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THE POPULATION DYNAMICS OF LETHRINUS BUNGUS FROM THE EGYPTIAN RED SEA COASTAL WATERS

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ABSTRACT

Assessment of MSY, MEY and mortality coefficients of Lethrinus bungus are based upon its age composition and growth parameters of the von Bertalanffy growth formula obtained by Salem (1990), where L = 25.59 cm, K = 0.378395 year, t0 = -0.929955 and W = 438.66 grams, and age composition at the different years of life, were 251, 804, 171, 119 and 51 for eges 0^+, 1^+, 2^+, 3^+, and 4^+, respectively. The maximum sustainable yield (MSY) and maximum economic yield (MEY) per recruit for Lethrinus bungus, were 34.446 and 32.24 grams, respectively.

INTRODUCTION

Lethrinid fishes are amongst the most widely distributed types of economic importance in the Egyptian Red Sea waters where they from a major component of long and hand-line catches. The fishery assessments are generally based on dynamic pool analysis, which utilizes parameters of growth, recruitment and mortality rates (Ricker, 1975). Fundamental to an estimation of this parameter is the reliable technique for determining age, and this together with an estimate of growth has been developed for Lethrinus bungus (Salem, 1990).

Once reliable age can be assigned to individual fish, an age frequency distribution is readily obtained. Hence, survival and mortality rates can be computed from these data (Ricker, loc. cit.).

On the whole, the biological studies and population dynamics of economic fishes have been subject to limited studies. The present work is directed to Lethrinus bungus in this respect. So, the attempt is made in this paper to assess age length key, age composition, total mortality (Z), Natural mortality (M), Fishing mortality (F), length at first capture and yield per recruit coincides with the maximum sustainable yield (M S Y) and maximum economic yield (M E Y).

MATERIAL AND METHODS

The catches were sampled periodically during the period from January to December during 1987. For each specimen of the sample, the standard length and the weight of fishes were recorded to the nearest centimeter. Scales, beneath the pectoral fin of the sampled fish, were removed for the fish

ranging from 5 to 25 cm standard length (Salem, 1990). The age of fish from these scales is defined as being equivalent to the number of annuli present on the scales.

Age - Length Key and Age Composition Construction

The catch age composition was determined by the use of age-length key, constructed from scales' readings. Age - length key was constructed from the proper sampled fish adopted in age determination. Then, the total collected length frequency data were converted by the use of that previously prepared one into its respective age. Age composition is then estimated as the total number of fish corresponding to the different age groups.

Estimation of Mortality Rates

For the calculation of mortality rates, the instantaneous mortality coefficient of Lethrinus bungus was estimated first according to Robson and Chapman (1961), Jackson (1 and mean coded age method. It is known that these m depend mainly upon the use of age composition frequen ed: obtained previously from age determination.

For Robson and Chapman (1961) method, the equation us

$$S = T / N + T - 1 \text{ ; for Jackson (1939):}$$
$$S = N - N_o / N - N_x \text{; for Heinke (1913):}$$
$$S = N - N_o / N \text{ and for "mean coded age":}$$
$$S = x / 1 + x; \quad \text{and} \quad x = T / N$$

Where, S is the survival rate, N_o is the symbol of the age of full recruitment, $T = N_1 + 2N_2 + \ldots\ldots\ldots x\, N_x$ (N_1 is the next age of that of full recruitment), $N = N_o + N_1 + \ldots N_x$.

The instantaneous total mortality coefficient (Z) is equal to "minus" the natural logarithm of survival rate (S).

Instantaneous natural mortality coefficient (M) was estimated according to :

1- Pauly (1983) using the equation:

$$\text{Log } M = -0.0066 - 0.276 \text{ Log } L_T + 0.6543 \text{ Log } K + 0.4634 \text{ Log}$$

2- Garcia and Reste (1981) using the following formula:

$$M = -\text{Log}_e (N_t / N_o) / t.$$

Where, M is instantaneous natural mortality coefficient,

N_t is the frequency of the maximum age t,
N_o is the frequency of fully recruited age

group,

T is the water temperature.

Instantaneous fishing mortality coefficient (F) is a result of subtraction of natural mortality from the total mortality coefficient (F = Z - M)

RESULTS

1- Age-Length Key and Age Composition

Age length key of L. lethrinus bungus is illustrated in Table 1 and graphically represented in Figure 1. Thus, length of fishes belonging to 0^+ age group extend from 5 to 14 cm. Whereas fishes below 11 cm totally belong to group

TABLE 1
Age-length key for Lethrinus bungus

Length Interval (cm)	Age Groups 0^+	1+	2^+	3^+	4^+	Total
5 - 5.9	8					8
6 - 6.9	10					10
7 - 7.9	5					5
8 - 8.9	3					3
9 - 9.9	3					3
10- 10.9	30					30
11- 11.9	86					86
12- 12.9	79	78				157
13- 13.9	21	136				157
14- 14.9	6	151				157
15- 15.9		179	13			192
16- 16.9		131	8			139
17- 17.9		81	35			116
18- 18.9		40	37	3		80
19- 19.9		80	33	29		70
20- 20.9			26	13	4	43
21- 21.9			6	46	6	58
22- 22.9			7	15	15	37
23- 23.9			6	13	12	31
24- 24.9					9	9
25- 25.9					5	5
Total Number	251	804	171	119	51	1396
Average Length	11.404	15.236	18.915	21.171	23.108	
Varience	3.592	2.841	3.553	1.766	1.885	

