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# ON THE GROWTH AND DEMOGRAPHIC STRUCTURE OF *LETHRINUS VARIEGATUS* CUV. & VAL. (1830) FROM THE RED SEA.

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## ABSTRACT

The age of 179 males and 171 females of *L. variegatus* from the Red Sea was determined by scalemetry and Bhattacharya methods. The observed maximum life span was 3 years for males and 4 years for females. Back-calculated mean total length were from 11.13 cm at age 1 to 19.29 cm at age 3 for males and from 11.04 cm at age 1 to 21.03 cm at age 4 for females. Von Bertalanffy growth model was fitted to the resultant size-atage data. Annual total mortality rate (A), survival rate (S) and instantaneous total mortality (Z) estimates were computed using different methods based on the analysis of catch curves as well as length frequencies.

## INTRODUCTION

Family Lethrinidae has a wide distribution in the Indo-Pacific region and its representive are considered as one of the most esteemed and commercially significant marine fish by many nations. Inspite of the economic importance of the fishes of this family, knowledge on their biology on international or national levels is very limited. In this paper, the age, growth and demographic structure are described.

## MATERIALS AND METHODS

Sampling of this study was conducted from April 1984 through April 1985 in the vicinity of El-Ghardaqa area. In the laboratory, all fish were measured for total length to the nearest millimeter and for total weight to the nearest gram. Scales were removed from beneath the tip of the pectoral fin from the left side of the fish. The scales were soaked overnight in one-tenth ammonia solution, cleaned and mounted dry between two glass slides. For age determination and growth studies, the scaleswere viewed in an optical system consisting of Nikon zoom stereomicroscope focusing block, Heidenhain's stand and stage with transmitted light and Heidenhain's electronic bidirectional read out system VRX 182. Measurements to the nearest 0.001 mm were made for the scale focus to each annulus and to the scale edge in the anterior field, for marginal increment analysis and back-calculating fish length at the time of annulus formation. Lengths by age were back-calculated from a scale radius fish length regression, (Lee, 1920).

The most widely used theoretical growth model, the Von Bertalanffy

$$L_t = L [ 1 - e^{-k(t-t_0)}]$$

was fitted to back-calculated lengths at age data (Ford, 1933 and Walford, 1946).

Annual total mortality rate (A), survival rate (S) and instantaneous total mortality coefficient (Z) were estimated by analyzing catch curves (Chapman and Robson, 1960 and Ricker, 1975) and length frequencies (Jones, 1981 and Pauly, 1983).

## RESULTS AND DISCUSSION

### Age Determination

Age was determined by both length frequency analysis using the logarithmic difference method described by Bhattacharya (1967) and scalemetry.

1- Bhattacharya Method:
Tables (1 and 2) describe the results of the separation of the mixture of Gaussian distributions of length frequencies of males and females of **L. variegatus**. The results revealed the presence of 3 and 4 components in the males and females, respectively.

Since the mean length for each component is highly close to the corresponding back-calculated length, age groups I, II and III were attributed respectively to the three components in the male mixture and age group I through IV to the four components in the female mixture.

2- Scalemetry:
Scales of **L. variegatus** are small in size and typically of the ctenoid tupe, with smooth anterior margins and spiny posterior ones. The scale focus lies slightly posterior to the center. The ciculi of the anterior half of the scale run parallel to the edge of the scale and are divided into long sections by radial ridges (radii) that originate at the focus.

Table (1)

Mean lengths, variance and standard deviation of the different subpopulations (age groups) of males **Lethrinus variegatus** from the Red Sea.

| Sub-population / Parameter | 1 | 2 | 3 |
|---|---|---|---|
| **Mean length (cm)** | .11.50 | 15.64 | 20.27 |
| **Variance** | -0.856 | -3.117 | -0.367 |
| **Standard deviation** | 0.926 | 1.766 | 0.606 |

Table (2)

Mean lengths, variance and standard deviation of the different sub-populations (age groups) of **females** **Lethrinus variegatus** from the Red Sea.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| **Mean length (cm)** | 11.05 | 15.31 | 18.89 | 22.38 |
| **Variance** | -0.802 | -2.819 | -1.856 | -1.199 |
| **Standard deviation** | 0.895 | 1.679 | 1.362 | 1.095 |

To evaluate the reliability of scales for age determination, they were examined and the following results were obtained:

(1) As the fish grows the number of scales on the lateral line of the examined specimens was found to be nearly constant (46 - 47). Moreover, the fallen scales are replaced by new "regenerated" ones in which the characteristic structure of the central area of a normal scale is missing.

