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SOME BIOLOGICAL ASPECTS ON THE HAKE MERLUCCIUS MERLUCCIUS MEDITERRANEUS L. FROM THE EGYPTIAN MEDITERRANEAN WATERS.

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ABSTRACT

Samples of Merluccius merluccius mediterraneus L. from the Egyptian Mediterranean waters were studied and compared for the years 1961, 1972 and 1992. The length-weight relationship is computed. Results showed no statistical difference at the 95 % prob. Level between the weight-at-Length data of the three sampled periods, while the condition factor estimates proved that the value of 1972 period was lower than the others. This was attributed to the adverse environmental conditions exerted after building the Aswan dam that prevented the Nile water from flooding into the area. This in turn affected the availability of nutrients and food for the flora and fauna of the area. The parameters for the Von Bertalanfy Growth Formula (VBGF) were calculated and the annual Mortality rates were computed.

The results proved also that the fishery of this species in the investigated area was and still depending on the age classes 2 - 4 years. These contribute about 73 % by numbers and /or 53 % by weight of the landing from the species. The value of (E) obtained indicates that the fishery of this species is shifted towards overfishing and calls for some regulatory measures to be considered for the trawl fishery in the area.

INTRODUCTION

Hake fishes are valuable edible large fishes. They are carnivorous feeding on crustacea while young; then prefer sardines when adult, Karlovac (1959). Among the various subspecies distributed all over the world, Merluccius merluccius mediterraneus L. is recorded in the Mediterranean sea (Soliman. 1973). Figueras (1965), stated that there are some geographical differences between species from the Atlantic and the Mediterranean as from the biological aspects point of view. While Merluccius merluccius mediterraneus L. is of economical importance in many countries, yet; it is represented by marginal percent in the Egyptian fish catch (Anon, 1962-1988). In the Egyptian waters; Hashem (1972), reported that M. m. mediterraneus was insignificantly represented through out the year at shallow depths less than 100 meters, while at 100 - 200 meters it was the most dominant fish in the month of May giving a catch of 3.434 Kg /trawling hour, while in August it gave only 1.363 kg.

The present study is an attempt to understand the various biological aspects of *M. m.* **mediterraneus** in the Egyptian Mediterranean Waters and to compare them with that obtained from other parts of the world. It is also an attempt towards management of the Hake's fishery in Egypt.

MATERIALS AND METHODS

Samples of *M. m.* **mediterraneus** were collected from the fishmarket during 1992. The samples were treated likewise other ones of the same species collected on several back occasions during 1961 and 1972 for the sake of comparison. Back calculation of the age was estimated via otolith reading. The otolith was broken from a transverse cross-section through the center of the nucleus. The otolith's broken surface was burnt in a crucible until it reached a light-brown color. The prepared section was mounted in plasticine, immersed in xylol, illuminated from above and viewed under a stereo-microscope at X10.

Growth in length was determined from the otolith using lee's formula (1920):

$$L_n = L_t \ (O_n \ / \ O_t) \qquad (1)$$

where:

L_t is the total fish length at capture;

L_n is the length at n years;

O_t is the total scale radius;

O_n is the radius at n years

The length and weight data of each sampling year-namely 1961, 1972 and 1992- was worked on separately. The student T-test was applied to compare the growth of both sexes within each of the mentioned sampling year.

The parameters of Von Bertalanffy's Growth Formula (VBGF) were obtained by fitting the length at age data into Ford-Walford Plot method to estimate Loo and K according to Pauly, (1980).

Total Fishing Mortality (Z) was estimated by three methods:-

1) Catch curve method, by applying the equation:

$$\log N = a + b\ t \qquad (2)$$

where (N) represents the numbers of fishes at different age group (t). The regression analysis was carried out between log (N) against (t), then the resultant (b) which is the equation constant that represents the slope of the curve equals (Z), Ricker, (1975).

2) Beverton and Holt method, in which:

$$Z = K \, (Loo - L) \, / \, (L - L^{*}) \qquad (3)$$

where K and Loo are the growth constants, (L) is the mean length of the catch and (L*) is the smallest fish length that was Fully represented in the catch (Beverton and Holt, 1957).

3) ELEFAN program: (Electronic Length Frequency ANalysis).

It is a program designed to estimate mortality and related parameters from length frequency data. In which are given a representative set of length frequency samples and a set of "seed" growth parameters (Loo and K of Von Bertalanffy Growth Formula) to estimate the total Mortality (Z) according to Pauly et al., (1983). This program will also be used for optimizing VBGF's parameter-combinations obtained by applying the length frequency data.

