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POPULATION DYNAMICS OF TWO PICAREL SPECIES IN THE MEDITERRANEAN WATERS, EGYPT

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ABSTRACT

*Population dynamics of two fish stocks belonging to family: Centracanthidae **Spicara smaris** (L.) and **Spicara flexousa** (Raf.) were studied. Samples were collected during 1993 from the catch of the Egyptian Mediterranean trawlers. Results revealed that, the fishing mortality (F= 0.9508) and natural mortality (M= 0.7933) for **S. smaris** was greater than those of **S. flexousa** (F= 0.4168 and M= 0.4741). The survival rate for **S. flexousa** (S= 0.4103) was higher than that of **S. smaris** (S= 0.1748). The yield/recruit for current level of **S. smaris** (3.77 g) was nearly similar to that obtained from the maximum economic level (3.88 g) whereas for **S. flexousa** (9.8 g) was less than the maximum economic level (11.50 g) by about 14.78%.*

INTRODUCTION

Spicara smaris and ***Spicara flexousa*** are the most dominant species of picarels in the Egyptian Mediterranean waters. They are mainly caught by bottom trawlers (Al-Zahaby *et al.*, 1992 and Rizkalla, 1995). Only Tsangridis and Filippousis (1989) gave an approach on the estimation of mortality parameters of ***S. smaris*** in the Saronikos Gulf, Greece. The following paper is considered to be an attempt to evaluate the state of picarel stock in Egypt.

MATERIAL AND METHODS

Samples of picarels (*S. smaris* and *S. flexousa*) from the Egyptian Mediterranean trawlers were monthly collected during the period from January to December 1993. A total of 891 specimens of ***S. smaris*** and 817 of ***S. flexousa*** were taken measuring 7.0 - 17.0 and 8.0 - 21.0 cm respectively. Age of fishes was determined by otolith readings. Length frequency data for both species were converted into age composition using the previous determined ages. The instantaneous total mortality rate (Z) was calculated from the catch curve i.e. from the slope of decreasing right limb of age composition (Ricker, 1975). The value of natural mortality coefficient (M) was determined using the empirical equation of Pauly (1980) :

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

where $L\infty$ and K are the growth parameters and (T) is the mean annual water temperature. The instantaneous fishing mortality coefficient (F) is calculated as a result of subtraction of natural mortality from total mortality : $F = Z - M$ (Beverton and Holt, 1957).

Yield per recruit (Y/R) was determined according to the following model developed by Beverton and Holt (1957) :

$$Y/R = F.\ \exp.\ [-M(t_c - t_r)].\ W\infty \sum_{n=0}^{3} \frac{U_n \exp.\ [-nK(t_c - t_0)]}{F + M + nK}$$

where :

Y= annual yield in weight.
R= annual recruitment.
F= fishing mortality coefficient.
M= natural mortality coefficient.
t_c= age at first capture.
t_r= age at recruitment.
U_n= summation variable taking the values 1, –3, +3, –1 for n= 0, 1, 2, 3 respectively.

$W\infty$, and t_0 are von Bertalanffy's growth parameters. The biomass (B) which is confined as the weight of a stock or some defined portion of it is derived by dividing the yield per recruit (Y/R) by the corresponding fishing mortality (Ricker, 1975).

RESULTS

A- Age composition

Tables (1 & 2) show age composition of the two species of picarels. It is clear that the population of ***S. smaris*** and ***S. flexusosa*** were constituted of five age groups (o^+ - 4^+) of which age group 1^+ & 2^+ comprised 76.09% and 65.60% of the catch respectively.

B- Mortality

B-1- Instantaneous total mortality coefficient (Z)

The catch curves for ***S. smaris*** and ***S. flexousa*** are given in figures 1 and 2 respectively. The total mortality was found to be 1.74410 for ***S. smaris*** and 0.89085 for ***S. flexousa***.