(2) The increase in size of fish is accompanied by an increase in the number of annuli on the scale. Hence, the scales of larger fish show more annuli than those of smaller ones.

(3) The close approximation between calculated and observed lengths in any age group is an additional evidence of the validity of the annulus as a true year mark.

(4) Samples collected during February and March have true annuli on the marginal region or close to it. On the other hand, samples collected from April to the following January show variation in the marginal growth of the scale. The marginal increment increases progressively from April till January of the next year, where the highest value is recorded.

(5) There is a relation between the type of circuli and season of growth. Narrow bands of circuli have been found at the margin during winter period (Dec.-Feb.), while the broader bands of circuli have been found at the margin during the summer period.

(6) The close agreement between the mean lengths estimated by Bhattacharya method for the different age groups and the back-calculated lengths shows clearly the validity of scalemetry and the accuracy of age determination for **L. variegatus**.

**Growth in Length**

a- Body Length-Scale Radius Relationship:

The relationship between the total body length (cm) and scale radius (mm) of males and females were studied and the following regression equations were computed:

**Fore males**

$$L = 1.2851 + 6.8326\ S$$

with $r = 0.996309$

**For females**

$$L = 0.8243 + 7.4129\ S$$

with r = 0.993889

Where,
L= total length in centimeter.
S = scale radius in millimeter.
r = correlation coefficient.

b- Back - Calculation:

The total lengths at the end of each year of life were back-calculated using the following equations:

For màles

$$l_n = s_n / S ( L-1.2851) + 1.2851$$

For females

$$l_n = s_n / S ( L-0.8243) + 0.8243$$

Where,
$l_n$ = calculated lengths at the end of n th. year.
L = total length at capture.
$s_n$ = scale radius to nth. annulus.
S = total scale radius.

The back-calculated lengths at the end of the different years of life for males and females are given in Tables (3) and (4). From these tables, it is clear that the highest growth rates of males and females takes place in the first year of life, after which the annual increment decreases with further increase of age. It is also evident that the growth rates of males and females at the end of the first year of life are nearly the same. In the second and third years of life, males showed a relatively higher growth rates than those of females. Fishes older than three years are only represented by females.

The only work that we found in literature concerning age and growth of this species is that of Salem (1976). She found that the life span of **L. variegatus** from the North-western part of the Red Sea is three years. She gave the following back-calculated lengths at the end of the three years of life:

| Age | 1 | 2 | 3 |
|---|---|---|---|
| Back-calculated lengths | 7.7 | 13.3 | 17.1 |

It is worthmentioning here to state that she used the standard lengths and combining the data of both sexes.

Table (3)
Average back-calculated lengths at the end of different years of life of *Lethrinus variegatus* (males) from the Red Sea.

| Age group | Frequency | Mean length at capture (cm) | Average calculated lengths at the end of each year (cm). | | |
|---|---|---|---|---|---|
| | | | 1 | 2 | 3 |
| I | 119 | 13.75 | 11.13 | | |
| II | 51 | 17.80 | 11.10 | 16.19 | |
| III | 9 | 20.00 | 11.11 | 15.54 | 19.29 |

TABLE 4
Average back-calculated lengths at the end of different years of life of *Lethrinus variegatus* (females) from the Red Sea.

| Age group | Frequency | Mean length at capture (cm.) | Average calculated length at the end of each year (cm.) | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| I | 82 | 13.57 | 11.04 | | | |
| II | 61 | 16.98 | 11.01 | 15.74 | | |
| III | 22 | 19.78 | 10.77 | 15.56 | 18.73 | |
| IV | 6 | 22.55 | 10.76 | 15.07 | 18.50 | 21.03 |

## Length – Weight Relationship

For the calculation of the length-weight relationship of males and females, 245 and 247 fish were used and the results are presented in Table (5).

TABLE 5
Estimated constants of length-weight relations of *Lethrinus variegatus* from the Red Sea.

| Sex | No. of Fish | Range (cm.T.L.) | $W = a L^b$ a | b | Correlation Coefficient (r) |
|---|---|---|---|---|---|
| Males | 245 | 10.0-22.5 | 0.0186726 | 2.846742 | 0.9837237 |
| Females | 247 | 9.0-24.2 | 0.0319122 | 2.654793 | 0.9878134 |

## Growth in Weight

The calculated weight at the end of each year at life for males and females were estimated by applying the corresponding length-weight equation to the back-calculated lengths, and the results are represented in Tables (6) and (7). The data shows that the growth in weight for both sexes is much slower in the first year of life and then the annual increment in weight increases progressively in the second year. It is also evident that males and females have nearly the same weights during the first year of life, after which males characterised by a higher growth rates than the females.

