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THE USE OF MINUTE EMBEDED SCALES FOR AGE DETERMINATION OF THE MEDITERRANEAN SEA SIGANID: *Siganus rivulatus* FORSKAL.

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ABSTRCT

The embeded minute scales of **Siganus rivulatus** were investigated and succefully used for age determination. Original scales which carry the all formed "year marks" were encountered in the most posterior body area. Anterior and mid areas did not bear all the classical "year marks" and could not be used for age determination. Scales formation did not start at once, the posterior area, in contrary to many other fish species, may virtually secrete the first scales on the body. Up to five "year marks" could be interpreted on the posterior scales, and "real year mark" was identified. Annual growth of **Siganus rivulatus** was estimated by "back calculation" and shown to be decreased as the fish aged.

INTRODUCTION

Siganids or as called " rabbit-fishes" are economically valuable in both the Mediterranean and Red Seas. They are naturally confined to the Indo-Pacific, at least two species namely, **Siganus rivulatus** Forskal and **Siganus luridus** Ruppell have immigrated from the Red Sea to the Mediterranean through the Suez Canal with resultant large populations now. Several biological investigations concerned mainly with the feeding, breeding and rearing of siganids (Ben-Tuvia 1964, 1966, George et al. 1964, George and Athanassiou 1967, Tortonese 1970, Westernhagen 1973, Lam and Soh 1975, Popper and Gundermann 1975, Bryan and Madraisau 1977, Lundberg and Lipkin (1979). Recently, Al-Elyani, (1983) and Hashem, (1983) proposed the application of length-frequency analysis for determining the age of **Siganus rivulatus** in the Red Sea.

For determining the fish age, the scale sampling from the fish body represents a substantial step. The so-called standard scales cannot be defined without defining the most appropriate body area for scale sampling first (Monastuirsky 1926, Dannevig and Host 1931). The number of annulii may very in the different body areas. Sometimes not all scales from all body areas deposit the same number of "year marks" (Blackburn 1951, Leider 1959). Therefore, if the scales are taken from wrong area, the number of annual rings seems to be likely misinterpreted.

The present work represents a first attempt for age determination of a siganid fish (**Siganus rivulatus**) by using the minute embeded scales.

MATERIAL AND METHODS

The material used counted a total of 215 fish samples of **Siganus rivulatus** obtained from the hook and line catch near the Eastern Harbour (Alexandria) and fish market during the period from May 1985 to May 1986. Total length was measured in centimeters and weight in grams. Three areas were fixed on the fish body (Fig. 1), A- anterior, B- mid, and C- Posterior from which scales were gently removed from their sockets by acute forceps under a simple microscope. Following the recommendations of Cassie (1956), approximatley 6 to 10 scales were taken from each area for examination. The removed scales were arranged on a glass slide, mounted in Canada Balsam and covered by a glass cover. Scales were examined under a binocular microscope at two different powers, X100 and X400. Scale radius was measured by an eye-piece micrometer from the nucleus to the anterior tip. Sections of 6 µ thickness were made for the fish skin to determine the scale thickness.

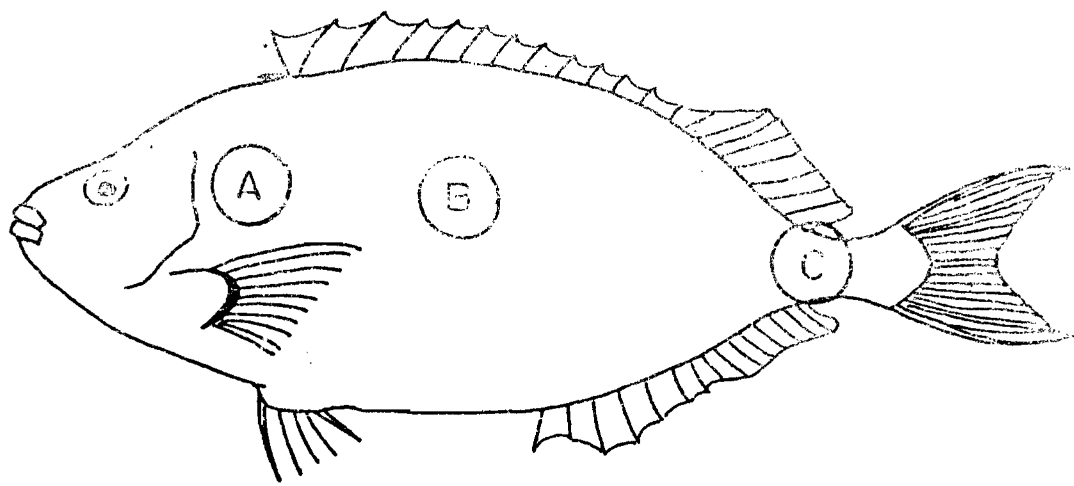

Fig. (1)
A drawing showing the three areas of scale collection, A- anterior, B- mid and C- posterior.