B-2- Natural mortality (M) and fishing mortality (F)

According to Pauly (1983) the natural mortality coefficient was estimated by using the calculated $L\infty$ 20.78 cm) & K (0.2968) for ***S. smaris*** and $L\infty$ (27.51 cm) & K (0.1524) for ***S. flexousa***. Water temperature (T) used in the calculation equal to 21.65 ^{o}C (Maiyza and Said, 1988). The obtained values of natural mortality were 0.7933 for ***S. smaris*** and 0.4741 for ***S. flexousa*** whereas the calculated fishing mortality were 0.9508 and 0.4168 respectively.

B-3- Annual mortality (A)

It was computed from the equation A= 1 – S where (S) the survival rate ($S= e^{-Z}$) is equal to 0.1748 for ***S. smaris*** and 0.4103 for ***S. flexousa***. The calculated values for annual mortalities were 0.8252 and 0.5897 for ***S. smaris*** and ***S. flexousa*** respectively.

C- Exploitation rate (E)

Rate of exploitation gives an indication of whether a stock is over- fished or not on the assumption that the optimal value of (E) is about or equal to 0.5 (Gulland, 1971 and Pauly, 1983). The exploitation rate in the present study (current state) was calculated using the formula E= FA/Z given by Cushing (1968). The values obtained were 0.4498 and 0.2759 for ***S. smaris*** and ***S. flexousa*** respectively.

Table (1): Age-length composition of ***Spicara smaris*** catch in the Egyptian Mediterranean waters..

Length (cm)	Age groups					Total No.
	0^+	1^+	2^+	3^+	4^+	
7.0	2					2
8.0	10					10
9.0	19					19
10.0	36	31				67
11.0	20	72	2			94
12.0	22	109	17			148
13.0		87	82			169
14.0		19	123	4		146
15.0			94	21	2	117
16.0			34	40	5	79
17.0			8	26	3	37
18.0				2	1	3
Total	109	318	360	93	11	891
%	12.23	35.69	40.40	10.44	1.23	100.00

Table (2): Age-length composition of ***Spicara flexousa*** catch in the Egyptian Mediterranean waters .

Length (cm)	Age groups					Total No.
	0^+	1^+	2^+	3^+	4^+	
8.0	3					3
9.0	2	3				5
10.0	3	9				12
11.0	6	37	2			45
12.0		58	19			77
13.0		91	55			146
14.0		39	101	6		146
15.0		2	70	63		135
16.0			41	71	2	114
17.0			7	48	19	74
18.0			2	22	15	39
19.0				4	5	9
20.0				3	7	10
21.0					2	2
Total	14	239	297	217	50	817
%	1.71	29.25	36.35	26.56	6.12	100.00

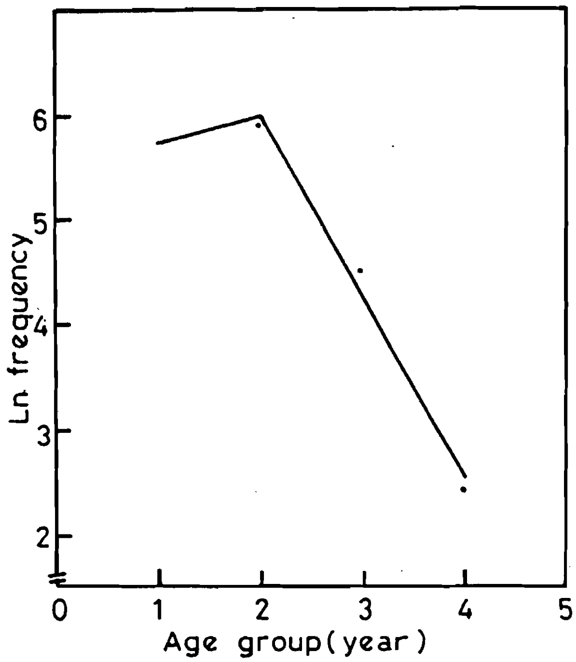

Figure (1): Catch curve of ***S. smaris*** caught by trawlers in the Egyptian Mediterranean waters.

