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POPULATION DYNAMICS OF *UPENEUS JAPONICUS* UTTUYN, 1782), FAMILY: MULLIDAE, FROM THE GULF OF SUEZ, RED SEA, EGYPT.

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ABSTRACT

The length frequency data of *Upeneus japonicus* collected from the Gulf of Suez during the fishing season 2001/2002 were analyzed using the FISAT soft ware to estimate the population parameters. The von-Bertalanffy growth parameters were calculated as L_∞ =23.97 cm; K= 0.459 yr^{-1}; and t_0 =-0.125 yr. The mortality rates were computed as (Z) = 2.98 yr^{-1}; (M) = 1.03 yr^{-1} and F=1.95 yr. The exploitation rate was estimated as E_{cur}= 0.65. The Beverton and Holt (1966) model was applied to estimate the yield per recruit in order to evaluate the status of the fishery. The results indicated that the stock of the *U. Japonicus* in the Gulf of Suez is exposed to an over-exploitation and the current exploitation rate must be reduced to maintain the optimum condition.

1. INTRODUCTION

Family Mullidae (Red Mullets) is considered to be the most economic important fish group in the trawl fishery of the Gulf of Suez, Red Sea. Red Mullets are endemic in the southern region of the Gulf and the northern part of the Red Sea, Egypt since 1933 (Norman, 1939). Generally, the fishing ground for Mullidae by trawling increases as we go southward, on both sides of the Gulf of Suez, (Yousif & Sabrah, 2004), so this region in Egypt is the most productive area of the Red Mullets (*Upeneus species*). Mullidae caught at depths of 20-200 m. by means of trawls and were found near the coral reefs area, in sandy and muddy bottoms (Moyle & Cech,1988 and Yousif & Sabrah, 2004).The Red Mullets have a wide geographical distribution in tropical, sub-tropical and temperate sea (Rundall, *et al.*1993). The genus *Upeneus* is the most common Mullets in the Gulf of Suez and is represented by five species in the Gulf, namely: *Upeneus japonicus; the synonamy of Upeneus bensasi; Upeneus tragula, Upeneus vittatus, Upeneus sulphorus* and *Upeneus moluccensis* (Fouda & Hermosa, 1993 and Rundall, *et al.* 1993). *Upeneus* species contribute about 10% of the total trawl landing from the Gulf of Suez (Fig.1). *U. japonicus* is the most abundant species in this genus; it constitutes about 70% of that genus.

U. Japonicus is a small fish not exceeding 20 cm. in total length, but it is considered to be the most economic fish in the Gulf due to its excellent quality of flesh and its high price in the local markets. Although the economic importance of that species, there was no information about its fisheries biology or its population dynamics. Yousif and Sabrah (2004) studied the behaviour characters, distribution and the abundance of the *Upeneus* species in the Gulf of Suez during autumn 1998. The biology, occurrence and

migration of this species were investigated in some tropical regions, in Japan, Ishida (1986) and Horikawa & Kishid (1986). In the Gulf of Aden, Al-Sakaff&Esseem (1999) and in USA, Hardy (2003).

The present work is considered as the first attempt to study the population dynamics of the most abundant Mullets (*U. Japonicus*) in the Gulf of Suez for the management purpose of that important species.

2. MATERIALS AND METHODS

Monthly samples of unsorted Upeneus species were collected from the Attaka harbors landed by the bottom trawl fishery (Gulf of Suez) during the fishing season 2001/2002.The fishing unites operating in the Gulf were about 27 m. in length and powered by an engine of 425 hp. The length of the fishing gear was 25 m. with a cod end mesh size of 1.8 cm. Hauls ranged in duration from 90 to 180 minutes (El-Ganainy, *et al.* 2005).

The samples were sorted according to the five species and classified to detect the catch composition. A total of 3118 samples were measured to study the length frequency distribution of *U. japonicus*, which were grouped into 1.0 cm length class. About 10% of the total samples were taken as a sub-sample. 366 fish of *U. japonicus* were measured to the nearest 0.1 cm and weighed to the nearest 0.1 g.