RESULTS

The scales of **Siganus rivulatus** are embeded under the epidermal pigmented layer of the skin. A loose part projects backwards by which the scales are easily detached (Fig. 2). Scales are very thin of about 0.006 - 0.008 mm in thickness. They vary considerably in regard to shape and size in the different body areas, oftenly appear in an oval shap and devoid from any ctenii. Scales encountered in area A and area B are more regular and significantly smaller than those in area C. In most cases, the nucleus which represents the first formed sclerite was backwardly shifted and could be easily recognized. Scale radius (Distance from nucleus to anterior tip) represented from 65 to 75% of the total scale's length. Few numbers of regenerated scales appeared among the examined ones. Such scales had no visible nucleus. Identical subsequent sclerites were running around the nucleus either in the anterior or posterior sectors of the scale. Sclerites were opaque, in-between narrow hyaline zones were distinguished. Annual ring was characterized by the presence of discontinuous circulii, formed after a comparatively wide hyaline zone. The lateral circulii were obviously branched in the "year mark's" position into 3-4 anterior circulii indicating a true "annual mark" (Fig. 3).

Fig. (2)
Distribution of scales on the body of S. rivulatus.

Fig. (3)
A magnified scale showing the features of "annual mark".

Scale Radius-Fish Length Relationship

The values of average scale radius calculated for each group taken from the anterior, mid, and posterior body areas of different fish lengths were represented in Table (1). On treating the obtained data with the least squares method, the characteristic three lines were illustrated in Fig. (4), representing the three body areas:

1- $L = 10.4 + 20.7503\ S$ (for the anterior area).
2- $L = 6.01 + 21.0314\ S$ (for the mid area).
3- $L = 3.78 + 18.5506\ S$ (for the posterior area).

The first onset of scale formation started on the posterior area at a length of 3.78 cm as expressed in formula (3).

This value was used in the formula,

$$L_n = S_n/S \quad (L - a) + a,$$

to estimate the back lengths at different years of life.

TABLE (1)

Measurements of scale radius (mm) in the anterior (R_1), mid (R_2), and posterior (R_3) body areas and the corresponding fish length (cm).

Fish length	Fish number	R_1	R_2	R_3
15	9	0.30	0.50	0.68
16	12	0.32	0.53	0.70
17	8	0.36	0.57	0.74
18	7	0.39	0.60	0.79
19	4	0.41	0.61	0.81
20	7	0.43	0.63	0.84
21	16	0.44	0.66	0.86
22	17	0.49	0.67	0.93
23	22	0.54	0.73	0.00
24	19	0.61	0.81	1.06
25	21	0.69	0.93	1.11
26	30	0.76	0.96	1.19
27	26	0.84	1.03	1.29
28	17	0.90	1.08	1.37

The value (10.4 cm) of intercept (a) in formula (1) may indicate to the length at which the scales appeared for the first time on the anterior body area. In fact, nearly all the anterior scales did not bear " annual rings".

The value (6.01 cm) noted in formula (2) may rather give an indication to the length at which the scales first appeared in the mid area, where the scales were of moderate sizes forming considerably less numbers of "year mark" than in the posterior body area. This might show that scales 1st appeared on the posterior area of the high flank. For this we adopted the value of intercept 3.75 for back calculation of length at different ages.

Age Determination

A through examination of the obtained scale samples revealed that the posterior body area of **Siganus rivulatus** have the largest scales with maximum number of "year marks". Almost, all the posterior scales showed detectable "year mark". Frequently, most of the scales taken from the anterior area did not have "annual rings". Scales taken from the mid area have deposited less numbers of "annual rings" than in posterior area of the same fish.

