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Population dynamics of Por's Goatfish (*Upeneus pori* Ben-Tuvia and Golani, 1989) inhabiting Red Sea, Egypt

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Abstract

The present work intended to estimate the basic parameters required for the management of the por's goatfish in the Red Sea age composition, growth parameters, sex ratio, length at first sexual maturity, mortality exploitation rate, relative yield per recruit, and relative biomass per recruit of por's goatfish (*Upeneus pori*) caught from the Red Sea was studied .Females and males made up 43.47% and 56.53%, respectively, of the population of this species. The total length of females ranged from 8.0cm to 16.5 cm and from 6.3cm to 17.5cm for males. The length-weight relationship for combined sexes was estimated as $W=0.012* L^{2.926}$.The age estimated from length frequency data were used to estimate the growth parameters of the von Bertalanffy equation. The estimated parameters were: $L\infty$ =18.73 cm, K=0.501and t_o =-1.38.The maximum age was three years. The 2-year age group was dominant. Females reached sexual maturity at a total length of 10.7 cm while males matured at a total length of 10.5 cm .The annual rates of total ,natural and fishing mortalities were calculated as 1.72, 0.501 and 1.219 $year^{-1}$, respectively. In addition to this, it was found that the exploitation rate on the *Upeneus pori* in the Red Sea was 0, 71.

Keywords: Red Sea por's goatfish; length at first sexual maturity; mortality; exploitation rate; relative yield per recruit, and relative biomass per recruit.

1. Introduction

The Goatfish family (Mullidae) is commercially important demersal fish group throughout their distribution around the world. It includes about 50 species belonging to six genera. Thirteen species have been reported from the Red Sea region, belonging to three genera: *Mulloidas* ,*Parupeneus* and *Upeneus*, (Dor and Ben-Tuvia,1984; Al-Absey,1988; Ben-Tuvia and Kissil,1988).

The genus *Upeneus* or the Red Mullet constitutes one of the most economically edible fishes in the Egyptian waters especially in the Gulf of Suez and the Red Sea. They are demersal fishes caught by trawling. *Upeneus pori* (Figure 1) is a subtropical species, distributed along the western Indian Ocean , from the Red Sea to southern Oman (Ben-Tuvia and Golani,1989), living mostly in sand and muddy or gravel bottom and caught in large quantities by trawl in shallow waters of 10-40 m (Golani, 1994; Ismen, 2006).

There are only very few attempts to describe the biology and ecology of the por's goatfish. Guce and Bignal, (1994); Torcu and Mater (2000) studied the occurrence and distribution of *U. pori*, while Taskavak and Bilecenoglu (2001) studied the length-weight relationship. Cicek *et al*. (2002, 2006) and Ismen (2006) estimated growth and reproduction of the species. Cicek and Avsar (2011) studied age, growth and mortality of *U. pori* in Turkish waters.

Knowledge on the age of this important species is essential for a more detailed study on its biology and management of its fisheries. This species represents an important food and economical source in the Red Sea due to its excellent quality of flesh and its high price in the local markets, however studies concerning its biology and population dynamics are still lacking in the Red Sea.

The present work is the first study dealing with the investigation of population dynamics of *U. pori* in the Red Sea, it aims to determine the age, growth rate, length, weight and age composition of *U. pori* with von Bertalanffy growth model. Additionally, the natural and fishing mortality and the level of exploitation of this species in the Red Sea are essential for management purpose.

Figure 1.*Upeneus pori* from the Red Sea.

2. Materials and methods

2.1 Materials

This study was carried out during the fishing season 2006/2007 from October to May. Samples of *Upeneus* species (Family Mullidae) were monthly collected from the trawl fishery landings in the Gulf of Suez (Attaka site) . In the laboratory ,monthly random samples of unsorted mullidea were separated into the five *Upeneus* species, namely; *U. japonicas; the synonymy of U. bensasi; U. tragula; U. pori synonymy of U. vittatus; U. sulphorus and U. moluccensis* (Fouda& Hermosa ,1993; Rundall *et al*., 1993; and Golani ,1994) . A total of 560 fish of *U. pori* were obtained lengths to the nearest 0.1cm and total weight to the nearest 0.1g were taken for each individual of *U. pori*. The sex and maturity stage of each specimen were determined by visual examination of the gonads. The stages of maturation were classified according to Holden and Raitt (1974) scale.

