Growth, Condition and Sexuality of the Indian Sandwhiting, *Sillago sihama* (Forskal)

H. HONNE GOWDA
P. SANTHA JOSEPH
M. MOHAN JOSEPH
College of Fisheries,
University of Agricultural Sciences,
Mangalore – 575 002,
Karnataka.

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Abstract

In the sandwhiting *Sillago sihama* (Forskal) inhabiting the coastal and estuarine waters of Mangalore region, the value of the equilibrium constant ∝ was 2.9554 indicating isometry in the relation between fish length and body weight. Condition in both sexes was highest in June and related to gonadal maturity. Variabilities in K_n as a function of fish size indicated size optima 15 cm T.L. for males and 25 cm T.L. for females. Peaks in condition were at sizes 13, 17 and 25 cm T.L. in females and 15, 19 and 23 cm T.L. in males. The male:female ratio was 1:1.45 (P<0.05).

Introduction

The Indian sandwhiting, *Sillago sihama* (Forskal) occurs all along both coasts of India and contributes considerably to the coastal and estuarine fisheries. The only studies carried out on this fish are by Radhakrishnan (1957) and Krishnamurthy and Kaliyamurthy (1978) from the east coast. There being no study on its biology from the west coast of India, the present work was undertaken to study the growth, condition index and sexuality of *S. sihama* inhabiting the coastal waters of Mangalore.

Material and Methods

Total length and weight of 1,108 fishes (656 females, 452 males) of 8.0 cm to 33.6 cm in T.L. collected from landing centre at Mangalore during April 1983 to March 1984 were recorded. The length-weight relationship for either sex was calculated using the relation $W = aL^b$ and the relationships tested using analysis of covariance technique (Snedecor and Cochran, 1967). Isometry/allometry in growth was tested by the t/test. The relative condition factor, K_n was calculated for individual fish using the expression $K_n = \frac{W}{\overline{W}}$ where W = observed weight, $\overline{W}$ = calculated weight and the results for either sex tested for probable relations with spawning season. The weighted K_n average for either sex for the entire period of study was also calculated. Fluctuations in K_n with respect to length of fish were examined from data on K_n of fish of different size groups. Sexuality was examined with respect to months and size groups of the fish using chi-square test.

Results and Discussion

The length-weight relationship in the male was $W = 0.0092^{L2.9083}$ and in female was $W = 0.0078^{L2.9676}$. Results of the analysis of covariance showed that between males and females the relationships did not vary significantly (F = 2.0050). Therefore, a common relationship ($W = 0.0081L^{2.9554}$) was calculated and illustrated in Fig.1. Monthly variations value of 1:w relationship are shown in Table.

T-test was applied to find out whether the value of the equilibrium constant ∝ varied significantly from the hypothetical value of 3 in the cube law $W = aL^3$ (Le Cren, 1951). The results indicated no significant difference.

Data on the temporal variations in the mean K_n values for either sexes are presented in Fig. 2. In females, K_n was higher than the weighted average (1.0077) in May, June, August, September and January and lower during the rest of the period. The range in K_n in female was from 0.9919 (March) to 1.0234 (June). In males, K_n was higher than the weighted average (1.0092) during May, June, August, October and December and lower during the rest of the period. The range in K_n was from 0.9959 (April) to 1.0429 (June).

Fig. 3. illustrates the relation between the mean K_n values and size of fish in either sex. In females K_n remains low in the size range of 8.0-9.9 cm followed by a gradual increase in the next two size groups. A slight decrease in K_n in size group 14.0 – 15.9 was noticed, followed by a sudden recovery in the size groups 16.0 – 17.9 to 22.0 – 23.9 cm. The size groups of 24.0 – 25.9 and 28.0 – 29.9 cm exhibited higher K_n, while the size groups 26.0 – 27.9 and 30.0 – 31.9 cm had low K_n. In males K_n was low in the size range of 10.0 – 11.9 cm followed by a sudden increase in the size groups 12.0 – 13.9 and a fall later. Low K_n was observed in size groups 26.0 – 27.9 cm.

Data on the sexuality are presented in Table 2. Males to females ratio was 1:1.45. Dominance of either sex in the population was significant during most part of the year under study. Data on the sexuality of fishes belonging to different size groups (Table 3) showed dominance of female in all size groups except 16.1 – 20.0 cm T.L. Even in these size groups the dominance of male was marginal.