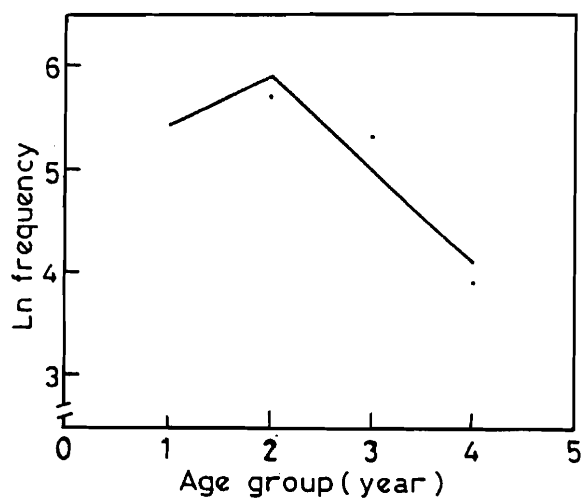

Figure (2): Catch curve of ***S. flexuosa*** caught by trawlers in the Egyptian Mediterranean waters.

D- Length (L_c) and age (t_c) at first capture

The L_c parameter was calculated using the following equation given by Beverton and Holt (1957):

$$L_c = L' - K\,(L\infty - L'/Z$$

where L' the mean length of the total catch equal to 13.12 cm for ***S. smaris*** and 14.41 cm for ***S. flexousa***. The calculated lengths at capture were found to be 11.82 cm and 12.17 cm for ***S. smaris*** and ***S. flexousa*** respectively. By using von Bertalanffy's growth constants, the corresponding ages of these lengths were found to be 1.20 year for ***S. smaris*** and 1.30 year for ***S. flexousa***.

E- Length (L_r) and age (t_r) at recruitment

Recruitment is the process in which young fish enter the exploited area and become liable to contact for the first time with the fishing gear. Length at recruitment was graphically determined from the cumulative curve obtained from plotting the proportions of recruits against the corresponding lengths (Fig. 3 and 4). The lengths obtained were 9.80 cm for ***S. smaris*** and 9.56 cm for ***S. flexousa***. The corresponding ages were 0.52 and 0.27 years respectively.

F- Yield per recruit (Y/R)

Estimations of yield per recruit were given for different fishing mortalities 0.1 up to 7.5 for ***S. smaris*** and 0.1 to 5.0 for ***S. flexousa*** where the input parameters were : M= 0.7933, $W\infty$ = 77.60 g, K= 0.2968, $t_o = -1.63$, $t_c = 1.20$ and $t_r = 0.52$ for ***S. smaris*** and M= 0.4741, $W\infty$ = 228.48 g, K= 0.1524, $t_o = -2.53$, $t_c = 1.30$ and $t_r = 0.27$ for ***S. flexousa*** (Fig. 5 and 6). The results obtained show that the maximum sustainable yield (MSY) for ***S. smaris*** was 7.07 g at fishing mortality F= 6.20 while for ***S. flexousa*** it was 12.25 g at fishing mortality F= 2.0. At the level of the fishing mortality operating where F= 0.95 for ***S. smaris*** and F= 0.40 for ***S. flexousa***, the yield per recruit (Y/R) reached 3.77 g and 9.8 g respectively. As the maximum economic yield MEY (optimum yield) is a preferable target in the fishery management (Beverton and Holt, 1957), it was found to be attained in the present study at exploitation rate 0.4648 for ***S. smaris*** and 0.4523 for ***S. flexousa*** which encountered the fishing mortality F= 1.0 and F= 0.8 respectively (Table 3).