2.2 Methods

The length –weight relationship was estimated according to Ricker's (1975) equation:

$W=aL^b$ where W is the total weight in gram, L is the total length of the fish in cm and the parameters (a) and (b) are constants. Age was determined by Bhattacharya (1967) method which depends on the analysis of length frequencies, the back-calculated lengths were applied according to Gulland and Holt (1959) plot incorporated in The FISAT (Gayanilo *et al*., 1998) software package to estimate the von Bertalanffy growth parameters ($L\infty$ and K). (t_o) is the theoretical age when fish would have been at zero total length was estimated by the equation: $t_o = t + 1/K \ln (L\infty - L_t/L_\infty)$.where Lt is the length at age "t". The growth performance index (ø) was computed according to the formula of Pauly and Munro (1984) as:

$ø = \text{Log } K + 2 \text{ Log } L\infty$.

The length converted catch curve (Pauly, 1984) was applied to estimate the total mortality coefficient (Z). The coefficient of natural mortality (M) was estimated by the empirical Pauly's equation (Pauly, 1980), where the annual water temperature of the area under study (T) was 24.4 c^0. The fishing mortality coefficient (F) was calculated as: F= Z–M. The exploitation rate (E) was calculated using the formula of Gulland (1970) as: E= F/Z. Relative yield per recruit (Y/R)' and relative biomass per recruit (B/R)' were estimated using the model of Beverton and Holt (1957) as modified by Pauly and Soriano (1986) and incorporated in the FISAT software. The data of probability of capture M/K values were used to estimate both (Emax), which represent the optimum exploitation ratio that may maximize the yield per recruit and (E0.5) the exploitation level at which the biomass is reduced to 50% of the unexploited stock.

3. Results and discussion

3.1. Catch description

The annual total trawl catch and the Red Mullets catch landed during the fishing seasons from 1998/1999 to 2007/2008 are represented in (Figure 2).(Source of data the General Authority for Development and Fish resources). It is obvious that the total trawl catch and the Mullets catch fluctuated from a fishing season to another and there was a trend of increase during the seasons (2001 to 2004) in Red Mullets this increase may be attributed to the fact that in the recent years, the operating trawlers advanced equipments, which enable the fishermen to operate between the coral reefs which are rich in fish populations (Sabrah, 2006). The annual percentage of

Red Mullets catch to the total trawl catch varied between 3.52 (2001/2002) and 28.73 percent (2004/2005) with a mean value of 16.95 percent. Fluctuations in the landed catch, could be attributed to many factors such as : fisheries , lack of food biological factors e.g. inter specific competition, and a biotic conditions

3.2. Length-weight relationship:

The total length of 153 individual of the females ranged from 8.0 cm to16.5 cm, made up (43.47%) of the studied samples. The males 199 individual ranged from 6.3cm to 17.5cm represented about (56.53%) (Figure 3).

Length and weight measurements of 560 specimens were used to describe the length weight relationship of *U. pori* (Figure 4).The total length ranged between 6.3 and 17.5cm while the total weight varied between 6.6 gm., and 58.4 gm. The length –weight relationship was described by the equation:

$W=0.008* L^{3.102}$ for females
$W=0.015* L^{2.830}$ for males
$W=0.012* L^{2.926}$ for combined sexes

In the Gulf of Suez and Red Sea There were no studies on *Upeneus pori* that could be found to compare it with the present study. The length-weight constants for *U. pori* at different regions in the Mediterranean Sea are reported in Table (1). These data show that in the previous studies, the value of "b" was very closed to 3 which indicates isometric growth ,this result is in good agreement with the present study b=2.926.