The length weight relationship was estimated by using the power equation $W = a L^b$ where W is the total weight (g), L is the total length (cm) and a & b are constants.

The monthly length frequency distribution was pooled into annual ones for the determination of age and growth rates. Bhattacharya (1967), method was used for the decomposition of the length composition into its normal components. The assigned age at length groups were used for the estimation of the von Bertalanffy's growth parameters (L_∞ , K and t_0) where $L_t = L_\infty (1 - e^{-k(t-t_0)})$

Where L_∞: asymptotic length in cm, K: growth coefficient and t_0: length at age 0. The V.B.G. parameters were estimated by applying the least square method as incorporated in FISAT soft ware (Gayanilo, *et al.*, 1998).

The instantaneous total mortality coefficient (Z) was estimated by using the linearized catch curve derived by Pauly (1983). The instantaneous natural mortality coefficient (M) was computed by applying the empirical equation developed by Pauly (1980), using the growth parameters and the annual water temperature of the Gulf of Suez as 22.5°C (Selim, 1970; El-Sabh & El-Beltagy, 1983 and Yassien, 1998).

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

Where, T is the annual mean temperature of water in which the stock live.

The fishing mortality coefficient (F) was calculated directly where, $F = Z - M$

The current exploitation rate (E_{cur}) was estimated according to the formula of Gulland (1971), $E = F/Z$

The length at first capture (L_c) was estimated from the ascending left part of the catch curve according to the method of Pauly (1984) and incorporated in the FISAT soft ware.

The variations in the relative yield per recruit (Y/R) and the relative biomass per recruit (B/R) with the different exploitation rates were examined by applying the analytical yield per recruit model developed by Beverton and Holt (1966) and modified by Pauly & Soriano (1986).

3. RESULTS AND DISCUSSION

3.1. Catch description.

Red Mullets come in the fifth category in the trawl fishery of the Gulf of Suez. Fig. (1) Shows the annual total catch and the Red Mullets catch landed during the fishing seasons from 1990/1991 to 2003/2004 (source of data: the General Authority for Development and Fish resources). It is

evident that the total trawl catch and the Mullets catch fluctuated from a fishing season to anther and there was a trend of increase during the recent years (2001/2002 to 2003/2004). This increase in the total and the Red Mullets catch may be attributed to the fact that in the recent years, the operating trawl harbors had navigator machines that encourage the fishermen to operate through out the narrow areas between the coral reefs which are rich with the intensive recruits of fish.

3.2. Length-weight relationship.

Lengths and weights of 366 fish were used for the analysis of the length-weight relationship (total length ranging between 8.0 & 19.8 cm and their weight varied between 7.0 to 77.8 gm). The computed length-weight relationship (Fig. 2) for *U. japonicus* was in the form of the equation:

$$W = 0.0087\ L^{3.0783}$$

The correlation coefficient $r^2 = 0.9443$. It is clear that the value of b = 3.0783 is nearly around to 3, indicating the isometric growth of that fish in its natural habitat. Ahmad, *et al.* (2003), reported the length weight constants of U. japonicus at different regions in Malaysia as:

Country	*Region*	*a*	*b*	R^2
Malaysia	*West coast*	*0.013*	*2.94*	*0.93*
“	*East coast*	*0.010*	*3.04*	*0.95*
“	*Sabah*	*0.008*	*3.14*	*0.96*

These constants are in high agreement with the results of the present study.

3.3. Age and growth.

Length frequency distribution of *U. japonicus* (Fig. 3), was analyzed by Bhattacharya method (1967). The estimated annual normal components resulting from the model progression analysis are given in Table (1). Four age groups were identified from the pooled data with mean model length of 8.09, 13.13, 18.0 and 19.5 cm. These are almost well discriminated according to the value of the separation index, which must be over 2 to allow an objective separation of the adjacent groups (Rosenbery & Beddington, 1988).