The length-weight relationship of *S. sihama* showed an increase in weight as the cube of length (α = 2.9554). Since this is not significantly different from the hypothetical regression coefficient 3.00 of an ideal fish, growth may be considered isometric. Radhakrishnan (1957) reported an value of 2.8862 in *S. sihama* of Mandapam and Rameshwaram areas. Krishnamurthy and Kaliyamurthy (1978) reported that in juveniles and adults of *S. sihama* the length-weight relationships were log W = 3.0277 log L-5.1600 and log W = 3.0887 log L-5.3887 respectively. Thus, in general *S. sihama* has an isometric growth pattern. This is expected of a fish which does not change its general shape during its growth from juvenile to adult. While discussing the merits of allometric equations in contrast to cube formula in expressing the length-weight relationship, Beverton and Holt (1957) state that the values of 'a' and 'b' may vary within the wide limits for very similar data and instances of important deviations from isometric growth in adult fishes are rare.

Data on seasonal variations in the condition of both sexes indicate that the values are the highest in June. This could be attributed to the maturity of gonads and probably feeding (Gowda, 1984). The condition of fishes of both sexes dropped suddenly in July when maturing and immature fishes dominated. These two factors seem to be interrelated. But presence of fishes with high condition in April, suggests that maturity and spawning may not be the only factors responsible. There seems to be no relation with feeding habits as March and July were period of intensive feeding when the condition was low (Gowda, 1984). Thus, based on available data, it is difficult to suggest probable reasons for the monthly variation in the condition. Blackburn (1960), in his studies on *Thyrsites atun*, also remarked that it was not possible to interpret the changes in condition. He felt that other than sexual and feeding cycles, there could be several alien factors responsible for temporal variations. A similar view was expressed by James (1967) in the case of the ribbon fish *Eupleurogrammus intermedius*. Baragi and James (1980) also found it difficult to explain the changes in condition of the sciaenid *Johnieops osseus* based on the intake of food and sexual cycle and that these dependent on several other unknown factors.

Data from the present study on the fluctuations in the K_n values with respect to size showed that females were in good condition at 25 cm T.L. and males at 15 cm T.L. The female fish attained peak condition at three different lengths i.e. 13, 17 and 25 cm T.L., while in males the peaks at 15, 19 and 23 cm T.L. These trends in relative condition factor in both sexes may be related to feeding, onset of maturity or other factors.

Other than indicating dominance of a Sex, the differential fishing (Kesteven, 1942) and differential growth between sexes,(Qasim, 1966) may be indicated from the sex ratio. Dominance of female may be attributed to any one or more of the following factors as reported by Del-Zarka and Sedfy (1970) in *Mugil salianus:* (i) Segregation of the sexes through various periods of the year including segregation resulting from sex differences in age and size at maturity, (ii) gear selectivity in relation to sex differences in morphology and in physiological activity and (iii) differences in natural and fishing mortality between sexes and (iv) greater activity which in turn increase changes of being caught.

Data on sex-ratio in different sizes showed absence of males above 28.1 cm. This indicates that females grow to a larger size than males. Krishnamurthy and Kaliyamurthy (1978) reported a preponderance of males in the 161-240 mm size range and females in the 101-120 mm and 261-340 mm size groups. Males larger than 280 mm T.L. were not recorded. Thus distinction between the two sexes appears to be an interesting feature in *S. sihama*.

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Table 1. Length-weight relationships of *S. sihama*

Month	$W = aL^b$	
	Female	Male
APR. '83	$W = 0.0107^{2.8537}$	$W = 0.0085L^{2.9381}$
MAY	$W = 0.0142L^{2.7266}$	$W = 0.0142L^{2.7131}$
JUN.	$W = 0.0177L^{2.7028}$	$W = 0.0180L^{2.6685}$
JUL.	$W = 0.0061L^{3.0637}$	$W = 0.0071L^{3.0084}$
AUG.	$W = 0.0057L^{3.0892}$	$W = 0.0048L^{3.1490}$
SEP.	$W = 0.0087L^{2.9561}$	$W = 0.0139L^{2.7715}$
OCT.	$W = 0.0124L^{2.8141}$	$W = 0.0107L^{2.8678}$
NOV.	$W = 0.0185L^{2.7012}$	$W = 0.0089L^{2.9154}$
DEC.	$W = 0.0180L^{2.6902}$	$W = 0.0245L^{2.5723}$
JAN. '84	$W = 0.0084L^{2.9354}$	$W = 0.0045L^{3.1437}$
FEB.	$W = 0.0083L^{2.9496}$	$W = 0.0136L^{2.8143}$
MAR.	$W = 0.0031L^{3.2557}$	$W = 0.0014L^{3.5217}$
MEAN	$W = 0.0078L^{2.9676}$	$W = 0.0092L^{2.9083}$