Table 1. Estimates of the length-weight constants of *U. pori* in different regions.

Country	Region	a	b	sex	Source
Turkey	East Mediterranean	0.0051	3.265	Combined sexes.,	(Taskavaka&Bilecenoglu ,2001).
Turkey	North Eastern Mediterranean	0.0083 0.0103 0.0073	3.068 2.977 3.121	Combined sexes., Males. females	(Cicek *et al* .,2002).
Turkey	Iskenderun Bay	0.0102 0.0108 0.0097	3.01 2.99 3.03	Combined sexes., Males. females	(Ismen ,2006).
Turkey	Iskenderun Bay	0.0107	2.948	Combined sexes.,	(Cicek & Avsar, 2011)
Egypt	Red Sea	0.012 0.015 0.008	2.926 2.83 3.102	Combined sexes., Males. Females.	Present study

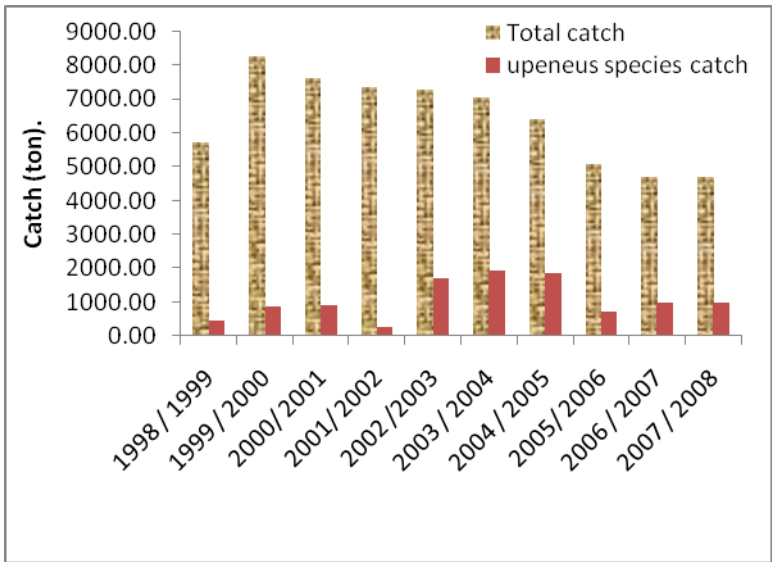

Figure 2. Annual trawl total catch and Upeneus species catch from the Red Sea during the period from 1989/1999 to 2007/2008

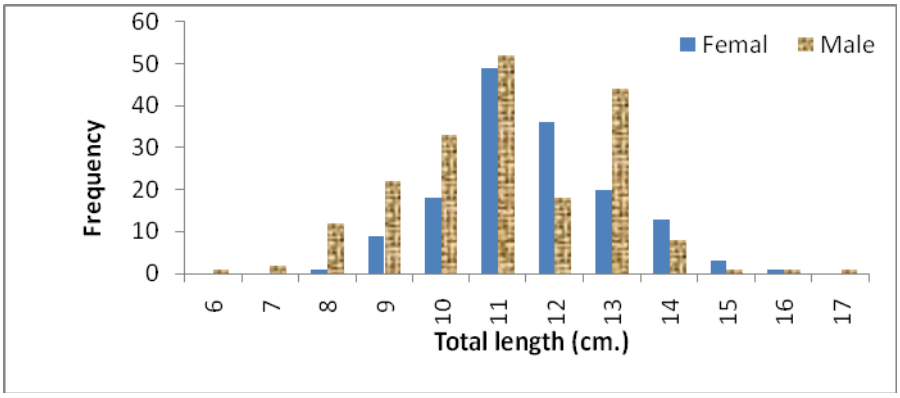

Figure 3. Length-frequency distribution of male and female *Upeneus pori* from the Red Sea.