The assigned model lengths were computed to fitting the theoretical growth curve and the von-Bertalanffy growth parameters were estimated. The von-Bertalanffy growth parameters that describes growth in length (L_∞, K and t_0) and the derived performance index (ϕ) are in Table (3).

In Egypt (Gulf of Suez and Red Sea) there were no studies on U. Japonicus that could be found to compare it with the present study. Some studies were done in the indo-pacific area including the growth parameters, mortality rates and the exploitation rate of *U. japonicus*, Table (4). The results show a good agreement with the present study, but there were some slightly differences that may be attributed to the differences in the environmental conditions as temperature and the food availability.

3.4. Mortality rates:

3.4.1. Total mortality coefficient (Z).

Fig. (4) Shows the FISAT out put of the length converted catch curve (Pauly, 1983) for *U. japonicas*. For estimation of the total mortality rate the black dots represented the used points through out least square linear regression, while the open dots represented the points either used or not, too close to L_∞ or not under full exploitation and hence deleted from the calculations. The estimated total mortality rate (Z) and the annual mortality rate (A) are given in table (3).

Table (4), shows the different values of “Z”, “M” and “F” of other studies on *U. japonicus* in different regions in Malaysia.

3.4.2. Natural mortality coefficient (M).

The natural mortality coefficient (M) of *U. japonicas* was estimated by using the equation of Pauly, 1980 in which the V.B.G. constants (L_∞ and K) and the mean annual water temperature of the Gulf of Suez (22.5 ^{0}C) were used. The obtained result shows

that (M) for U. japonicus was found to be 1.03 yr^{-1}. The calculated natural mortality coefficient could be ascertained by using the ratio of M/K where Beverton and Holt (1957) pointed that this ratio lies between 1.12 and 2.5 for different fish species. In the present study the ratio of M/K was 2.24. Table (4) shows different values of (M) in different regions which are in a good agreement with the present results.

3.4.3. Fishing mortality coefficient (F).

The fishing mortality coefficient could be estimated directly as F =Z-M So (F) according to the present results is estimated to be 1.951 yr^{-1}.

3.4.4. Exploitation rate (E).

The exploitation rate E = F/ Z and the current exploitation rate was found to be (E_{cur} = 0.65), this value refers to an over exploitation on the stock of *U. japonicus* from the Gulf of Suez, where Gulland (1971) reported that the optimum exploitation (E_{opt} = 0.50).

3.4.5. Length at first capture (L_c).

The estimation of the length at first capture, which is closely related to the mesh size, was derived from the length converted catch curve analysis (the method of Pauly, 1984). Table (2) and Fig. (5) Show the probability of capture and the length at first capture of *U. japonicus*. The length at first capture was found to be 8.49 cm. Sabrah (in press), studied the reproductive biology of *U. japonicus* from the Gulf of Suez and the results revealed that the length at first sexual maturity of that species was found to be 10-11 cm. This result means that *U. japonicus* caught by the trawl fishery before spawning even for the first time and this will have a negative effect on the recruits in the future. Therefore the mesh size must be managed to catch fishes longer than 12.0 cm to give the fish the chance to spawn even once in its life span.

3.5. Relative yield per recruit (Y/R) and relative biomass per recruit (B/R).

U*peneus japonicus* is the most dominant species belong to genus *Upeneus* (Family:Mullidae) in the trawl catch from the Gulf of Suez, so the relative yield per recruit analysis was done for *U. japonicus*. The estimation of relative yield per recruit (Y/R) and the biomass per recruit (B/R) as a function of exploitation rate (E) are shown in Fig (6). It is indicated that the maximum relative Y/R of *U. japonicus* was obtained at (E_{max} = 0.61) and the relative (Y/R) will decreases as the exploitation rate increases. Also, the results revealed that the estimation of ($E_{0.1}$ = 0.52) and ($E_{0..5}$ = 0.36); where $E_{0.1}$ is the economic relative yield per recruit at which the marginal increase in Y/R reaches 1/10 of the marginal increase computed at very low value of E and $E_{0.5}$ is the exploitation level which will result in a reduction of the unexploited biomass by 50%.