TABLE 6
Calculated weight at the enf of different years of life of *Lethrinus variegatus* (males) from the Red Sea.

| Age group | Frequency | Calculated weight at the end of each year (gm.) 1 | 2 | 3 |
|---|---|---|---|---|
| I | 119 | 17.81 | | |
| II | 51 | 17.67 | 51.75 | |
| III | 9 | 17.71 | 46.05 | 85.21 |

TABLE 7
Calculated weight at the end of different years of life of
*Lethrinus variegatus* (females) from the Red Sea.

| Age group | Frequency | Calculated weight at the end of each year (gm.) | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| I | 82 | 18.74 | | | |
| II | 61 | 18.61 | 48.06 | | |
| III | 22 | 17.55 | 46.61 | 76.26 | |
| IV | 6 | 17.51 | 45.82 | 73.80 | 103.72 |

## Theoretical Growth

The Von Bertalanffy theoretical growth equations for growth in length and in weight can be written in the form:

$$l_t = L_{\infty} [ 1 - e^{-K (t - t_0)} ]$$ for growth in length, and

$$W_t = W_{\infty} [ 1 - e^{-k (t - t_0)} ]^b$$ for growth in weight,

Where:
$l_t$ = length at age t.
$L_{\infty}$ = assymptotic length.
k = growth coefficient.
$t_0$ = age at which the length is theoretically nill.
$W_t$ = weight at age t.
$W_{\infty}$ = theoretical maximum weight calculated by the conversion of theoretical maximum length using the length-weight equation.
b = the exponent of the length-weight equation.

The Von Bertalanffy parameters were estimated using the Ford (1933) and Walford (1946) methods and the following equations were computed

**For males**

$$l_t = 24.19 [ 1 - e^{-0.4899 ( t + 0.2575)} ]$$

$$W_t = 162.32 [ 1 - e^{-0.4899 ( t + 0.2575 )} ]^{2.846742}$$

**For females**

$$l_t = 25.68 [ 1 - e^{-0.3808 ( t + 0.4886 )} ]$$

$$W_t = 176.25 [ 1 - e^{-0.3808 ( t + 0.4886)} ]^{2.654793}$$

From the computed parameters, it is clear that females have a higher maximum theoretical length L and weight W than males. It is also obvious that males have a higher value of "K" than females, indicating a higher diminition of growth rate of males with the increase of length.

**Demographic Structure**

a- Length Frequency:

The length frequency distribution of males and females of **Lethrinus variegatus** are represented in Fig (1). The size of males ranged from 10 to 22.9 cm with three modes at 11, 14 and 20 cm. The size of females ranged from 9 to 24.9 cm and showed four overlaped model structure at the lengths 11, 16, 19 and 22 cm.

b- Age Composition:

The age composition of L. **variegatus** in the catch varied among sexes. Our results showed that the life span of this species was three years for males and four years for females. Fishes of age group I were the most abundant and contributed 66.5% and 47.9% for males and females, respectively, (Table 8). It is also evident that both males and females are fully recruited to the fishery at age $1^+$.

c- Mortality:

Mortality estimates of males and females are based on the analysis of catch curve and length frequency composition. Three different methods, namely Chapman and Robson, semilogarithmic and coded mean age, were used for estimating mortality from age composition. On the other hand, mortality estimates from length frequency composition were carried out by the methods of Pauly and Jones. The estimated results are presented in Table (9). From this table it is clear that males are characterized by a higher instantaneous mortality coefficient than females (Z = 1.2713 for males and 0.8857 for females).

