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BIOLOGY OF *SPARUS SARBA* FORSKÅL FROM THE QATARI WATER, ARABIAN GULF*

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Abstract

The length weight relationship, the growth rates in length and weight as well as the condition factor of the fish are studied. Age determination and growth studies were deduced from the examination and measurement of scales. The spawning season was determined and the size, age at first maturity as well as sex ratio were investigated. The presence of different groups of ova in the ripe ovary indicates the probability of fractional or prolonged spawning habit. The absolute and relative fecundities were estimated according to fish length and weight. Analysis of stomach contents reveals the presence of polychaetes, crustaceans, molluscs, fishes, shelled protozoans and sand particles.

Introduction

Sparus sarba Forsskal belongs to family sparidae, which are of considerable importance to the bottom fisheries in the Arabian Gulf. These fishes are moderate in size, bright in colour and are slow swimmers in the water close to the bottom (Kuronuma and Abe, 1986). The catch of sparid fishes is included together in one category and the annual landings decreased from 132.97 to 105.2 tonnes between 1985 and 1986 (Ministry of Industry & Agriculture, State of Qatar, 1985 ; 1986).

Despite their commercial importance as food there has been a notable lack of knowledge about the biology of this fish in the Arabian Gulf.

The aim of the present work is to study the growth history of *S. sarba* in Qatari waters in order to manage and improve its fishery.

Material and Methods

The samples for this study were obtained from commercial catches brought to the central fish market and from fishermen at Al-Khor Harbour during the period from January to December 1986. The lengths and corresponding weights of about 600 fishes ranging in total length between 8-30 cm were measured. Fish age was determined from the annuli on the scales and from Peterson's length frequency method. Measurements of the total scale radius as well as the distance from the focus to the successive annuli were taken by means of an ocular micrometer. Gonads and stomachs were fixed in 4% formalin for the relevant studies.

Results and Discussion

Length-weight relationship and condition factor

The length weight relationship has been found by the least squares method (Beckman, 1948) for the combined data for all fish regardless of time of capture, sex and state of gonad maturity. For groups at intervals of one cm

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in length and the corresponding weights, the following equation was obtained

$$W=0.0238\ L^{2.89}$$

where W = weight in gm and L = total length in cm.

From the study, it was obvious that, the value of the exponent (n = 2.89) increases to a power less than the cube of length and this indicates that the living conditions of *S. sarba* in Qatari waters is not very good. The agreement between the calculated and observed weights is satisfactory (Table 1 and Fig. 1).

TABLE 1. *The empirical and calculated weights, as well as condition factor of* S. sarba *in the Qatari waters, according to length (Number of fish are given in parentheses)*

Total length (cm)		av. emp. weight (gm)	cal. wt. (gm)	condition factor (K)
8 (4)	..	11	9.71	2.15
9 (9)	..	14	13.63	1.92
10 (12)	..	17	18.51	1.70
11 (16)	..	23	24.32	1.73
12 (22)	..	30	31.31	.174
13 (31)	..	39	39.52	1.77
14 (25)	..	49	48.90	1.78
15 (38)	..	60	59.71	1.78
16 (30)	..	75	71.94	1.83
17 (36)	..	90	85.53	1.83
18 (34)	..	105	101.01	1.80
19 (31)	..	125	118.50	1.82
20 (45)	..	142	137.18	1.77
21 (51)	..	160	157.75	1.73
22 (19)	..	180	180.21	1.69
23 (53)	..	205	205.86	1.68
24 (29)	..	230	232.06	1.66
25 (20)	..	257	261.59	1.64
26 (19)	..	290	292.92	1.65
27 (25)	..	322	325.83	1.64
28 (11)	..	365	362.43	1.66
29 (7)	..	400	400.48	1.64
30 (8)	..	435	442.52	1.61

