disadvantages of conventional data sets and this method produces a more systematic geometric characterization of fish shape and has demonstrated increasing resolving power for describing inter-specific shape differences. (Humphries *et al.*, 1981; Strauss and Bookstein, 1982). Winans (1984) compared the conventional and truss network in juveniles of Chinook Salmon (*Oncorhynchus tshawytscha*) in an effort to study stock differences through shape change. He opined that the expression of morphometric covariability is influenced to some degree by the nature and timing of environmental variation during development. The concordance of the two results from the multivariate analyses on one genetic stock grown in two separate hatchery environments in his study suggested the presence of a distinct and desirable shape change in the early development of Chinook Salmon. The author further opined that the notion of using measures of multivariate morphometric variation to discern stock differentiation of juvenile Chinook Salmon, has been tested. Loy *et al.* (2000) studied the geometric morphometrics and internal anatomy in juvenile and adult European Sea bass *Dicentrarchus labrax* The authors reported that shape differences between groups decrease during growth and morphological variability is higher in juvenile stages relative to adults.

In India, the Central Institute of Brackishwater Aquaculture at Chennai, has been successful in breeding the Asian Seabass in captivity. The production of larvae has been standardized (Thirunavukkarasu *et al.*, 2001). However, there is an urgent need to study the different stocks that are available in our coastline. The information thus gained would be very much helpful in planning a selective breeding programme for this species. Hence, the present study examines the stock differences in juvenile/pre-adult *Lates calcarifer* obtained from different locations in the East and West coasts of India, through truss network analysis using the concept of size and shape.

Materials and methods

Truss network measurement data were obtained from *L. calcarifer* collected from four locations viz., Chennai (Tamil Nadu), Kakinada (Andhra Pradesh), Chilka Lake (Orissa) and Kakdwip (West Bengal) in the East Coast and from Goa region in the West Coast. A total of 436 juveniles/pre-adults have been collected (Table 1). The freshly caught specimens were placed on a water-resistant paper and the body posture and fins were teased into a natural position to identify the landmarks (Fig.1). There are five landmarks in the dorsal and a similar number in the ventral side. At the point of the landmark, a hole was made on the water-resistant paper, using a dissecting needle. After the landmarks were recorded the specimen was removed. These points were then transferred to a graph sheet and the X-Y co-ordinate data were collected. The co-ordinates were then used to calculate the truss network distances between pairs of landmarks using the Pythagorean Theorem.

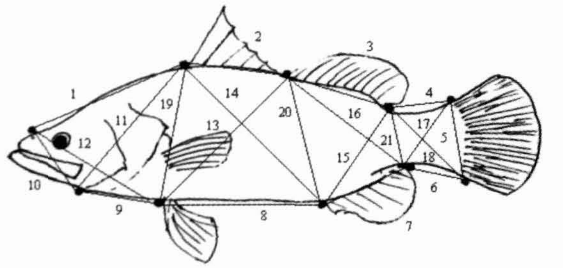

Fig. 1. Truss measurements

Truss measurements (TM): TM1: point from top of nostrils to anterior tip of first dorsal fin, TM 2: point from tip of first dorsal fin to end of first dorsal fin., TM 3: point from anterior portion of second dorsal fin to the end of second dorsal fin, TM 4: point from posterior portion of second dorsal fin till the point on caudal fin where caudal rays commence, TM 5: point on the caudal fin from where the caudal rays start to the ventral portion of the caudal fin where the caudal rays commence, TM 6 :the ventral point on the caudal fin from where the caudal rays commence to the posterior portion of the anal fin, TM 7: point from posterior portion of the anal fin to the anterior portion of the anal fin, TM 8: point from anterior portion of the anal fin to the anterior portion of the ventral fin, TM 9: point from anterior portion of ventral fin to the interopercular point below the preopercle. TM 10: point from inter-opercle to top of the nostrils, TM 11,12,13,14,15,16,17 and 18: diagonal measurements obtained by connecting the points on the dorsal and the ventral sides and TM 19,20,21 : traverse measurements from dorsal to ventral points.

There were 21 distance measures for each fish. These were log-transformed to reduce the correlations of the measurement means and variances (Sokal and Rohlf, 1969) and also according to an allometric model, diverse distance measures relate log-linearly in a homogenous population. Statistical Analysis of the truss measurements data was carried out in two stages. In the first stage, Principal Component Analysis (PCA) was performed on the entire data set pooling samples from different locations. In the second stage, based on the clusters identified from a plot of the PC-I and PC-II scores, the size-free shape component (H) and the within group size component (S) were estimated for each sample following the sheared PCA algorithm given by Humphries *et al.* (1981). The H values were plotted against S to get the stock discrimination.