Table 2. Sex ratio of *S. sihama*

Month	n	Males	Females	Sex-ratio (male:female)	X^2
APR. '83	64	22	42	1 : 0.52	6.25*
MAY.	99	30	69	1 : 0.43	15.36*
JUN.	105	66	39	1 : 1.69	6.94*
JUL.	82	37	45	1 : 0.82	0.78
AUG.	100	37	63	1 : 0.69	3.64*
SEP.	110	45	65	1 : 0.59	6.76*
OCT.	107	49	58	1 : 0.84	0.76
NOV.	104	71	33	1 : 2.15	13.88*
DEC.	106	46	60	1 : 0.77	1.85
JAN. '84	60	23	37	1 : 0.62	3.27
FEB.	109	7	102	1 : 0.07	82.8*
MAR.	62	19	43	1 : 0.44	9.29*
Pooled	1108	452	656	1 : 1.45	

* $P < 0.05$

Table 3. Percentage of males and females of *S. sihama* in the samples collected during April 1983 – March 1984.

Size (cm)	n	Females (%)	Males (%)	X^2
8.1 – 10	2	100	0	0
10.1 – 12	17	88.24	11.76	9.94*
12.1 – 14	49	71.43	28.57	9.00*
14.1 – 16	111	56.76	43.24	2.03
16.1 – 18	176	45.45	54.55	1.45
18.1 – 20	239	49.79	50.21	0.005
20.1 – 22	187	50.27	49.73	0.004
22.1 – 24	127	65.35	34.65	11.98*
24.1 – 26	89	66.29	33.71	9.45*
26.1 – 28	60	91.67	8.33	41.67*
28.1 – 30	30	100.00	0	0
30.1 – 32	18	100.00	0	0
32.1 – 34	3	100.00	0	0
Total	1108	59.21	40.79	