The condition factor (K) which is considered as a direct and quantitative measure of form or relative robustness of the body was derived from the sampling records, by the well known equation : $K=W\times 100/L^3$ (Hile, 1936 ; Thompson, 1943), where W = weight in gram and L = length in cm. The values of K for the different size groups were given in Table 1. It is evident that, the values of K at different

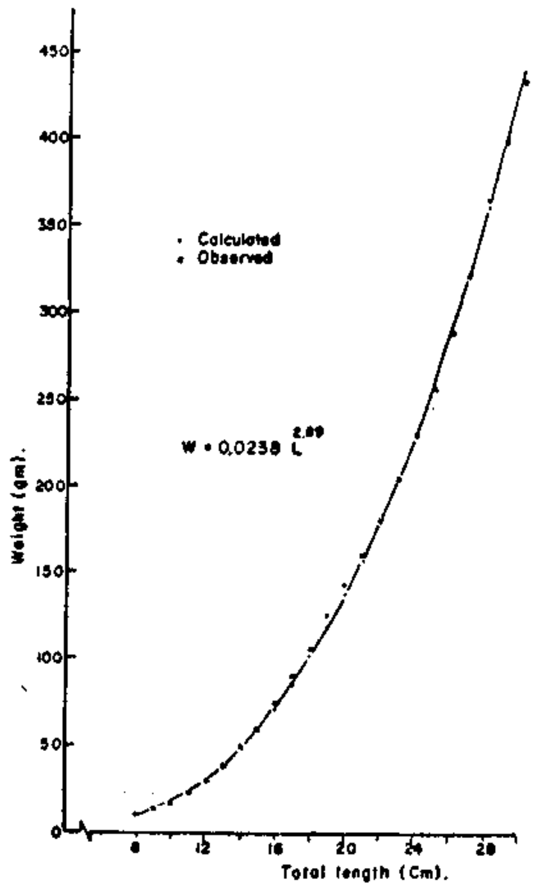

FIG. 1. The relation between length and weight of *S. sarba*.

lengths are relatively higher for small fishes than for larger ones. This means that, the smaller fish are in a better condition than the larger ones. This may be attributed to sexual maturation and active spawning of the larger fish. The seasonal changes in the condition factor have been shown to be correlated with gonad cycle, rate of feeding (Hickling, 1930 ; Hart, 1946 ; Menon, 1950 ; Le Cren, 1951 ; Rao, 1963).

The mean values of the coefficient (K) for the total lengths between 8 and 30 cm ranged between 1.61 and 2.15.

Age and growth

A good knowledge of age and growth rates of fish is extremely useful in management of its fishery. Scales of *S. sarba* are typically of the ctenoid type, oval shaped, as it is common for most spiny rayed fishes (Lagler *et al.*, 1977). They are moderate in size and deeply embedded in the skin and so they are relatively inconspicuous. They are dislodged with difficulty and consequently few are regenerated. Accessory marks are frequently detected in scales of this species and sometime resemble the true annuli, so closely as to makes acurate age determination difficult (Fig. 2). But the true annual rings could be easily identified on the scales by the ' cutting over ' of the circuli, but varied according to its location with respect to the focus of the scales. This focus may be central or slightly posterior to the centre of the scale.

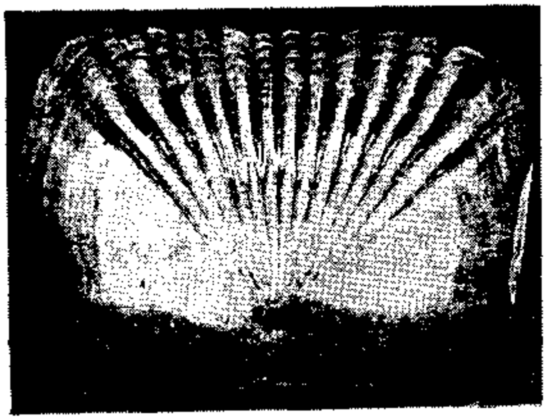

FIG. 2. A ctenoid scale of *S. sarba*.