The results also showed that the current exploitation rate (E_{cur} = 0.65) was slightly higher than that which gives the maximum Y/R (E_{max} = 0.61) and also higher than the optimum exploitation rate ($E_{0.5}$ = 0.36) which maintain 50% of the stock biomass.

4. CONCLUSION

U*peneus japonicus* or the Red Mullets are an important commercial species in the Gulf of Suez. This study reflects the fishery status of *U. japonicus* and the results indicate that the *Upeneus* species resource in the Gulf of Suez is exposed to an over-exploitation and to achieve the management purpose for that species, the following notes recommended:

1- The length at first capture must be increased from 8.49 cm. to at least 12.0 cm. i.e. the cod end mesh size must be increased and developed to caught the longer fishes to improve the production of the recruitment.

2- The exploitation rate must be reduced from 0.65 to 0.52 to maintain sufficient biomass or yield per recruit.

Table (1): Mean assigend lengths, standard deviation and separation indecies for *U. Japonicus* from the Gulf of Suez estimated by Battacharya method.

Age group	No.	S.d.	Mean length	S. I.
I	64	0.96	8.09	-
II	3011	1.98	13.13	3.43
III	32	0.45	18.0	4.42
IV	11	2.04	19.5	0.80

S.d.: Stander deviation
S.I.: Separation index

Table (2): The probability of capture of *U. japonicus* from the Gulf of Suez

Length class	Estimated lengths at capture	Probability of capture
5.0-7.0	7.1	0.25
7.0-9.0	8.5	0.5
9.0-11.0	9.9	0.75

Table (3): Estimated population parameters of *U. Japonicus* from the Gulf of Suez.

Parameter	value	parameter	value
L_∞	23.97 cm	A	0.664
K	0.459 yr^{-1}	E (f/z)	0.654
t_0	-0.125 yr	L_c	8.490 cm
Ø	2.421	M/K	2.244
Z	2.981 yr^{-1}		
M	1.031 yr^{-1}		
F	1.950 yr		

Table (4): Estimates of growth parameters, mortality parameters and exploitation ratio of *U. japonicus* in different endo-pacific regions.

Country	Area	L_∞	K yr^{-1}	Z	M	F	E	ø	Source
Malaysia	South coast	23.4	0.86	5.4	1.31	4.09	0.76	2.67	Ahmad, A. T. *et.al*. (2003)
Malaysia Malaysia	West coast	25.0	0.55	5.3	1.67	3.63	0.68	2.54	Ahmad, A. T. *et.al*. (2003)
Malaysia	Sarawak	29.0	0.58	2.53	1.30	1.23	0.49	2.69	Ahmad, A. T. *et.al*. (2003)
	Sabah	24.0	0.80	7.11	1.70	5.41	0.76	2.66	Ahmad, A. T. *et.al*. (2003)
Malaysia	East coast	23.8	0.69	4.15	1.79	2.36	0.57	1.60	Ahmad, A. T. *et.al*. (2003)
Malaysia	South & south east	25.35	0.70	1.54	3.34	4.88	0.64	2.64	Ahmad, A. T. (1999)
Nansha Island	South west shelf	15.7	0.66	-	-	-	-	2.21	Chen, P. (2003)
Egypt	Gulf of Suez	23.97	0.46	2.98	1.03	1.95	0.65	2.42	Present study