Results and discussion

Principal Component Analysis on the entire truss measurement data of 436 juveniles/pre-adults revealed that approximately 94.2% of the total variation in the multivariate data was explained along the first two principal component axes (PCI and PCII). PCI was a measure of general size as indicated by the roughly equal and positive elements of the first eigen vector. However, PCII contains information on shape as well as size. In order to obtain a shape component which is free from the effect of size, the algorithm of Humphries *et al.* (1981) was

Table 1. *Details of* Lates calcarifer *sampled from different locations*

Location	Chennai	Kakinada	Chilka	Kakdwip	Goa
Number of fish	97	86	101	72	80
Mean of total length (cm)	26.80	26.99	33.14	25.26	27.08
Length range(cm)	18.2 - 47.0	19.8 - 35.2	22.5 - 39.5	16.1-52.3	20.9 -34.0

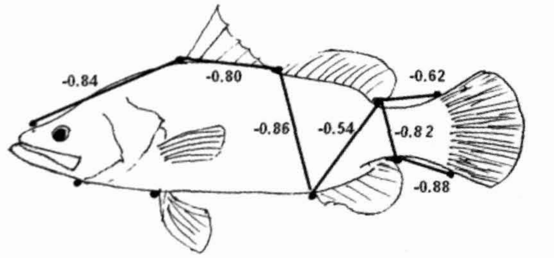

Fig. 2. Truss measurements contributing to variation in the stocks

deployed. Here again, approximately 87.8% of the total variance was explained along the first two principal component axes. Hence, only the first two principal scores were taken into consideration. Another observation was that all the first factor loadings (elements of the first eigen vector) were positive and nearly of the same magnitude indicating that all the 21 characters contribute equally to the total variation. PCI was thus a measure of size (Table 2).

Table 2. *The elements of the eigen vector 1(size component loadings) and SPC II (shape component loadings)*

PC Variable	Eigen vector-1	Eigen vector-2
1	0.20	-0.84
2	0.23	-0.80
3	0.20	0.78
4	0.24	-0.62
5	0.22	0.29
6	0.24	-0.88
7	0.20	0.83
8	0.22	0.55
9	0.21	-0.08
10	0.18	0.96
11	0.20	0.91
12	0.21	0.92
13	0.22	0.09
14	0.20	0.77
15	0.20	-0.54
16	0.21	0.13
17	0.21	0.98
18	0.21	0.67
19	0.21	0.51
20	0.23	-0.86
21	0.23	-0.82

Perusal of the loadings of sheared principal component (SPCII) indicates that the coefficients of a few truss measurements were high and negative (Fig.2). The coefficient of the truss measurement from the inter-opercular region to the anterior tip of the ventral fin can be ignored as the value is insignificant (-0.08).However, the other values depicted are high and negative indicating that SPCII was an indicator of shape variability associated with the traits (Fig. 2). These truss measurements contributed to the shape differences among the stocks studied.

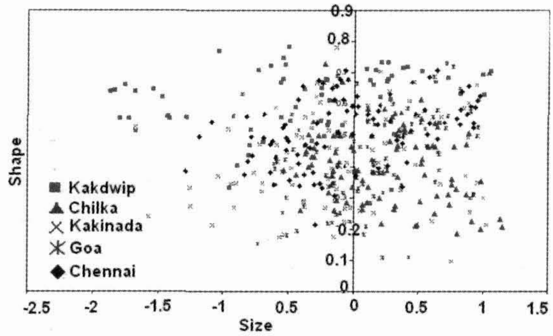

Fig.3. Principal Component Scores after shearing. Size vs. size-free shape component

Figure 3 depicts the principle component scores of the stocks with size in the X-axis and size-free shape in the Y-axis. Figure 4 summarises the shape differences among the stock of juveniles/pre-adults . As far as shape differences are concerned, the Kakdwip stock was different from the rest of the stocks. The Chennai stock was also different from the rest of the stocks. No shape differences were observed among Chilka, Kakinada and Goa stocks. It would be worthwhile to study in detail, the performance characteristics like growth and reproductive traits of the different stocks so that a clear picture can emerge as to which stock is good with respect to a particular trait. The stock showing superior performance in a certain trait can then be used for the selective breeding programme.

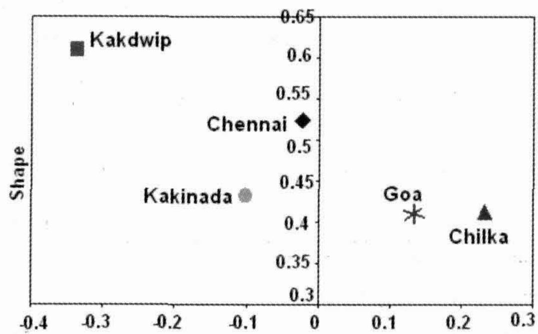

Fig.4. Depicting stock means

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