There are radial grooves and spaced circuli extended from the focus to the anterior edges of the scale. It was found that, the scale rings were formed in spring, as a result of the increase in water temperature, since this affects the food supply of the fish, besides its effect on its metabolism (Thompson, 1923 ; Ricker, 1971). This period coincides with the luxuriant food in the Arabian Gulf waters, which plays a great role in the onset of annulus deposition in fishes (El-Agamy, 1986).

A marginal ring was evident in about 20% of fish examined in April. By the end of May, 75% of the fish had marginal annuli and all fish examined had assumed new growth in the first half of June.

The relation between the total length and the scale radius is close to a straight line originating close to zero. This permit us to use a simple proportionality in back calculation of growth rate (Lee, 1920). The discrepancies in the calculated lengths attained at the end of different years of life are obvious from one age-group to the next (Table 2), this might be

TABLE 2. *Ranged and means of empirical lengths and weights from sum of increments and from von Bertalanffy's equation*

Age in years	Length (cm)				Weight (gm)	
	Range	Mean	calc. from sum of increments	calc. from von Bertalanffy equation	calc. from sum of increments	calc. from von Bertalanffy equation
1	10—14	12.1	11.6	11.75	28.37	29.44
2	13—18	16.0	15.7	15.60	68.03	66.79
3	16—21	19.7	19.5	18.87	127.28	115.76
4	19—24	23.1	22.4	21.66	190.02	172.44
5	23—27	25.6	24.7	24.03	252.04	232.79
6	25—28	27.5	26.8	26.04	319.07	293.62
7	26—29	28.6	28.2	27.76	369.65	353.23
8	28—30	29.5	29.0	29.22	400.78	409.63

attributed to the pressure exerted by the new growth zone on the early annuli. The apparent trend of the calculated length values is generally to decrease with the increase in age. This conforms with Lee's (1920) phenomenon of apparent decrease in growth rate.

Table 2 shows, the calculated length at the end of different years of life. From this Table, it is evident that the calculated and the corresponding actual length show fairly good agreement. As is shown in Fig. 3, these fishes achieve good length increment during their first year of life, while in the following years a decrease occurs gradually.

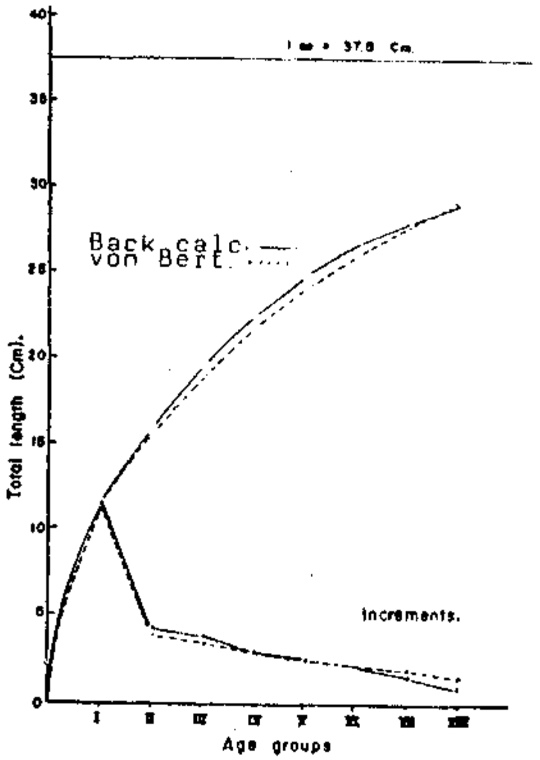

FIG. 3. Growth (cm) and annual increment curve in *S. sarba*.