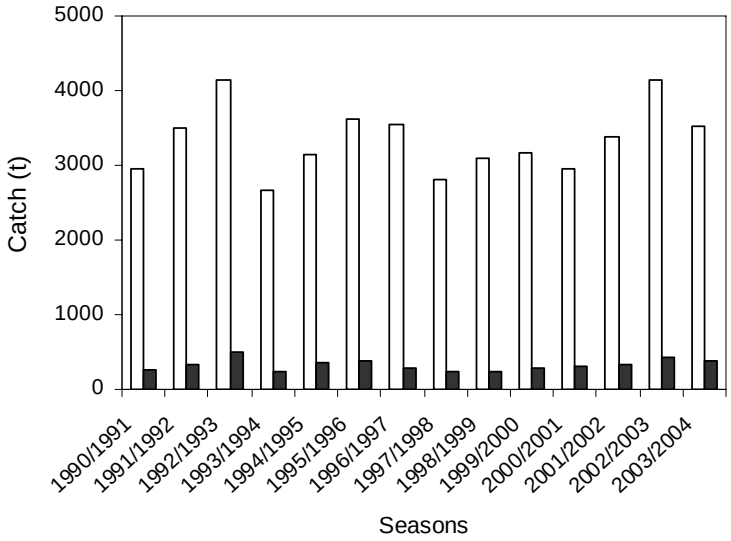

Fig. (1): Annual total catch and *Upeneus* species catch from the Gulf of Suez during the period from 1990/1991 to 2003/2004

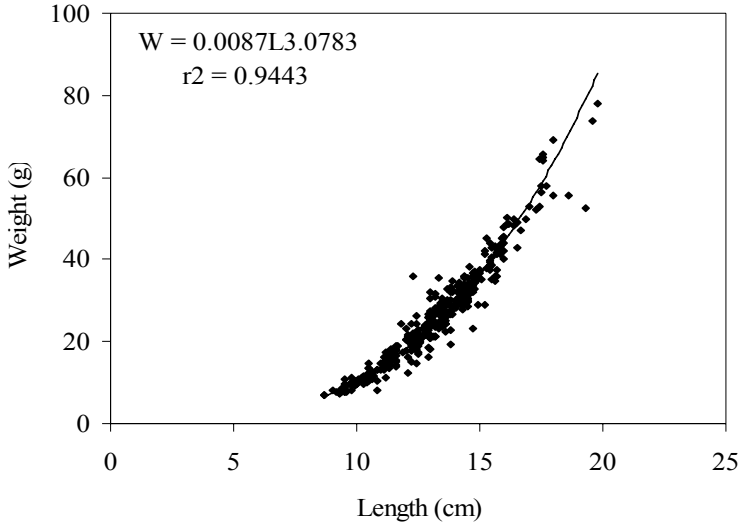

Fig. (2): Length weight relationship of the red mullet *U. japonicus* from the Gulf of Suez

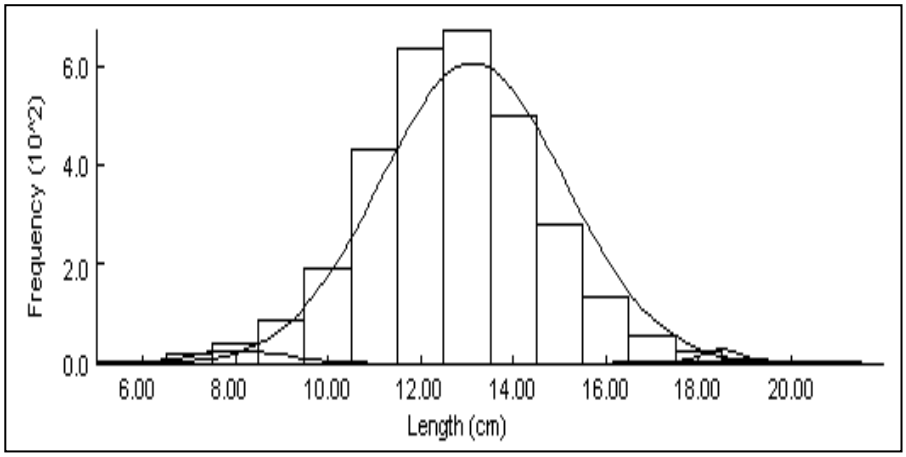

Fig. (3): Length frequency distribution of the Red Mullet *U. japonicus* showing the estimated age groups as decomposed by Bhattacharya method.