The natural mortality coefficient (M) was estimated according to the equation suggested by Pauly (1983);

$$\text{Log } M = 0.0066 - 0.279 \text{ Log } Loo + 0.6543 \text{ Log } K + 0.4634 \text{ Log } T$$

where Loo and K are the growth parameters, while T is the annual mean temperature (in ^{o}C) of the water inhabited by that population.

The fishing mortality (F) is calculated by simple subtraction of the value of M from the value of Z, since:-

$$Z = F + M \qquad (5)$$

The Exploitation ratio (E) is estimated by the following equation according to (Gulland, 1971) as:

$$E = F \, / \, (F + M) \qquad (6)$$

The Von Bertalanffy Growth Formula is represented as follows:

$$Lt = Loo \, (1 - e^{-k(t - to)}) \qquad (7)$$

where:

Lt = length at age t; Loo = asymptotic length of fish (ie. its maximum length),
e = base of the natural logarithm,
k = growth coefficient,
t = age of the fish in years,
and t_o = a parameter indicating the hypothetical time at which the fish would have been of zero size.

The theoretical weight growth equation of Von Bertalanffy was fitted to the weight at age data computed from the back calculated length as follows:-

$$Wt = Woo \left(1 - e^{-k(t - to)} \right) \qquad (8)$$

Statistical analysis of the data was carried out according to the standard methods described by Snedecor (1956). Computation of the biological statistics of fish populations was done according to the standard methods described by Ricker (1975). The mortality estimates is based on the length-frequency data as given by Pauly (1983).

RESULTS AND DISCUSSION

Length-Weight Relationship:

The study of length-weight relationship in fishes has been usually directed towards two objectives:-

(1) Either providing a mathematical relation between the two measurements as that one may be converted to the other.

(2) To calculate the general well-beipg of the fish or its condition factor), Le Cren (1951).

The length-weight relationship is well expressed as a power equation in the form of:

$$W = a\ L^b \qquad (9)$$

Where W is the fish weight, L is body length and a, b are constants. This relationship is affected by various factors such as the availability of food, rate of feeding, development of gonads, spawning...etc. So, for a length-weight equation to be most useful, it should include fishes of both sexes, sampled at various times of the year.

Based on the results that there is no statistical difference between the mean weight-at-length of both males and females; the data was combined for each sampling occasion to calculate their relevant relationship. The results are as follows:

Sampling Year	Regression Parameters a	b	r	Cond. Factor (Std. Dev.)
1961	0.007	3.01	0.985	0.730 (0.100)
1972	0.007	3.00	0.986	0.709 (0.066)
1992	0.005	3.109	0.989	0.772 (0.078)

Based on the above mentioned results; Statistical analysis showed that there is no significant statistical difference between the mean weights of the samples covering the length range 15 - 50 cm for the three sampling occasions 1961, 1972 and 1992 even at probability of less than 0.001%. On the contrary; the mean condition factor of the 1972 sample proved to be statistically lower than either of 1961 or 1992.

This finding proves that the adverse environmental conditions occurred in the Mediterranean waters of Egypt following damming the Nile from flooding into the Mediterranean; adversely affected the well-being of the fish through affecting its food supply. Then, during the present time the fish reached back to its normal condition. The present length-weight relationship of this species is shown in Figure (1) and is represented by equation (10):

$$W = .005\ L^{3.109} \qquad (10)$$

Growth Rates:

The calculated total length at the end of different years of life was obtained from the otolith readings. The values obtained were applied to Ford-Walford plot method to calculate the VBGF parameters. The parameters obtained were plugged into the ELEFAN program to optimize their combination. The results are as follows and are presented in Figure (2).

$L\infty = 61.0$ cm $\qquad K = 0.18 \qquad$ and $\quad t_0 = -0.1$ year

Using the above mentioned parameters, the growth rates relevant to length and weight at different age groups are shown in Table (1). The table shows that the absolute increase in length reaches its highest rate at the first year of life then decreases gradually. The absolute increase in weight shows that the growth in weight during the first to second year is almost 1/2 that of the 2nd to the 3rd year, while 1/3 that of the 3rd to the 4th year. Then growth is almost the same for the years after the 4th. The different types of growth rates are also presented in the