Growth in weight

The calculated growth in weight at the end of each year of life was estimated by applying the corresponding length-weight equation to the calculated lengths at each year of life. They were shown in Table 2 and represented graphically by Fig. 4. It can be clearly seen that the lowest growth in weight was attained in the first year of life after which the annual increment gradually and progressively increased reaching its maximum values at the 6th year of life.

The theoretical growth rate

The commonly accepted von Bertalanffy equation was fitted to *S. sarba*/data which is as follows :

$$L_t = L_\infty \left[1 - e^{-K(t-t_0)} \right] \text{ and } W = aL^b$$

where L_t and W=body length at age (t) and body weight L_∞, K and t_0 = the Von Bertalanffy parameters for maximum length, growth rate and age at zero length and a, b = regression coefficients for length-weight relationship.

The value of L_∞ was determined by using the method of Ford (1933) and Walford (1946). The value of t_0 was calculated graphically by using the method given by Ricker (1958). The estimated values of L_∞, K and t_0 were 37.5, 0.162 and —1.320 respectively. Thus the von Bertalanffy growth equation of *S. sarba* might be stated as :

$$L_t = 37.5 \left[1 - e^{-0.162(t-(-1.320))} \right]$$

This relationship adequately described the growth of *S. sarba* in the Qatari waters, since the calculated lengths for each age group derived from this equation were nearly identical to the mean lengths obtained by back-calculation based on scale readings and also to the mean lengths derived by length frequency method (Table 2).

The theoretical weights at each year of life is obtained from the length-weight formula, *i.e.* :

$$W = 0.0238 \; L^{2.89}$$

By substituting $L_\infty^{2.89}$ for $L^{2.89}$, the equation becomes :

$$W_\infty \text{(maximum weight)} = 0.0238\ L_\infty^{2.89}$$
$$W_\infty = 844.02 \text{ grams}$$

The hypothetical length and weight values of the different years of life are compared with the corresponding ones obtained from scale reading (Table 2 and Figs. 3, 4). By comparing the values obtained from the two methods, it is obvious that a very close agreement is obtained.

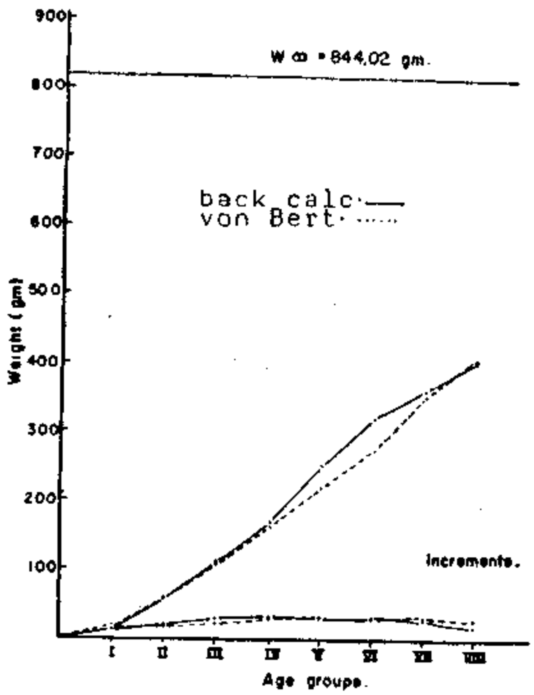

FIG. 4. Growth (gm) and annual increment curve in *S. sarba*.

Length and age composition

The different age groups in the polymodal frequency distribution were determined based on data collected. The length data were grouped into 1 cm (total length) size and the obtained samples of either male or female were combined together, since no great difference in size between sexes was observed.

The length composition curves (Fig. 5) show several peaks, corresponding to different age groups determined from Petersen's and scale reading methods, these estimations closely agree with each other. The first modal length is at 10 cm which represent 0-year class. From the 2nd to 7th modes represent 13, 15, 17, 21, 23, 26 and 29 cm in respective age classes from I to VII (Fig. 5). Over the whole year round, the apparent irregularity in the average size of fish during the different months was mostly attributed to the small number of fish caught during certain months. However, it can be illustrated that the small average sizes were found during the summer months and the large average sizes in winter months.