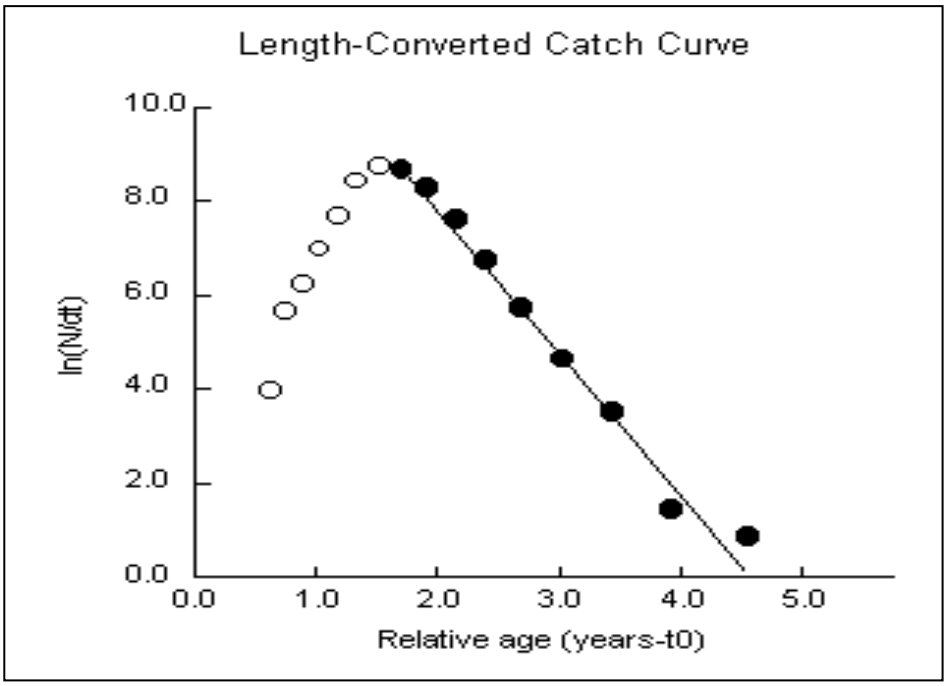

Fig. (4): Length converted catch curve for the Red Mullet *U. japonicus* from the Gulf of Suez

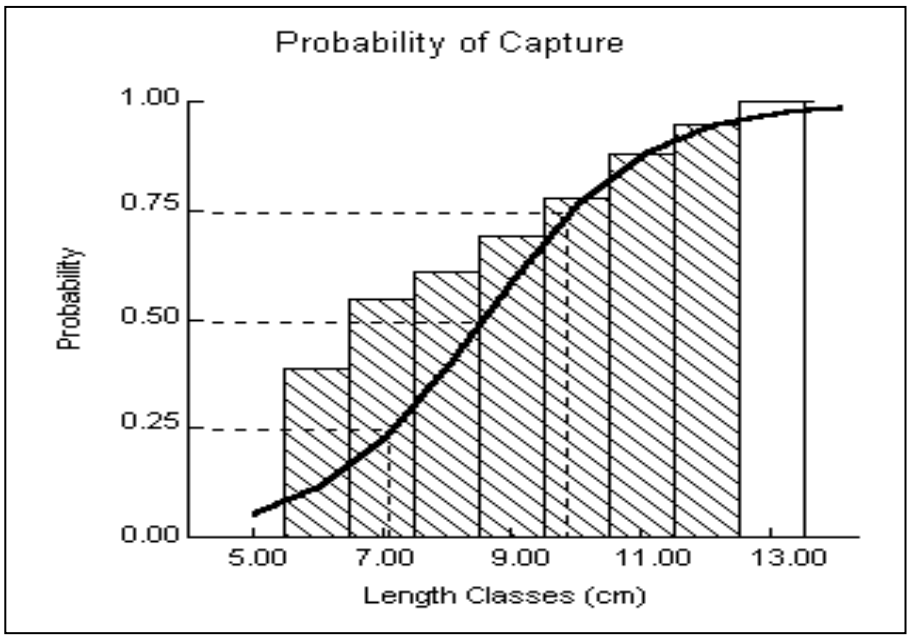

Fig. (5): Probability of length at first capture for the Red Mullet *U. japonicus* from the Gulf of Suez