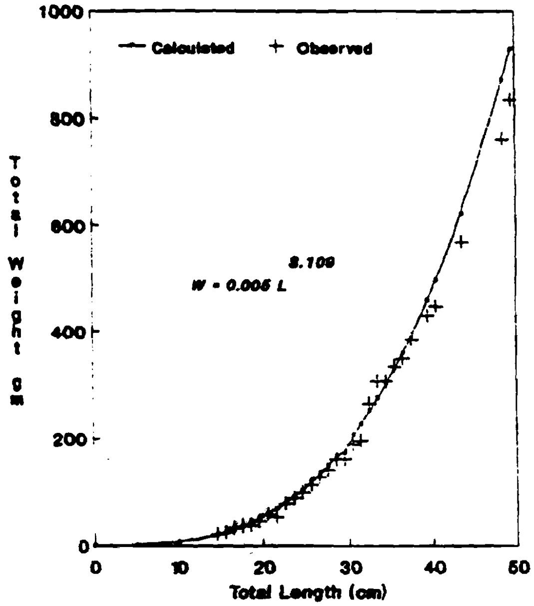
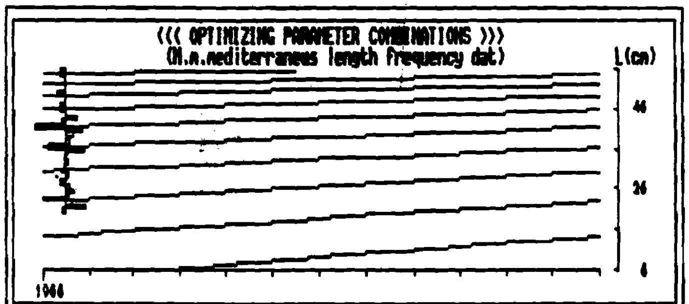


Fig. 1

Length-Weight relationship of *Merluccius merluccius mediterraneus* in the Egyptian Mediterranean waters during 1992.

Fig. 2

ELEFAN Program printout of optimizing VBGF parameter combinations of *M. m. mediterraneus* in the Egyptian Mediterranean waters during 1992.



BASE PT.	L∞ (+/- 1.00)	K (+/-0.010)	C (+/-0.000)	WP (+/-0.000)	STARTING LENGTH SAMPLE	Rn
2	60.00	0.190	0.000	0.000	36.000	0.431
3	60.00	0.180	0.000	0.000	35.500	0.653
4	61.00	0.180	0.000	0.000	35.500	0.702
OPT ?	61.00	0.180	0.000	0.000	35.500	0.702

Press [F7] to rerun the search
[F3] to return to ELEFAN I menu

Table 1.

Growth rates relevant to length & Weight at different Age Groups of: **Merluccius merluccius mediterraneus** L.
K = 0.18 L_{oo} = 61 cm t^{o} = -0.1 years

Age	Intervals of:		Absol Increase in:		Rate of Increase			
	Length (L)	Weight (W)			Relative		Instantan	
(Year)	(cm)	(gm)	(L)	(W)	(L)	(W)	(L)	(W)
1 - 2	10.4 - 18.3	7 - 42	7.9	35	76.0 %	500 %	0.57	1.79
2 - 3	18.3 - 25.0	42 - 111	6.7	69	36.6 %	164 %	0.31	0.97
3 - 4	25.0 - 30.6	111 - 208	5.6	97	22.4 %	87 %	0.20	0.62
4 - 5	30.6 - 35.4	208 - 327	4.8	119	15.7 %	57 %	0.15	0.45
5 - 6	35.4 - 39.4	327 - 456	4.0	129	11.3 %	39 %	0.11	0.33
6 - 7	39.4 - 42.8	456 - 590	3.4	134	8.6 %	29 %	0.08	0.26
7 - 8	42.8 - 45.6	590 - 719	2.8	129	6.5 %	22 %	0.06	0.20
8 - 9	45.6 - 48.0	719 - 843	2.4	124	5.3 %	17 %	0.05	0.16
9 - 10	48.0 - 50.0	843 - 957	2.0	114	4.2 %	14 %	0.04	0.13

Absolute Rate of Increase = $X_2 - X_1$

Relative Rate of Increase = $100 (X_2 - X_1) / X_1$

Instantaneous Rate of Increase = $Ln (X_2) - Ln (X_1)$

Weight is calculated using formula No. (10).

table. The relative contribution of each age group -both in number and in weight- is presented in Table (2). In terms of numbers, the age groups 2 - 4 contribute about 73 % of the population. It was expected that age group 1 - 2 contributes the most and not only 10 %. This could be explained on the bases that this group is not vulnerable to fishing by the commercial fishing net. The contribution in numbers of this group is almost 7 times its contribution in weight. The contribution of group 3 - 4 is almost equal for both number and weight. As the fish increases in age; then its age-group contribution to weight exceeds that to number.