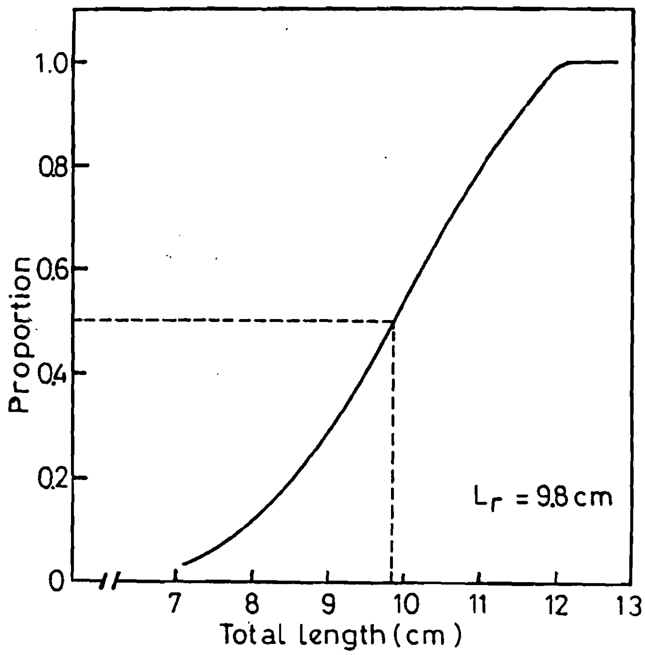

Figure (3): Cumulative curve of recruit proportions at different length for ***S. smaris*** in the Egyptian Mediterranean waters.

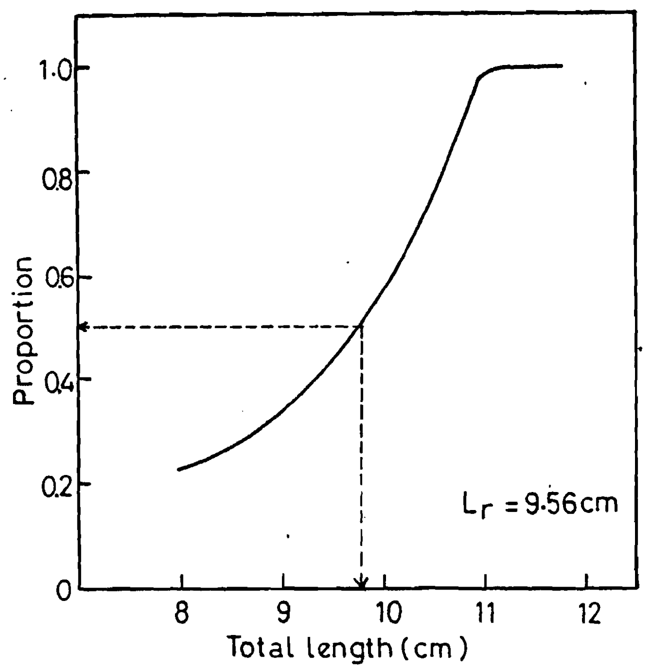

Figure (4): Cumulative curve of recruit proportions at different lengths for ***flexuosa*** in the Egyptian Mediterranean waters.

G- Biomass (B)

From the figures (5 and 6), the biomass for ***S. smaris*** at current yield, maximum economic yield and maximum sustainable yield were 3.97, 3.88 and 1.14 g, while for ***S. flexousa*** they were 24.50, 14.38 and 6.13 g respectively.

Table (3): The exploitation rate, yield per recruit and biomass at different exploitation levels for ***S. smaris*** and ***S. flexousa*** in the Egyptian Mediterranean waters.

Species	Exploitation levels	Fishing mortality (F)	Yield per recruit (Y/R)	Exploitation rate (E)	Biomass (B)
S. smaris	1-Current	0.95	3.77	0.4498	3.97
	2-Maximum (economic)	1.0	3.88	0.4648	3.88
	3-Maximum (sustainable)	6.2	7.07	0.8857	1.14
S. flexousa	1-Current	0.4	9.8	0.2759	24.50
	2-Maximum (economic)	0.8	11.50	0.4523	14.38
	3-Maximum (sustainable)	2.0	12.25	0.7403	6.13