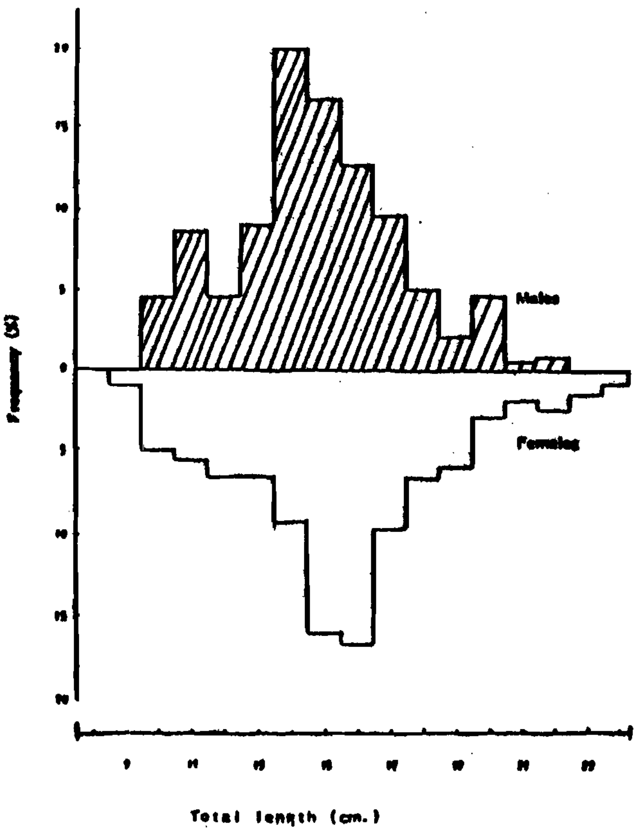


Fig. (1)

Length frequency distribution of *Lethrinus variegatus* from the Red Sea.

Table (8)
Age composition of males and females of Lethrinus variegatus
from the Red Sea.

| Age group | MALES | | FEMALES | |
|---|---|---|---|---|
| | No. | % | No. | % |
| I | 119 | 66.5 | 82 | 47.9 |
| II | 51 | 28.5 | 61 | 35.7 |
| III | 9 | 5.0 | 22 | 12.9 |
| IV | - | - | 6 | 3.5 |
| Total | 179 | | 171 | |

Table (9)
Estimated annual mortality rate (A), survival rate (S) and instantaneous
mortality coefficient (Z) of Lethrinus variegatus
from the Red Sea.

| Method | MALES | | | FEMALES | | |
|---|---|---|---|---|---|---|
| | A | S | Z | A | S | Z |
| Chapman and Robson | 0.7207 | 0.2793 | 1.2753 | 0.5808 | 0.4192 | 0.8693 |
| Semilogarithmic | 0.7250 | 0.2750 | 1.2909 | 0.5872 | 0.4128 | 0.8848 |
| Coded mean age | 0.7218 | 0.2782 | 1.2793 | 0.5822 | 0.4178 | 0.8722 |
| Pauly | 0.7158 | 0.2842 | 1.2581 | 0.5916 | 0.4084 | 0.8955 |
| Jones | 0.7143 | 0.2857 | 1.2528 | 0.5960 | 0.4040 | 0.9062 |
| Mean | 0.7195 | 0.2805 | 1.2713 | 0.5875 | 0.4124 | 0.8857 |

## REFERENCES


Battacharya, C. G., 1976. A simple method of resolution of a distribution into Gaussian componrnts. Biometrics, 23, 1: 115-135.

Chapman, D. G. and P. S. Robson, 1960. The analysis of a catch curve. Biometrics, 16: 345 - 368.

Ford, E., 1933. An account on the herring investigation conducted at Plymouth. J. Mar. Biol. Ass. U.K., 19: 305 - 384.

Jones, R., 1981. The use of length composition data in fish stock assessment (with notes on VPA and cohort analysis). FAO Fish. Circ., (734): 55 P.

Lea, R., 1920. A review of the methods of age and growth determination in fishes by means of scales. Min. Agr. Fish. Invest. Series, 4: 32-63.

Pauly, D., 1983. Some simple methods for the assessment of tropical fish stocks. FAO Fish. Tech. Pap., (234): 52 P.

Ricker, W. E., 1975. Computation and interpretation of biological statistics of fish populations. Fish. Res. Board of Canada, Bull, 191, 382 P.

Salem, S. A., 1976. On the biology of two Lethrinus species (from the Red Sea). Ph.D. Thesis, Cairo University, A.R.E.

Von Bertalanffy, L., 1934. Untersuchungen uber die Gesetzlichkeit des wachstums. 1. Allgemeine Grundlagen der theorie. Wilhelm Roux. Arch. Entumech. Org., 131: 613-653.

__________, 1983. A quantitative theory of organic growth. Hum. Biol., 10: 181-213.

__________, 1949. Problems of organic growth. Nature, 13: 163-158.

Walford, L. A., 1946. A new graphic method of describing the growth of animals. Biol. Bull., 90: 141-147.