Table 2.

Relative contribution of the different Age Groups of **Merluccius merluccius_mediterraneus** L. in the form of Numbers and /or Weight (Assuming a population of 100 individuals).

Age (Year)	Length Intervals (cm)	Mid Length (cm)	Mid Weight (gm)	Numbers Frequ (%)	Total Weight (gm)	Weight % Relative Contribut.
1 - 2	10.4 - 18.3	14.4	20	10.4	208	1.5
2 - 3	18.3 - 25.0	21.7	71	47.6	3379	24.6
3 - 4	25.0 - 30.6	27.8	154	25.0	3850	27.9
4 - 5	30.6 - 35.4	33.0	263	9.8	2577	18.7
5 - 6	35.4 - 39.4	37.4	388	4.3	1668	12.1
6 - 7	39.4 - 42.8	41.1	520	1.2	624	4.5
7 - 8	42.8 - 45.6	44.2	653	0.6	391	2.8
8 - 9	45.6 - 48.0	46.8	779	0.0	0	0.0
9 - 10	48.0 - 50.0	49.0	899	1.2	1078	7.8
Total				100.1	13775	99.9

For comparison of the growth rates in different localities; the parameters of VBGF were used in this regard are those presented in Table (3). These parameters were used to compute the length-at age values covering the age group 1 - 10 years; the corresponding results are presented in Table (4). Comparing the means of length-at-age of this fish species in the different locality revealed that; that of the present study are smaller than those of Aldebert, 1981 and Alegria and Jukic, 1990 due to a calculated (t) of 10.091 and 6.797 respectively. Meanwhile, they are significantly larger than those of Wurtz and Matricardi, 1986 and Oliver et al 1990 all due to a calculated (t) of 2.851 and 4.428 respectively compared to a tabulated (t) of 2.26 at a p. of .05 and 9 df.

Table 3

Von Bertalanffy Growth Formula (VBGF) parameters for **Merluccius merluccius mediterraneus** L. in different localities.

Author	Locality	L_∞	K	t_o
Aldebert, Y., 1981	Gulf of Lion	62.5	0.166	-0.1669
Wurtz M. & Matricardi, 1986	Ligurian Sea	49.9	0.2095	-0.373
Oliver et al, 1990	Adriatic	78.4	0.1	-0.7
Alegria, V. & Jukie, 1990	Balearic Island	92.83	0.097	-0.692
Present Study	Egypt. Mediterr.	61.0	0.18	-0.1

Table 4.

Comparison between Length-at-Age of Merluccius merluccius mediterraneus L. for various authors in different localities.

AGE Years	Aldebert 1981	Wurtz & M. 1986	Oliver 1990	Alegria 1990	PRESENT STUDY
1	11.0	12.2	11.7	14.1	10.4
2	18.9	19.2	17.6	21.3	18.3
3	25.6	24.8	23.0	27.9	25.0
4	31.2	29.4	27.9	33.9	30.6
5	36.0	33.1	32.3	39.4	35.4
6	40.0	36.1	36.3	44.3	39.4
7	43.5	38.5	40.0	48.8	42.8
8	46.9	40.5	43.2	52.9	45.6
9	48.9	42.1	46.2	56.6	48.0
10	50.9	43.4	48.9	59.9	50.0
MEAN	35.29	31.93	32.71	39.91	34.55
ST. D.	13.43	10.43	12.51	15.41	13.28

Total Mortality (Z):

The ELEFAN program was applied only on the 1992 sample-group to estimate the total Mortality Rate (Z) from both the catch curve and the mean length methods The plot of these sample groups is presented in Figure (3). In the mean time, the value of (Z) obtained by the Beverton and Holt method was 1.16 (covering a length range of 18 - 61 cm with a mean length of 23.8 cm). This value coincides well with that obtained from the ELEFAN program that will be solely considered here in estimating the value of (Z).