* $P < 0.05$

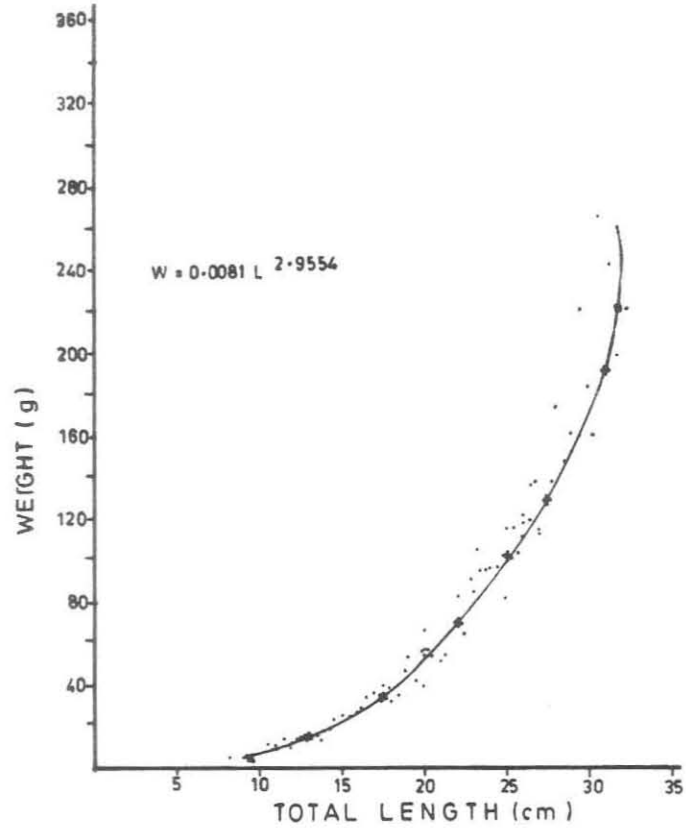

Fig. 1. Relation between length and weight of *S. sihama.*

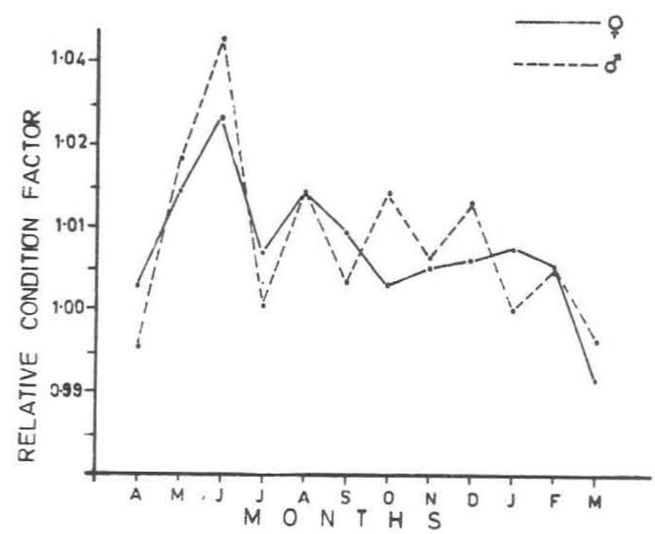

Fig. 2. Mean values of relative condition factor at different lengths of *S. sihama.*

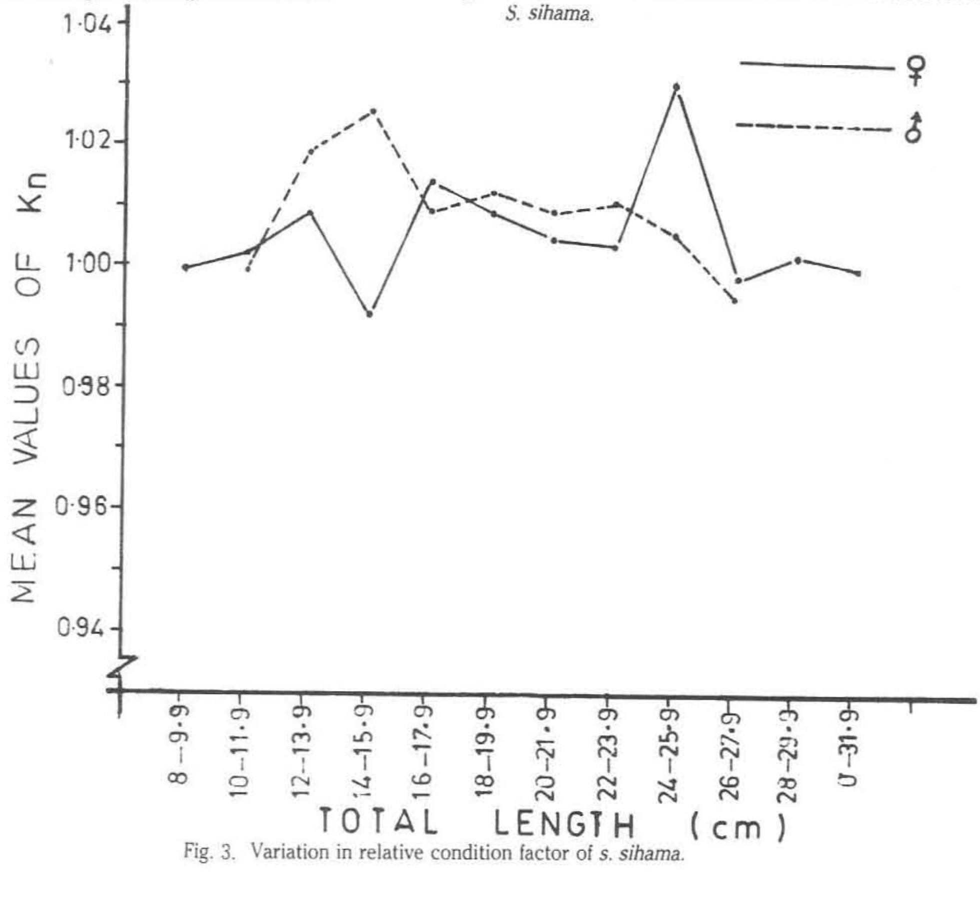

Fig. 3. Variation in relative condition factor of *s. sihama.*