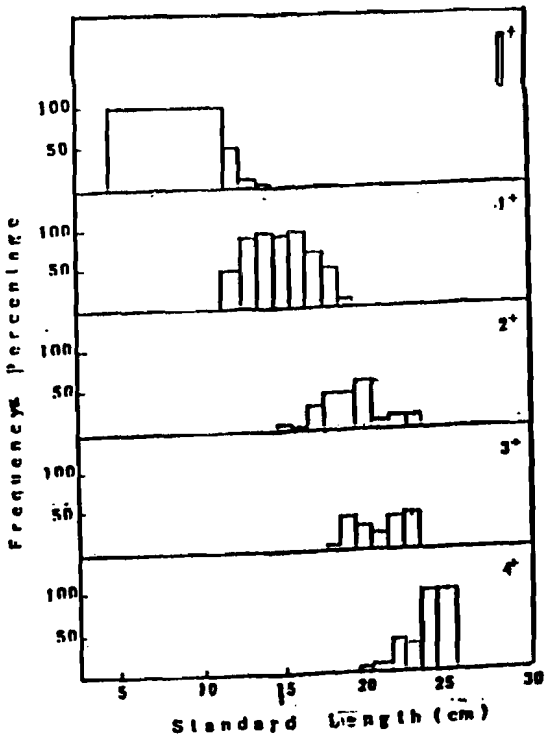

Fig. 3
Age-length key of Lethrinus bungus.

0^+, the length from 12 to 14 cm have an overlapping between fishes belonging to 0^+ and others belonging to age group 1^+. Moreover, fishes of age group 1^+ are also fully recruited in the catch.

Of 1396 individuals, there are 804 ones belonging to the age group 1^+ and 171, 119, and 51 individuals belonging to age groups 2^+, 3^+ and 4^+, respectively. The percentages of different ages from 0^+ to 4^+ were 17.98, 57.59, 12.25, 8.52 and 3.65, respectively (Table 2).

2- Instantaneous Total Mortality Coefficient

Table 3 represents the survival rates and instantaneous total mortality coefficient. The result by the four incorporated methods Robson and Chapman (1961), Jackson (1939), Heinke (1913) and mean coded age are to some extent comparable. Whereas the survival rate ranged from 0.29 to 0.32, the instantaneous total mortality ranged from 1.11 to 1.21.

TABLE 2
Age composition of Lethrinus bungus

Age	0+	1+	2+	3+	4+	Total
No.	251	804	171	119	51	1396
%	17.98	57.59	12.25	8.25	3.65	100.00

TABLE 3
The survival rate and instantaneous total mortality rate of Lethrinus bungus from the Egyptian Red Sea Coast.

Method	Survival Rate (S)	Total Mortality (Z)
Robson and Chapman (1961)	0.329426	1.110400
Jackson (1939)	0.311700	1.165714
Heinke (1913)	0.297817	1.211280
Mean coded age	0.329233	1.11099
Average	0.317044	1.149596

3- Natural and Fishing Mortality Coefficient

According to Pauly (1983), the natural mortality coefficient is estimated using water temperature 24.4°C (Morcos, 1970) as the following:

Log M = -0.006 - 0.279 Log (25.59) + 0.65433 Log (0.378395) + 0.4634 Log (24.4).

The author referred to that there is a group of tropical fishes, in which the estimates may be biased and he suggested, that it is appropriate to multiply it by 0.8. Hence, M is computed as 0.742001 as shown in Table 4. However, the estimate of natural mortality by Garcia and Reste (1981) method gave a relatively comparable result to that of Pauly (1983).

TABLE 4
Estimation of instantaneous natural mortality rate of Lethrinus bungus.

Subject / Method	Pauly (1983)	Carcia and Reste (1981)
Instantaneous Natural Mortality (M).	0.742001	0.689443

As known, the total mortality coefficient is really the sum of natural and fishing mortality coefficient (M + F). Thus, when one of these fractions (M or F) is known, the other fraction can be easily derived. Here, the fishing mortality coefficient is calculated by subtraction of the natural mortality coefficient (M) from the total mortality coefficient (Z). Where F = 1.149596 -0.742001 + 0.407595.

4- Length and Age at First Capture

Length at first capture of Lethrinus bungus was estimated using the formula:

$$L_C = L - K (L - L) / Z$$ ....Beverton and Holt (1956).

where L_C = 12.54 cm.

Age at first capture is also estimated according to the equation:

$$L_C = 1 /k \text{ Loge } (L / - L_C) + t_o.$$

where tc = 0.25 year.

5- Exploitation Ratio

According to Ricker (1958), the exploitation ratio can be estimated using the following equation:

$$U = F / M + F (_1 -e -M + F)$$

where, U is the exploitation ratio.