Estimating (Z):

From Catch curve (Z) = 1.48 and From Mean length = 1.22
Hence; the Average of (Z) = (1.48 + 1.22) / 2 = 1.35

Natural Mortality (N):

As estimated for (T) = 25 °C hence; M = 0.45

Fishing Mortality (F):

$$F = Z - M = 1.35 - 0.45 = 0.9 \qquad (11)$$

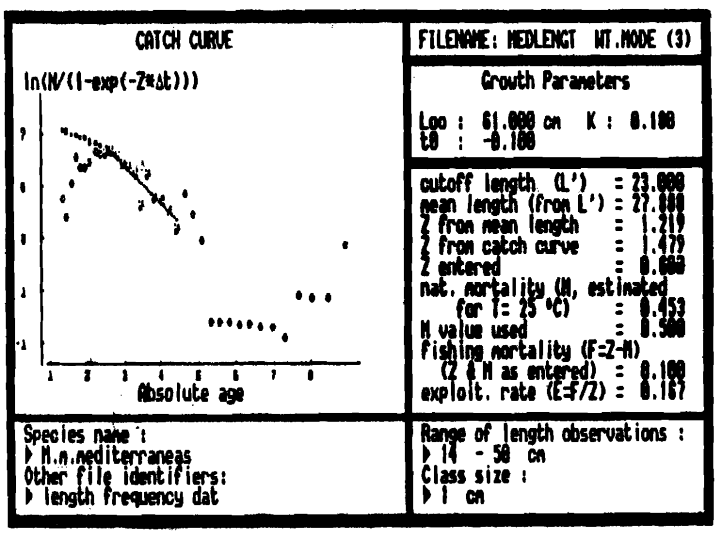


Fig. 3

ELEFAN Program printout of estimating total mortality (Z) of *M. m. mediterraneus* in the Egyptian Mediterranean waters during 1992, using the catch curve method.

Exploitation Ratio (E):

$$E = F / Z = (0.90) / (1.35) = 0.67 \qquad (12)$$

The value of (E) obtained represents a strong alarm that this species is suffering from an over-fishing problem, and correcting measures should be considered.

Assuming that the stock of this species is at equilibrium due to the fact that the production of this fish has been at almost steady level; the Equilibrium Yield from 1000 kg of recruits of **Merluccius merluccius mediterraneus** L. at age 2 years was 1535 kg. The calculated values presented in Table (5) are based on the following values:-

Table 5.

The Equilibrium Yield from 1000 kg recruites of *Merluccius merluccius mediterraneus* starting at age 2 years.
(Z = 1.35 F = 0.9 M = 0.45 E = 0.67)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2	18.3	42			1000		
			0.97	0.684		482	758
3	25.0	111			684		
			0.62	0.462		500	450
4	30.6	208			316		
			0.45	0.407		223	201
5	35.4	327			129		
			0.33	0.361		87	78
6	39.4	456			46		
			0.26	0.336		31	28
7	42.8	590			16		
			0.20	0.317		16	14
8	45.6	719			5		
			0.16	0.304		4	4
9	48.0	843			2		
			0.13	0.295		2	2
10	50.0	957			1		
TOTAL							1535

(1) = Age in years. (2) = Length (cm) at Age.

(3) = Weight (gm) at Age, Computed using $W = 0.005\ L^{3.109}$

(4) = Instantaneous Rate of Growth = (G) = $\ln (W_2) - \ln (W_1)$

(5) = Weight Changing Factor = ($e^{(G - Z)}$)

(6) = Weight of Stock (kg).

(7) = Avg. Weight (kg) = (Weight at Age (n) + Weight at Age (n + 1) / 2

(8) = Yield (kg) = Ave. Weight * (F).

K = 0.18, Loo = 61 cm, to = -0.1 year,

Total Mortality Rate Z = 1.35,
Natural Mortality Rate M = 0.45,
fishing Mortality Rate F = 0.90
and Exploitation Ratio E = 0.67

CONCLUSION

The power equations representing length-weight relationship of Merluccius merluccius mediterraneus in the Egyptian Mediterranean waters are not significantly different among samples collected during the years 1961, 1972 and 1992. The constants of the 1992 length-weight relationship are:-

(a = 0.005 and b = 3.109).

The samples of the 1972 showed a lower condition factor than any of the other sampling years. This difference is attributed to the adverse environnental conditions exerted on the food supply of the fish as a result of preventing the Nile water from flooding into the area after building the Aswan Dam.

The parameters of the VBGF that were obtained by the otolith reading and optimized by the ELEFAN program proved that the fishery of this species in the Mediterranean waters of Egypt is depending mainly on the age classes 2 - 4. Since the optimum exploitation ratio for a healthy fishery is about 0.5, while it reached a value of 0.67 at present. This is a clear indication that heavy fishing activity on this species is taking place and correcting measures should be considered.

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