The analysis of age groups has revealed that, there is a distinct overlapping between successive age groups *i.e.* a fish of a particular length could belong to 2 or 3 age groups. Also it has to be mentioned that, the majority of fish in the catches belongs to age group II, III and IV, while those of age group O,VII and VIII were of rare occurrence. This may be, because the young fish generally keep in shallow waters, while older fishes are usually found in deeper waters. The domination of age groups III and IV which is undoubtedly related to selection of the used gears, may affect the population. Hence, nets of more than one mesh size must be operated in fishing grounds of *S. sarba* in the exploited areas.

Commercial landings

In 1986 the total catch of *S. sarba* in Qatari waters was only 18.5 tonnes as compared with 33.97 tonnes in 1985 (Ministry of Industry & Agriculture, State of Qatar 1985 ; 1986). Table 3 shows the monthly landings of *S. sarba* from January to December 1985. The highest production was in April and more than 23% of the annual landings of this fish was during this month. As seen in Fig. 6, the catch tends to increase progressively from January till April and decreases afterwards till the end of the year. Analysis of the catch in different quarters of the year (Fig. 6) revealed that more than half of the catch is recorded in the second quarter, while the first quarter comes next and comprises more than one third of the catch. The third and fourth quarters showed the least landings and contributed less than 10% of the total catches.

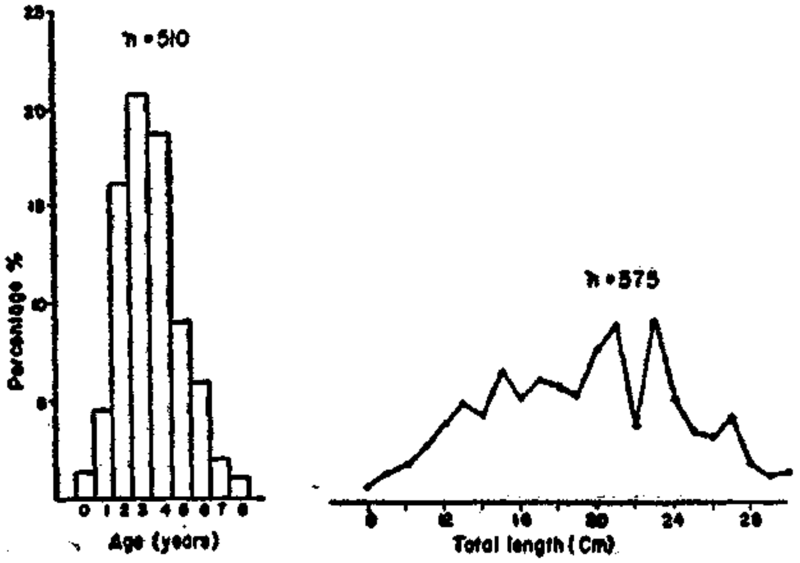

FIG. 5. Length and age composition in *S. sarba*.

TABLE 3. *Monthly landings of* S. sarba *in* 1985

Month		Kgs.	Percentage
January	..	1,800	5.31
February	..	3,600	10.53
March	..	7,300	21.53
April	..	8,000	23.60
May	..	6,300	18.58
June	..	3,900	11.50
July	..	1,600	4.72
August	..	200	0.59
September	..	100	0.30
October	..	200	0.59
November	..	400	1.18
December	..	500	1.47

On the whole, the landings showed increase from the first to the second quarter in 1985 and decreased in the following period. So more than 90% of the landings of *S. sarba* were recorded during the half year extending from January till June.