F is the instantaneous fishing mortality rate.
M is the instantaneous natural mortality rate.

For Lethrinus bungus, the exploitation ratio is 0.24224.

6- Yield per Recruit

Yield per recruit (Y / R) was determined according to the model proposed by Beverton and Holt (1957) and expressed in the form:

$$Y/R = F \exp [- M (T_c - T_r)] W [1/2 - \frac{3S}{Z+3K} + \frac{3S}{Z+K} - \frac{S^3}{Z+2K}]$$

$$\text{and} \quad S = \exp [- k (T_c - T_o)]$$

where the parameters involved and their measures included calculation were:

F is instantaneous fishing mortality =0.407595

M is instantaneous natural mortality =0.742001

T_c is age at first capture =0.85 year

T_r is age at recruitment =0.20 year

W is asymptotic body weight =438.66 gram

Z is instantaneous total mortality rate =1.149596

K is coefficient of growth =0.378395 year

T_o is the Von Bertalanffy growth parameter =-0.929955

The results of the estimation of yield per recruit (Y/R) for Lethrinus bungus, adopted in this study, were graphically represented in Figure 2. It shows that maximum sustainable yield can be attained at the level of F = 2.4, reaching 34.446 grams, while at the level of the fishing mortality operating (= 0.407595), the Y/R value was 23.87 grams.

However, the maximum economic yield can be attained at the level of instantaneous fishing mortality, nearly above 1.0, at which yield per recruit attains 32.24 grams (Fig. 2).

Biomass was analysed by dividing the yield per recruit (Y/R) of Lethrinus bungus by the corresponding fishing mortality (F) or B = (Y/R) /F. It is evident that the biomass at the maximum yield per recruit is 14.35% and 59.68% at the level of properly operating fishing mortality, while the biomass at the level of maximum economic yield is 32.247%.

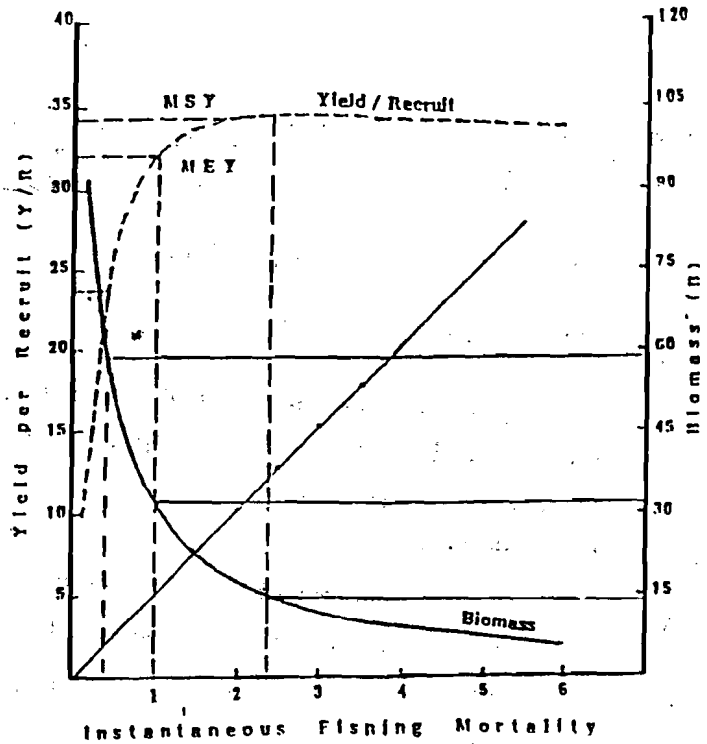

FIG. 2
Yield per recruit (Y/R) and Biomass (B) of Lethrinus bungus.

DISCUSSION AND CONCLUSION

The results show that the maximum sustainable yield is reached at the level of F = 2.40, at which Y/R reaches 34.446 grams. As it is known, the fishery biologists have agreed that the maximum sustainable yield is not the preferable target in fisheries management, but the tasked one in reaching is the level of economic yield (Table 5).

The present study shows that the fishing mortality rate of Lethrinus bungus in the Egyptian Red Sea coast is very low and that the population is nearly far from optimum exploitation. For the instantaneous fishing mortality (F = 0.4), which is properly operating in the area, the yield per

TABLE 5
Exploitation ratio (U), yield per recruit and biomass of Lethrinus bungus in the Egyptian Red Sea

Fishing Mortality (F)	Yield per Recruit (Y/R grams)	Exploitation Ratio (U)	Biomass (B)
0.4	23.870	0.2422	59.68%
1.0	32.240	0.4735	32.241%
2.4	34.446	0.7308	14.35%

recruit (Y/R) values were 23.87 grams, corresponding to an exploitation ratio (U) equal to 0.2422. For reaching the optimum value of exploitation, commonly known as the maximum economic yield, the optimum fishing mortality is then equal to 1.0, at which the yield per recruit is 32.24 grams and the exploitation ratio 0.4635 (reaching nearly double the properly working exploitation ratio).

Biomass encountered here is reduced from 59.68% at the level of fishing mortality working to 32.241% for reaching the optimum or economic yield exploitation ratio.

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