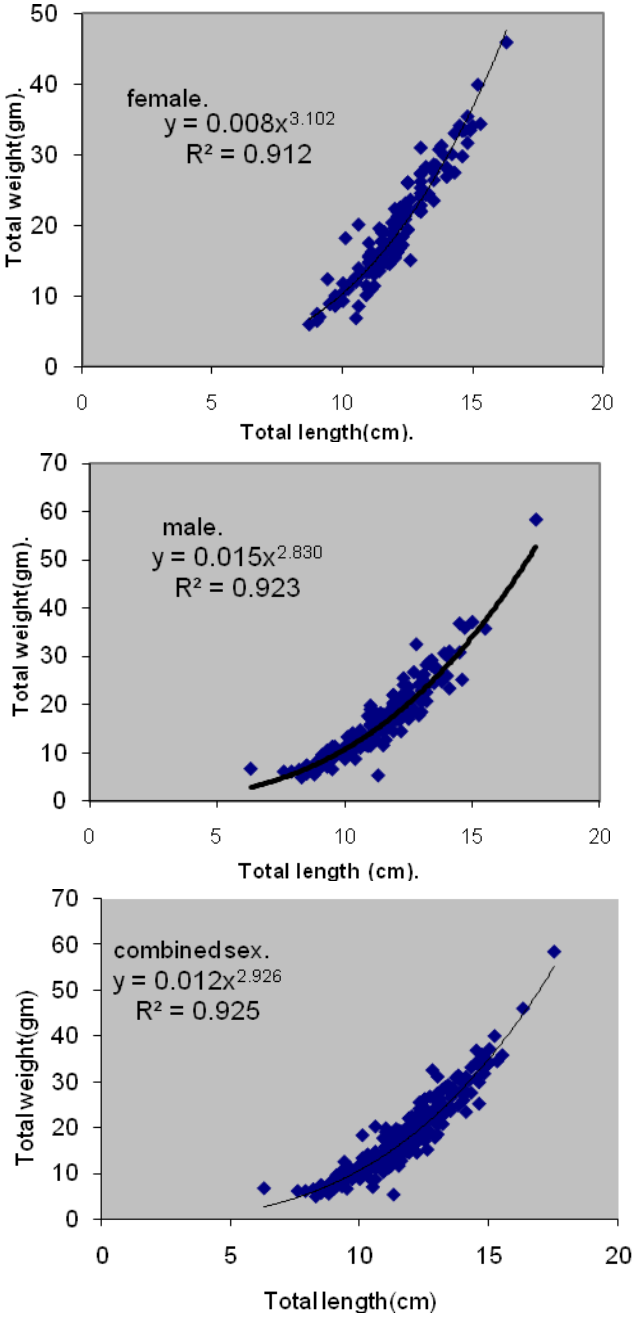

Figure 4. Length-weight relationship of *Upeneus pori* from the Red Sea.

3.3. Age determination

Length frequency distribution of *U. pori*, was analyzed by Bhattacharya's method (1967) as incorporated in FISAT software. Figure (5) shows the presence of three age groups which were estimated at lengths 9.74 cm, 13.20 cm and 15.50 cm respectively. Few studies were made in the eastern Mediterranean Sea area. Ageing in this study is lower than that calculated by Ismen (2006) in Iskenderun Bay who calculated four and five age groups for males and females respectively. This difference is probably due to the variations in the environmental condition.

3.4. Theoretical growth in length

The parameters of von Bertalanffy growth equations proved to be the most useful in studies of fish population dynamics and in particular assessment of the status of an exploited stock and the effect of fisheries regulations on it (Tomlinson and Abramson ,1961).The equation of von Bertalanffy for growth in length was estimated as follows:

$$Lt = 18.73\ (1\text{-}e^{-0.501(t+1.38)})$$

3.4.1.Theoretical growth in weight:

The von Bertalanffy growth equations for growth in weight for *Upeneus pori* was predicated as follows:

$$Wt = 63.48\ (1\text{-}e^{-0.501(t+1.38)})^{2.926}$$

Table (2) recorded the value of von Bertalanffy growth parameters of *U. pori* in different regions, it is clear that; growth of *U. pori* is faster the K observed in this study, is higher than that calculated by Ismen (2006); Cieck *et al*. (2002); Cicek and Avsar (2011) the estimated parameters may vary in function of a variety of factors such as geographical region, year and methodology (Goncalves *et al*., 2003).