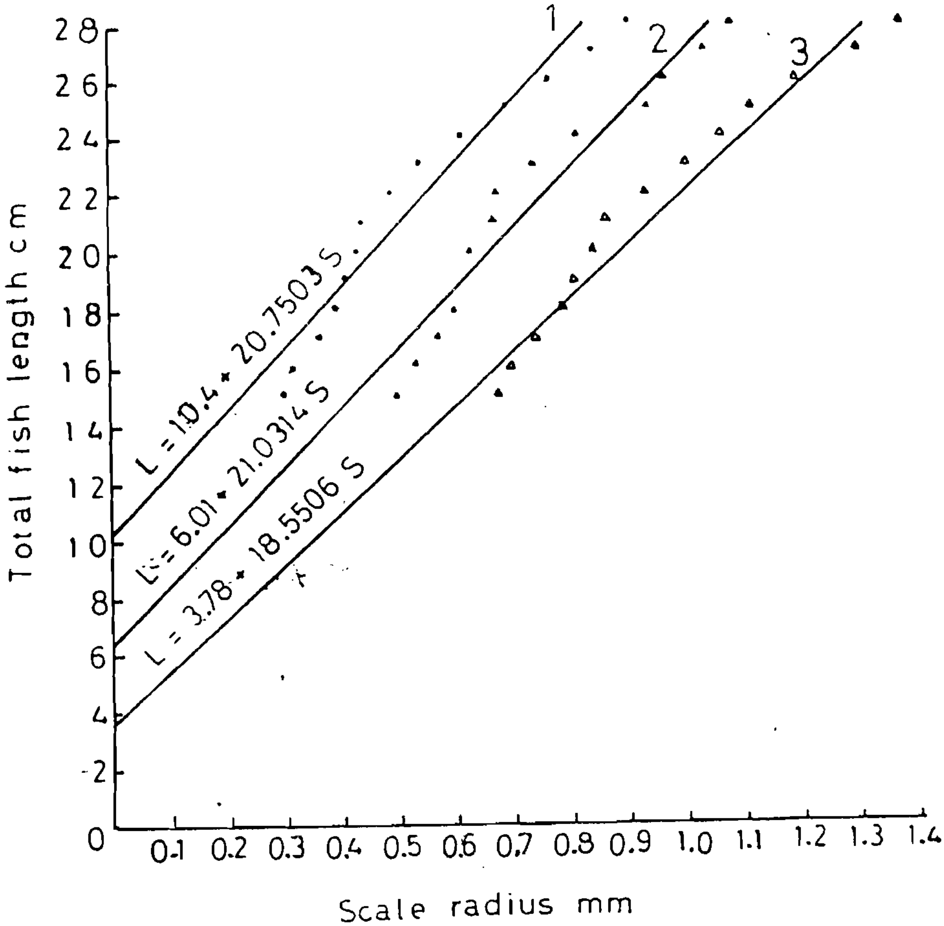

Fig. (4)
Relationship between scale radius in the arterior (1), mid (2) and posterior (3) body areas and total fish length.

One year old fishes were not represented in the obtained samples. Two years old fish (Fig. 5) measured from 15 to 19 cm. Fishes measuring from 20 to 23 cm have three "year marks" (Fig. 6). From 24 to 26 cm, four "year marks" were distinguished (Fig. 7). Fishes measuring 27 and 28 cm showed five "year marks".

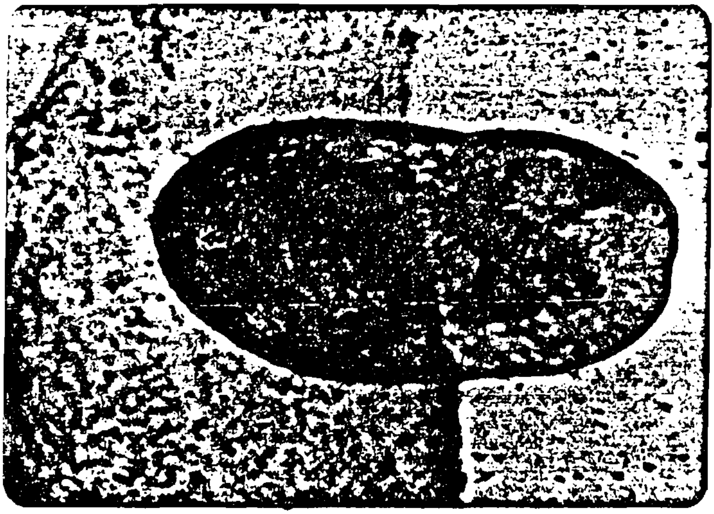

Fig. (5)
A scale of **S. rivulatus** with two "year marks".