Sexual maturity

Size and age at maturity : Spawning can be clarified by microscopic and macroscopic examination of the gonads. Although the first method is more accurate, the second is easier and more applicable. The five maturity

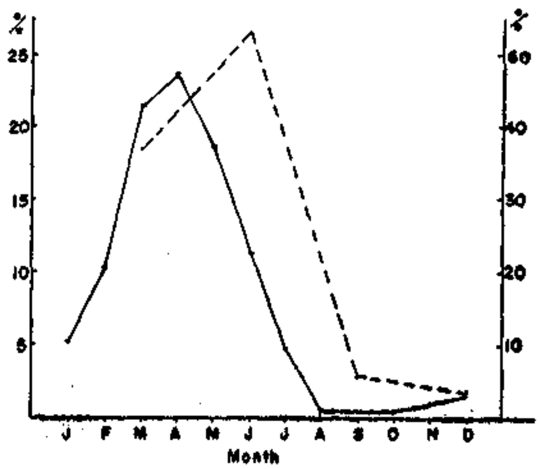

FIG. 6. Landings (%) of *S. sarba* in 1985.

stages described by Hjort (1910) were found satisfactorily applicable to define the state of gonads. On considering gonads of stage I or II as immature, of stage III as intermediate and of stage IV and V as mature. Gonads (testis and ovaries) are exclusively immature in September and October, they decrease in frequency till March. Gonads classified under stage III and IV were obtained in April from fish almost at the end of their second year of life. Mature gonads in stage V appear from April to June and increase in frequency till May and decrease afterwards (Fig. 7).

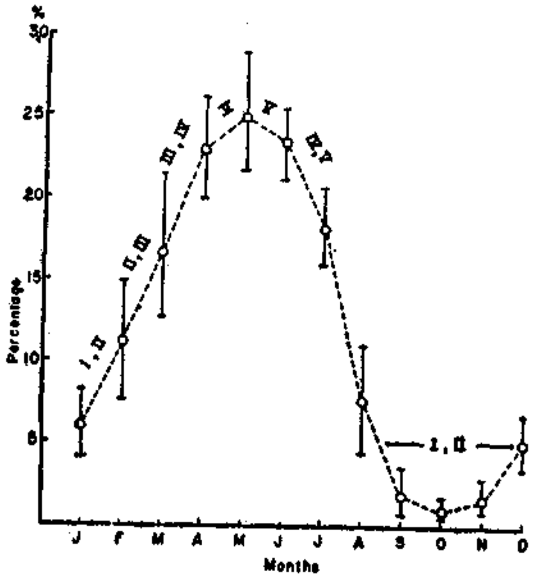

Fig. 7. Seasonal fluctuations (%) of different maturity stages of *S. sarba*.

It may therefore be concluded that *S. sarba* has a long spawning season which extends for about three months from April to June.

Regarding the age at first maturity, it was found that about 20% of the fish attain first maturity during their second year of life. The minimum length recorded for mature male and female was 13 and 15 cm respectively. It is evident that females mature at a larger length than males. During the third year more than 75% of males and females are sexually mature. So it is of interest to record here that, on the basis of the attainment of sexual maturity a size of 18 cm total length is the length at which 75% of the fish are sexually mature.

Sex ratio

It was found that among 550 fishes (ranging from 11-30 cm total length), caught through the year, the sex ratio was 198 males and 352 females with ratio of 1 : 1.8. The departure from 1 : 1 sex ratio, which is usually found in the majority of species may be explained on the basis of sex reversal which is usual phenomenon in sparid fish. This phenomenon was noticed in different species of the family Sparidae from different localities (Zei, 1961 ; El-Maghraby *et al.*, 1981, Hashem and Gassim, 1981).