3.4.2. Growth performance index (Ǿ)

Growth performance index (Ǿ) had been used since it is the best index for expressing the fish growth (Pauly and Munro,1984). It is calculated depending on Bertalanffy growth parameters L∞ &K. It was found that the growth performance of *Upeneus pori* is 2.244.

3.5. Mortalities

The obtained length converted catch curve (Figure 6) gives an estimate of the total mortality (Z) = 1.720 Y^{-1}. The calculated natural mortality (M) was 0.501 Y^{-1},and hence (F)=1.219 Y^{-1}.

Table 2. Estimates of growth parameters and exploitation ratio of *U. pori* in different regions.

Area	L∞	K yr^{-1}	T_0	Z	M	F	E	Source
Turkey	22.54	0.190	-1.96					(Cieck *et al*., 2002)
Turkey	19.1	0.360	-0.812					(Ismen,2006)
Turkey	21.98	0.194	-1.168	5.24	0.46	4.78	0.91	(Cicek &Avsar,2011)
Red Sea.	18.73	0.501	-1.38	1.720	0.501	1.219	0.71	Present study

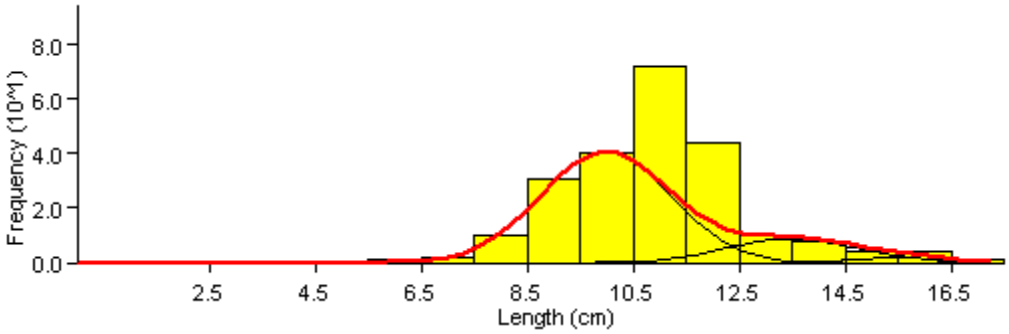

Figure 5 . Bhattacharya's method for age determination of *Upeneus pori* from the Red Sea

3.5.1. Exploitation rate

The current exploitation rate (E) was estimated at 0.71 year^{-1} (Gulland, 1971) suggested that the optimum exploitation rate in an exploited stock should be approximately 0.5. Thus, the high value of the current exploitation rate indicates that the stock of *Upeneus pori* in the Red Sea suffering from overfishing.

3.5.2. Length and age at first capture "L_c"

The length at first capture $L_{50\%}$ (the length at which 50% of the fish are vulnerable to capture) which was estimated as a component of the length converted catch curve analysis (FISAT) ,was found to be 9.77cm, which corresponds to an age of 1.078 year.

3.6. Length at first sexual maturity

Analysis of the percentage of mature and immature fish in each length class (Figure 7) showed that, the size at which 50% of fishes are sexually mature at 10.5 cm for males and 10.7 cm for females, corresponding to an age of 1.124 and 1.137 year respectively , thus all individuals over one year of age are sexually mature. Ismen (2006) in Iskenderun Bay found that males and females of *U. pori* matured at about 10 cm total length (1 years old). These results show a good agreement with a present study.