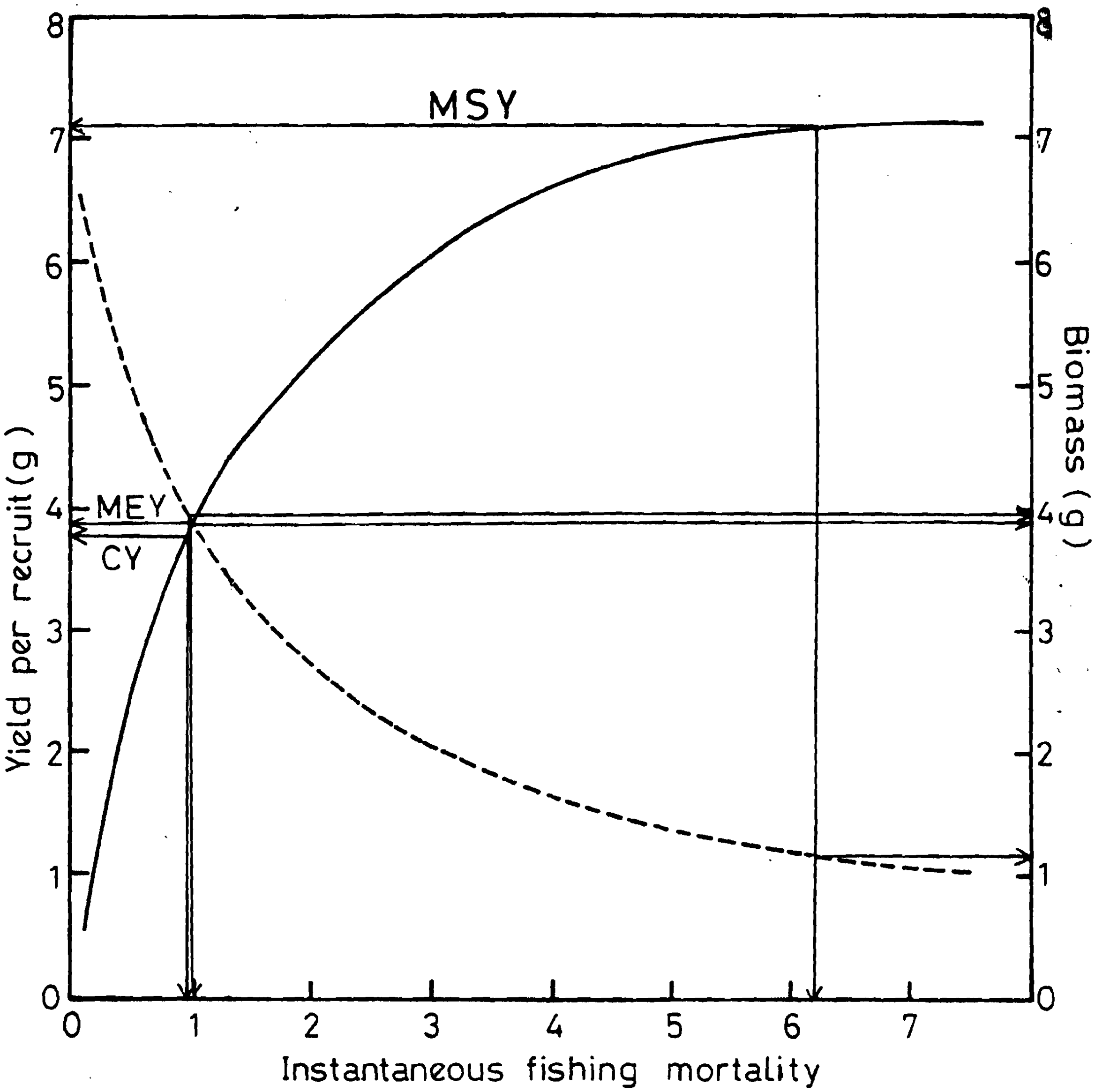

Figure (5): Relation between yield per recruit and fishing mortality for *S. smaris* in the Egyptian Mediterranean waters.