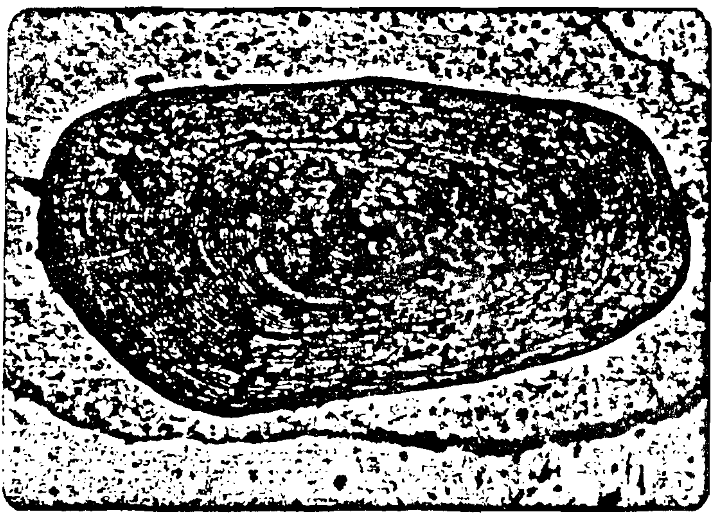

Fig. (6)
A scale of **S. rivulatus** with three "year marks".

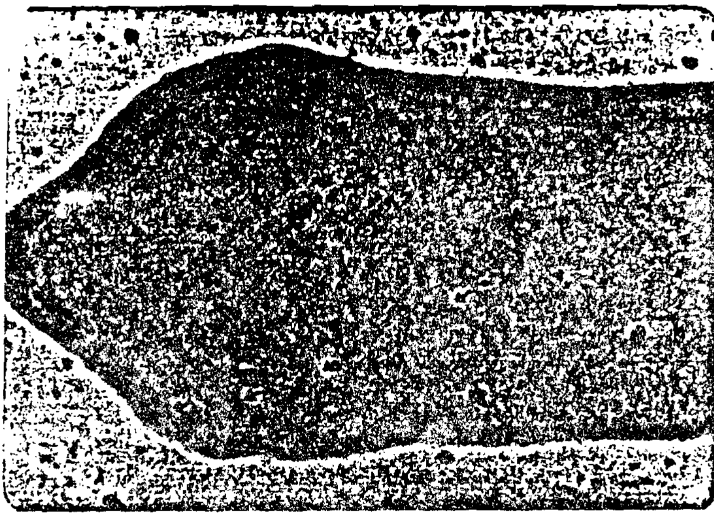

Fig. (7)
A scale of S. rivulatus with four "year marks".

Back Calculation and Annual Growth

The back calculated lengths of different passed years of life were listed in Table (2), and graphically represented in Fig. (8). The length of the first year of life varied from 8.9 to 11.7 cm with a mean length of 10.1 cm. The second year fluctuated from 15.2 to 16.7 cm with a mean value of 16.1 cm. The third year, from 19.3 to 20.8 cm with a mean of 19.9 cm. The fourth year measured from 22.3 to 23.4 cm and mean length of 22.[illegible] cm. The calculated length at the fifth year of life ranged from 25.5 to 25.9 cm and mean length of 25.7 cm.

Growth or increment in fish length during the first year of life amounted 10.1 cm. During the second year, the increment measured 6.0 cm. A total of 3.8 cm represented the increment during the third year of life. A continuous decrease in the annual increment took place in the fourth year of life to reach 3.0 cm. A further decrease was noticeable in the fifth year of life where the calculated increment measured 2.8 cm.

DISCUSSION

The scales of **Siganus rivulatus** were not used before for age determination. There was a thought that such scales do not bear "annual marks", therefore

TABLE (2)

The back calculated lengths for different years of life, annual incremrnt, and mean annual increment.