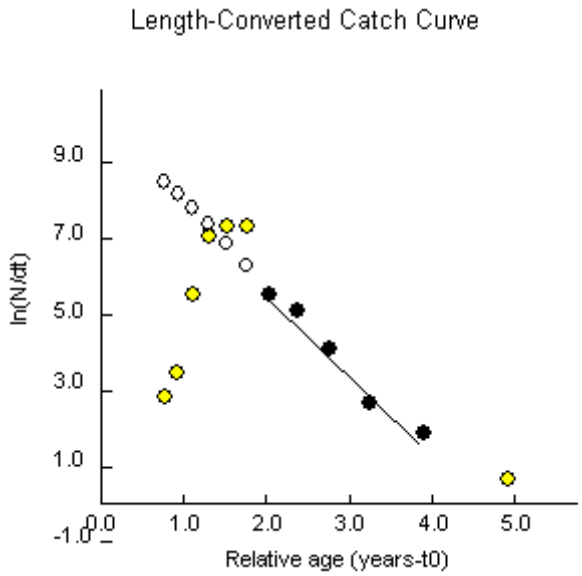

Figure 6. Length converted catch curve of *Upeneus pori* from the Red Sea.

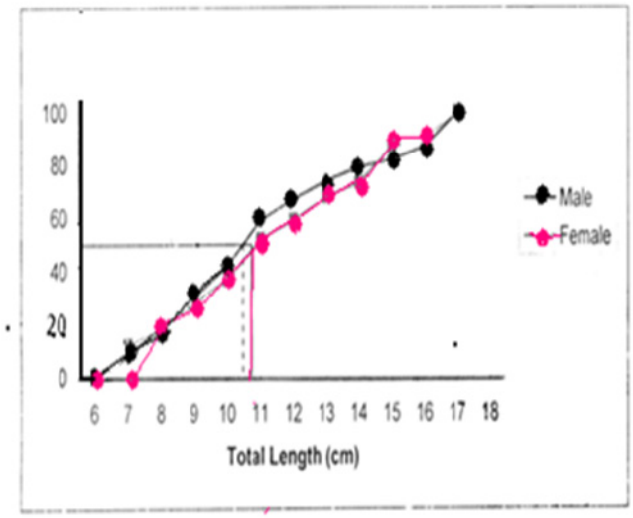

Figure 7. Length at first sexual maturity of males and females of *Upeneus pori* from the Red Sea.

3.7. Relative Yield per Recruit and biological reference point

The model of Beverton and Holt (1966) modified by Pauly and Soriano (1986) which is incorporated in the FISAT software package, was applied to estimate the relative yield per recruit of *Upeneus pori* from the Red Sea . This model allows a relative prediction of the long –term catch weights and stock biomass under different exploitation rates.The plot of relative yield per recruit Y/R and relative biomass per recruit (B/R) against E is represented in Figure (8). As shown from the figure the maximum yield per recruit was obtained at E_{msy}= 0.69.Both $E_{0.1}$ and E50 were estimated. The obtained values of E0.1 and E0.50 were 0.61 and 0.37, respectively. The present level of E (0.71) was higher than that which gives the maximum Y/R. moreover, the present exploitation rate is higher than the exploitation rate (E0.5) that protect the 50% of the stock biomass . For management purposes, the exploitation rate of *Upeneus pori* should be reduced from 0.71 to 0.37 (52.11%) to preserve a satisfactory spawning biomass. The maximum Y/R is not the target point but the maximum constant yield (the maximum constant catch that is estimated to be sustainable, with an acceptable level of risk, at all probable future levels of biomass) is the target reference point in fisheries assessment (Sissenwine ,1978;Smith *et al*., 1993;Caddy and Mahon,1995; Sinclair *et al*., 1996). To be safe must be stay on the left of the maximum Y'/R value. Therefore we need to reduce the applied fishing effort to keep the sustainability of the resource

Length at first capture, is associated with the mesh size, the Y'/R was calculated with Lc =11 cm. The results (Figure 9) indicated that with an increasing Lc a higher Y'/R can be obtained. When Lc became 11 cm, the maximum Y'/R (0.77) was obtained at present value E = 0.71. The values obtained for $E_{0.1}$ and $E_{0.5}$ were 0.66 and 0.39, respectively. So, we must increase the length and age at first capture by increasing the mesh size to maintain the stock of *Upeneus pori* in the Red Sea and increase the annual catches.