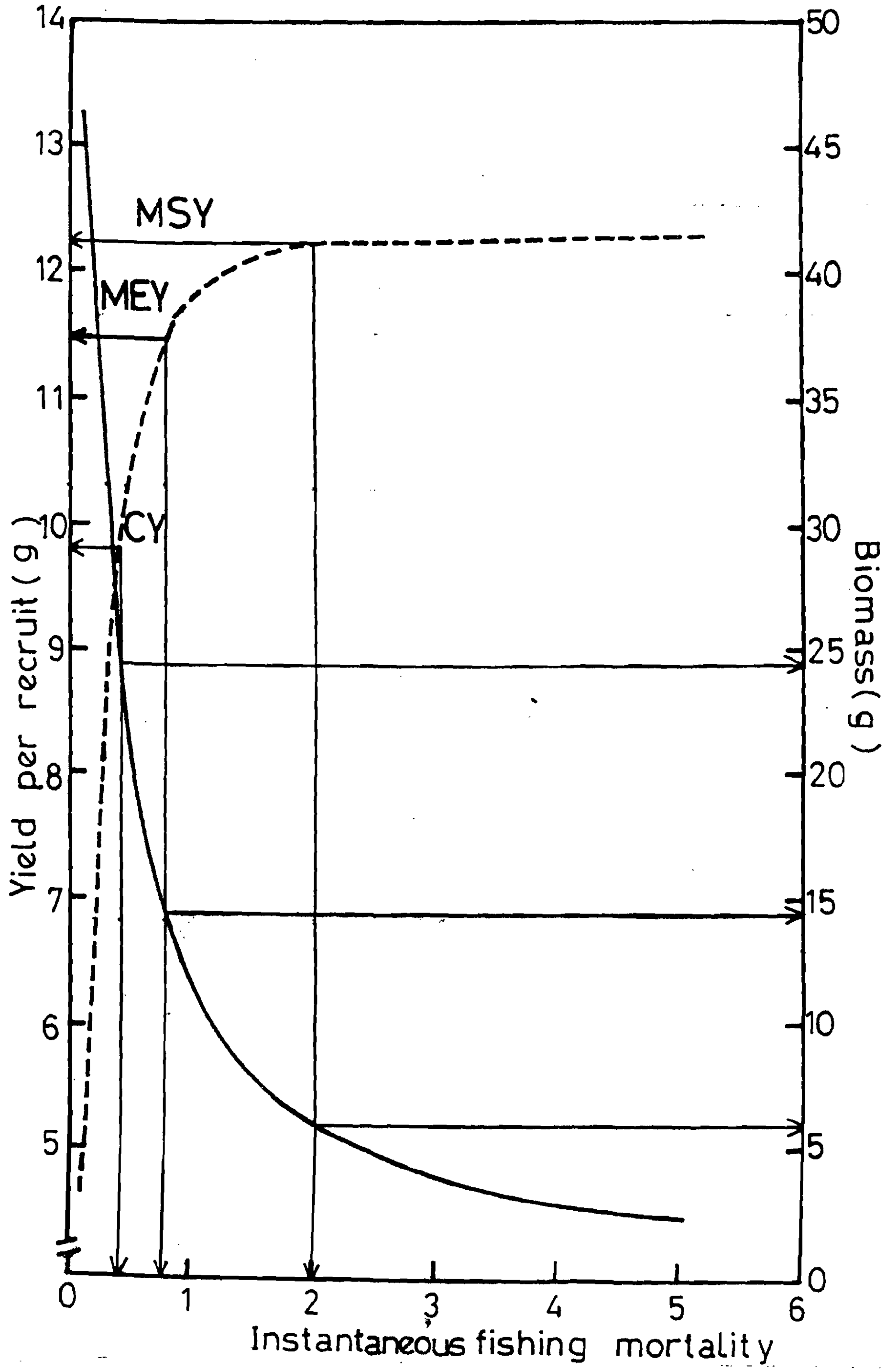

Figure (6): Relation between yield per recruit and fishing mortality for ***S. flexuosa*** in the Egyptian Mediterranean waters.

DISCUSSION

It is well known that one of the principal advantages of the stock assessment using yield-per-recruit analysis is that it does not need a long (multi-years) time series of data to obtain results (Munro, 1983). In respect to the management implications of this assessment it is found that the fishery of ***S. smaris*** harvests 53.3% of its potential yield (MSY) at fishing mortality (F= 0.95) and length at first capture (L_c= 11.82 cm) whereas it is 80% at F= 0.4 and L_c= 12.17 cm for ***S. flexousa***. The present results show that the value of length at first capture for ***S. smaris*** (11.82 cm T.L) is low as compared with that given by Livadas (1989) in Cyprus waters (L_c=12.75 T.L). Such differences may be attributed to that the Egyptian trawlers are characterized by having cod ends with small meshes which retained most of species of small sizes (Rizkalla, 1995).