Fish length	Fish number	l_1	l_2	l_3	l_4	l_5
15	9	9.8	15.8 (6.0)			
16	12	9.6	15.7 (6.1)			
17	8	8.9	15.2 (6.3)			
18	7	10.2	15.4 (5.2)			
19	4	10.9	15.8 (4.9)			
20	7	10.9	16.4 (5.5)	19.4 (3.0)		
21	16	9.5	16.4 (6.9)	19.3 (2.9)		
22	17	9.4	16.4 (7.0)	20.0 (3.6)		
23	22	10.6	16.7 (6.1)	20.8 (4.1)		
24	19	11.2	16.6 (5.4)	20.4 (3.8)	23.4 (3.0)	
25	21	10.0	16.0 (6.0)	19.6 (3.6)	23.1 (3.5)	
26	30	10.5	16.4 (5.9)	19.8 (3.4)	22.5 (2.7)	
27	26	10.2	16.7 (6.5)	20.3 (3.6)	23.4 (3.1)	25.9 (2.5)
28	17	10.1	16.4 (6.3)	19.9 (3.5)	22.3 (3.4)	25.5 (3.2)
Mean length		10.1	16.1	19.9	22.9	25.7
Mean increment		10.1	6.0	3.8	3.0	2.8

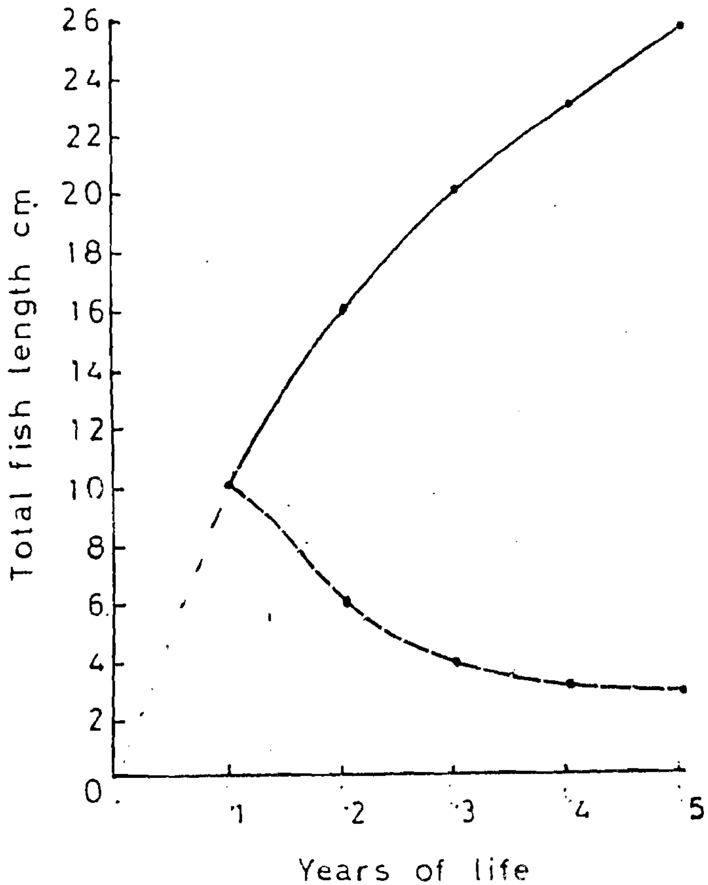

Fig. (8)
The growth in length curve (solid line) and annual increment in length (broken line).

the "length - frequency" method was frequently used for determining the age of **Siganus rivulatus** (Hashem 1983, Al-Elyani 1983).

Definition of "true annual mark" was our first task, thence the search for the most appropriate body area which bears the scales with clear and complete number of "annulii".

The first appearance of scales on fish body is specific for each fish species. For **Solea vulgaris** scales first appeared at the mid body area which deposit the maximum number of sclerites. In the present study, the posterior area of **Siganus rivulatus** showed the largest scales with the maximum number of "year marks". Therefore the intraspecific size variations of the scales of one species do not automatically account for other species in the same way and to the same extent (Gody 1959, McLarney 1973).

The appearnce of posterior scales with complete number of "year marks" and those in the mid or anterior areas with leeser numbers or are completely devoid from any trace of "year marks" is quite difficult to be explained at present.

Growth pattern of **Siganus rivulatus** as obtained in the present study is nearly similar to some other Mediterranean fish species (Hussein 1969). A maximum growth is attained during the first year of life, then a gradual decrease occurs as the fish ages. In the Red Sea, nearly similar ages and growth values were estimated for **Siganus rivulatus** by using the length-frequency" method (Hashem 1983, Al-Elyani 1983).

In conclusion, the minute embeded scales of **Siganus rivulatus** can be succefully used for age determination. The most posterior body area was shown to be most appropriate for the estimation of "year marks".

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