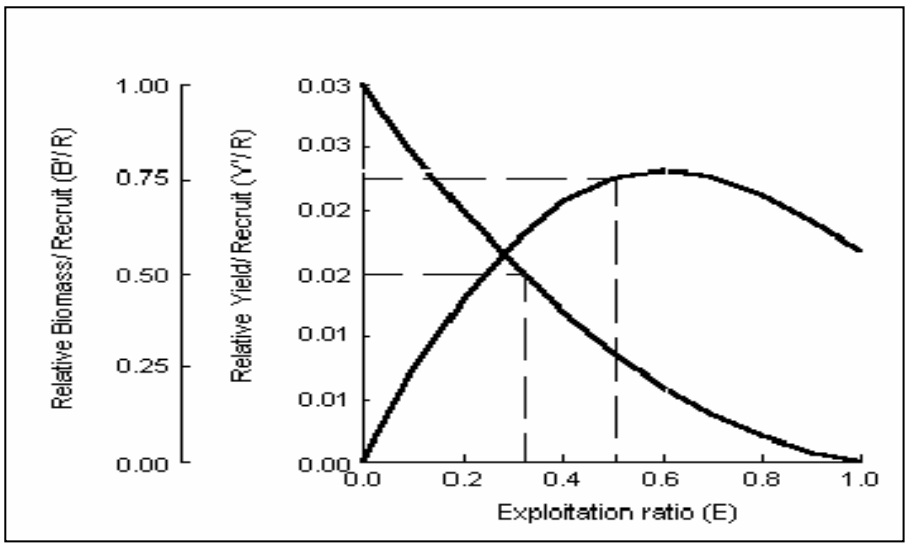

Fig. (6):Yield per recruit and biomass per recruit for the Red Mullet *U. japonicus* from the Gulf of Suez.

REFERENCES

Ahmad, A.T.: 1999, 'Status of the demersal fishery resource of Malaysia' (program report) in: Sustainable management of coastal fish stocks in Asia,1999.

Ahmad, A.T.; Isa, M.M.;Ismail, M.S.and Yusof, S.: 2003, 'Status of demersal fishery resource of Malaysia'. P. 83-135. In: Silvestre,G.; Garces,L.; Stobutzki, I.; Ahmad, M.; Valmonte-Santos,R.A.; Luna, C.; Lachica-Alio, L.; Munro,P.; Christensen,V.and Pauly, D. (eds). Assessment, management and future directions for coastal fisheries in Asia countries. World fish center.

Alsakaff, H. and Esseen, M.: 1999, 'Occurrence and distribution of fish species off Yemen' (Gulf of Aden and Arabian sea). NAGA, ICLARM Q.22 (1): 43-47

Bertalanffy von, L.: 1938,'A quantitative theory of organic growth'. Hum. Biol.,10 (2):181-213.

Beverton, R.J. and Holt, S.J.: 1957, 'On the dynamics of exploited fish population'. Fish. Invest. Minist. Agric. Fish. Food G.B., series 11, vol. 19: 533p.

Beverton, R.J and Holt, S.J.:1966, 'Manual for methods for fish stock assessment'. Part 2.Tables of yield function FAO Fish.Tech. Pap., (38) Rev. 1-67 pp.

Bhattacharya, C.G.: 1967, 'A simple method of resolution of a distribution into Gaussian components'. Biometrics, 23 (1) 115-135.

Chen, P.:2003, 'Optimum catchable size of 17 fish species in southwestern shelf of Nansha islands and optimum trawl mesh size for multiple fishes'. J. Fish. Sci. China 10 (1): 41-45.