It is worthy to mention that ***S. smaris*** in the present study was characterized by high values of fishing mortality (F= 0.9508) and natural mortality (M= 0.7933) as compared with those given for ***S. flexousa*** (F= 0.4168 and M= 0.4741 respectively). The highest natural mortality for ***S. smaris*** could be explained by the fact that these fishes have nearly slender body shape (Rizkalla, 1994) which make it easily to be attacked by predators. The same observation was noted by Nikolsky (1963) and Faltas (1993) as they mentioned that the cylindrical shaped fishes are easily consumed by predators rather than high bodied fishes.

Comparing the yield/recruit of the two species of picarels, it is clear from table (3) that the yield /recruit for ***S. smaris*** at current levels (3.77 g) was nearly equal to that obtained from the maximum economic level (3.88 g). At the same time the obtained biomass from the current level (3.97 g) was found to be nearly similar to the corresponding value given for MEY (3.88 g). This result shows that the exploitation rate of ***S. smaris*** at present reaches its optimum state. As regards to ***S. flexousa*** the yield/recruit at current level (9.8 g) was slightly decreased by about 14.78% from that obtained from the maximum economic level (11.50 g). On the other hand the biomass at current level (24.50) was about 1.7 times of the corresponding value given at the maximum economic level (14.38).

Generally, it must be noted that further expansion of fishing effort would seem unwise since the trawling net exploit multi-species, so it is difficult to determine the optimum fishing effort without studying the population dynamics of other species .

REFERENCES

Al-Zahaby, A. S.; Wadie, W. F.; El-Serafy, S. S. and Rizkalla, S. I., 1992. Studies on the fisheries of genus: ***Pagellus*** in the south-eastern part of the Mediterranean Sea . Pro. Zool. Soc. A.R.E. 23 (1): 137 - 142 .

Beverton, R. J. H. and Holt, S. J., 1957 . On the dynamics of exploited fish populations. Fish. Invest., London, Ser. 2(19), 533 pp.

Cushing, D. H., 1968 . Fisheries biology . A study of population dynamics. Univ. Wisconsin Press, Madison, 200 pp.

Faltas, S. N., 1993 . Studies on the fishery biology of lizard fish (Family : Synodontidae) in the Egyptian Mediterranean waters . Ph. D. Thesis, Fac. Sci. Alex. Univ., 305 pp.

Gulland, J. A., 1971 . Science and fishery management . J. Cons. CIEM, 33(3): 471 - 477 .

Livadas, R. J., 1989 . The selectivity of certain trawl cod-ends in Cyprus . FAO, Fish. Report, 412: 180 - 189 .

Maiyza, I. A. and Said, M. A., 1988 . The time variation of temperature, salinity and oxygen content in the Eastern Harbour of Alexandria . Bull. Inst. Oceanogr. & Fish. A.R.E., 14(1): 67 - 74 .

Munro, J. L., 1983 . A cost-effective data acquisition system for assessment and management of tropical multispecies, multi-gear fisheries . Fishbyte 1(1): 7 - 12 .

Nikolsky, G. V., 1963 . The ecology of fishes . Academic Press, London & New York, 322 pp.

Pauly, D., 1980 . On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks . J. Cons., Int. Explor. Mer, 39(2): 175 - 192 .

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

Ricker, W. E., 1975 . Computation and interpretation of biological statistics of fish populations . Bull. Fish. Res. Bd. Can. (191), 382 pp.

Rizkalla, S. I., 1994 . Identification of fishes belonging to family: Centracanthidae in the Egyptian Mediterranean waters . Bull. Nat. Inst. Oceanogr. & Fish. A.R.E, 20(2):119 - 127 .

Rizkalla, S. I., 1995 . A study on the trash fish obtained by the Egyptian Mediterranean trawlers. Bull. Nat. Inst. Oceanogr. & Fish., A.R.E, (21): 529 - 542 .

Tsangridis, A. And Filippousis, N., 1989 . Length-based approach to the estimation of growth and mortality parameters of ***Spicara smaris*** (L.) in the Saronikos Gulf, Greece,and remarks on the application of the Beverton and Holt relative yield per recruit model . FAO Fish. Report, 412: 94 - 107.