Fecundity

A sample of 20 mature females ranging from 17 to 26 cm in total length was studied. Total count of all mature ova distined to spawn in the ensuring spawning season was obtained by total enumeration. It revealed that there was no significant variation in the two lobes of the ovary. A considerable variation in the fecundity between fish of equal length as observed in this species is a common phenomenon due to environmental factor such as temperature, food availability and genetic differences (Bagenal, 1968 ; Gibson and Ezzi, 1978 ; Hoda and Akhtar, 1985 ; El-Agamy, 1987). The presence of more than one size group of yolk eggs inside the ovary of *S. sarba* indicates that this species undergo fractional spawning and consequently the spawning season is mostly a long one.

The absolute and relative fecundities generally increase with the increase of fish length or fish weight, although the increase is not regular (Table 4). The fecundity varies from 23 to 99,000 eggs (mean 60,000 for fishes ranging from 17-26 cm total length. The mean relative fecundity varies from 1353 to 3808 and from 256 to 374 eggs per cm and gram of fish respectively. However the small number of fish examined is responsible for the deviation from the increasing trend, as it was found that wide variation in fecundity exists for fishes of the same length, weight and age.

Food and feeding habits

During the period of observation the majority of the stomachs examined was empty. This may be due to the intensity of feeding and the influence of the trawl-net. The specimens observed for this study were collected from trawl-nets and traps (Gargoor) and were taken from the deep water layer. Therefore, the food might have been vomited during the time of trawling and lifting in the traps. The intensity of feeding increases after spawning and corresponds to the yearly physiological cycle of the fish. The majority of fishes feed when they are in maturity stages II and III. From stage IV the intensity of feeding decreases. It changes regularly during the growth of the fish. Small specimens upto 18 cm feed more intensively than the bigger ones. A significant decrease in the intensity of feeding was observed in specimens more than 25 cm, probably because their food was chiefly composed of fish whose nutritional values are very high. Analysis of the stomach contents reveals the presence of polychaetes, crustaceans, molluscs, fishes, shelled protozoans and some sand particles (Fig 8). The sand and the foraminiferan shells may not be considered as food items as they enter into the gut probably along with the bottom living organisms on which the fishes feed. Also a remarkable shift in their feeding habit with the increase of body length is observed. Fishes of smaller body length (upto 15 cm) prey mainly upon euphausids, shrimp larvae and amphipods, the larger ones mainly feed upon other crustaceans, fishes and mollusca. Seasonal

TABLE 4. *Absolute and relative fecundity of* S. sarba *in the Qatari waters during* 1986

Total length (cm)	No. of fish examined	Av. body weight (gm)	Absolute fecundity X 10^3	Relative fecundity No. of eggs/1 cm	Relative fecundity No. of eggs/ 1 gm
17 ..	1	90	23	1353	256
18 ..	3	110	31	1722	286
19 ..	2	120	39	2053	325
20 ..	4	145	45	2250	310
21 ..	3	172	63	2864	366
22 ..	1	188	55	2619	292
23 ..	1	211	75	3261	355
24 ..	2	238	89	3708	374
25 ..	2	260	80	3200	308
26 ..	1	300	99	3808	330

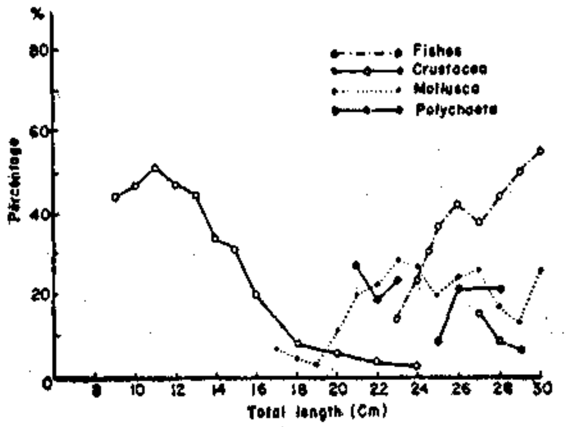

FIG. 8. Relation between length and food composition of *S. sarba*.

variation of different food items has also been observed. For instance fish occurred mostly in spring and summer and crustacea, mollusca and organic detritus in winter.

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