El-Ganainy,A.A.H.; Yassien, M.H. and Ibrahim, E. A.: 2005, 'Bottom trawl discards in the Gulf of Suez, Egypt'. Egyptian J. Aquatic Research, Vol. 31, Special issue:240-255.

El-Sabh, M.I. and El-Beltagy, A.F.: 1983, 'Hydrography and chemistry of the Gulf of Suez during September, 1966'. Bull. Inst. Oceanog. and Fish. No. 9: 78-83.

Fouda, M.M. and Hermosa, Jr. G.V.: 1993, 'A check list of Oman fishes'. Sultan Qaboos University press, Sultanate of Oman. 42 p.

Gayanilo, F.C. Jr.; Sparre, P. and Pauly, D.: 1998, 'The FISAT User's guide'. FAO Computerized information series Fisheries.99, ICLARM, DIFMAR, Rome.

Gulland, J. A.: 1971, 'The fish resources of the Ocean'. FAO Fish Tech. Pap., (97) : 425 p.

Hardy, J. D. Jr.: 2003, 'Coral reef fish species'. NOAA/National Oceanographic Data Center. NODC Coral reef Data and information management system.. USA. 537p.

Horikawa, H. and Kishida, S.: 1986, 'Reproductive cycle, growth and migration of the Red Mullet, Upeneus bensasi, in Tosa Bay, South western Japan'. Bull. NAMSEI, Reg. Fish. Res. Lab. 1986 no: 20, pp. 39-57.

Ishida, K.: 1986, 'Benthic life of Upeneus bensasi in the southwestern Japan Sea'. Bull. Jap. Soc. Fish.1986. vol. 52, no. 2, pp. 215-221.

Moyle, F. H. and Cech, C.: 1988, 'FISHES: An introduction to Ichthyology'. 2nd ed. Prentice Hall. Englewood Cliffs. New Jersey, 559 p.

Noman, J. R.: 1939, 'Fishes'. P. 1-116. On John Murray Exploitation Scientific Reports. Vol.7. British Museum of Natural History, London.

Pauly, D.: 1980, 'A selection of simple method for the assessment of tropical fish stocks'. FAO Fish. Circ. (729) : 54pp.

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

Pauly, D.: 1984, 'Fish population dynamics in tropical waters': a manual for use with programmable calculations. ICLARM Stud. Rev., 8: 325pp.

Pauly, D. and Soriano, M.L.: 1986, 'Some practical extension to Beverton and

Holt's relative yield per recruit model'. Proc.Asian Fish.Soc., 491-495.

Rosenberg, A.A. and Beddington, J.R.: 1988, 'Length based methods of fish stock assessment'. In Gulland, J.A. (ed.) " Fish population dynamics " John Wiley & Sons, London, 83-103.

Rundall, J.E.; Bauchot, M.L. and Gueze, P.: 1993, 'Upeneus japonicus (Houttuyn), a senior synonym of the Japanese goat fish U. bensasi (Temminck et Schlegel)'. Jap. J. Ichthyol 40 (3): 301-305.

Sabrah, M.M.: in press, 'Some biological aspects on Upeneus japonicas (Houttuyn, 1782), Family: Mullidea, from the Gulf of Suez, Red Sea, Egypt'.

Selim, M.A.: 1970, 'Physical and chemical oceanography of the Red Sea'. Mar. Biol. Ann. Rev., 8 : 73-202.

Yassien, M.H.: 1998, 'Biological and ecological studies on the pearl oyster, Pinctada radiata (Mollusca, Lamelli branchia) from the Red Sea with special reference to its tolerance to water pollution'. Ph.D. Thesis, Faculty of Science, Ain Shams university.

Yousif, A. and Sabrah, M.M.: 2004, 'Catchability of Red Mullet (Upeneus spp.) from North West, Red Sea during autumn'. Egypt. J. Aq. Res.Vol.30 (B), 2004.