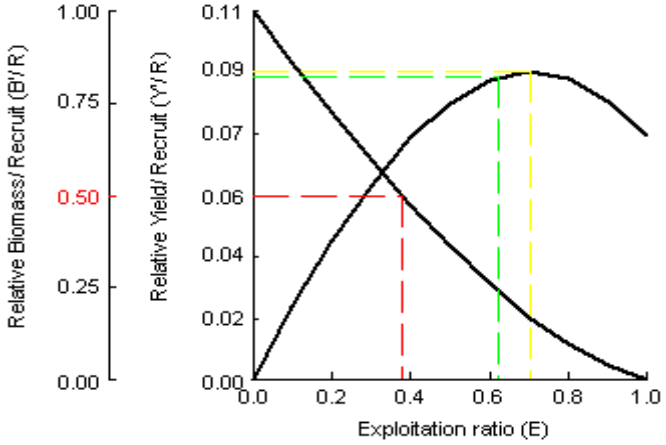

Figure 8. Yield of biomass per recruit of *Upeneus pori* from the Red Sea.(lc= 9.77 cm.)

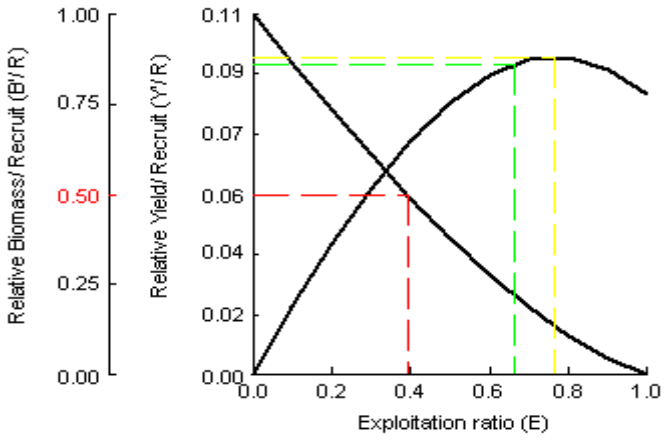

Figure 9. Yield of biomass per recruit of *Upeneus pori* from the Red Sea. (lc=11 cm.)

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دراسة ديناميكية لاسماك البربونى (*Upeneus pori*) من البحر الاحمر ـ مصر

أمل محمد محمود أمين

تمثل اسماك البربونى اهمية اقتصادية كبيرة وتعتبر من اهم الاسماك التى نحصل عليها من حرفة الجر . الهدف الاساسى للبحث هو الحفاظ على انتاجية هذا النوع وزيادتها. واوضحت الدراسة ان هذا النوع يصل الى عمر ثلاث سنوات كما تبين ان اقصى طول نظرى ممكن ان تصل اليه السمكة هو $L\infty$ =18.73cm ومعدل النمو،K=0.501 وبحساب معدلات النفوق الكلى لهذا النوع $Z = 1.720\ Y^{-1}$ ، والنفوق الطبيعى $M = 0.501\ Y^{-1}$ وقد وجد ان النفوق الناشئ عن الصيد $F = 1.219\ Y^{-1}$. كما تم حساب الطول عند اول صيد Lc =9.77cm وبعد تطبيق نموذج بفرتون وهولت لدراسة معدلات الاستغلال اتضح ان هذا النوع من اسماك البربونى يقع تحت تأثير عمليات صيد جائر ، وللحفاظ علي انتاجية هذا النوع يجب خفض معدل الاستغلال الحالي بنسبة 52.11% كما يجب رفع الطول عند اول مصيد عن طريق زيادة فتحات الشباك المستخدمة.