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Biology and assessment of the thread fin bream *Nemipterus japonicus* in Gulf of Suez, Egypt

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ABSTRACT

Monthly data of length frequency for *Nemiptrus japonicus* landed between September 2010 to July 2011 from commercial catch at El-Attaka fish landing along the Gulf of Suez were used to estimate the age composition, growth parameters, sex ratio ,condition factor, length at first sexual maturity, mortality exploitation rate, relative yield per recruit, and relative biomass per recruit. The maximum total length and weight were 29cm and 219.92 g, respectively. Females and males were represented by 46% and 54%, respectively, of the particular population of the species. The total length of females ranged from 8.5-25cm, and of males 10-29cm. The length-weight relationship for combined sexes were estimated as $W=0.025*L^{2.733}$. Age determination based on length frequency data showed that the life span extended to five years. The von Bertaianffy growth parameters were estimated as: $L\infty$ =33.65cm, K=0.450 and $t_{\circ}$ = -0.123. Females matured at a total length of 12.5 cm, while males matured at a total length of 11.4 cm.

The mortality rates were computed as (Z) =1.75 y^{-1}, (M)=0.529 y^{-1} and (F) =1.221 y^{-1}. The exploitation rate was estimated as $E_{cur.}$0.697. The relative yield per recruit and relative biomass per recruit analysis showed that the stock of *Nemiptrus japonicus* in the Gulf of Suez was overexploited.

Keywords: *Nemiptrus japonicus*, age, growth parameters, sex ratio, length at first sexual maturity, mortality rates, exploitation rate, relative yield per recruit, relative biomass per recruit.

INTRODUCTION

The thread fin bream *Nemipterus japonicus* is a demersal species belonging to family Nemipteridae which have an economic importance in the trawl fishery in the Gulf of Suez. It is very abundant in coastal water, found on mudy or sandy bottoms in 5 to 80 m depth, usually found in schools (Kerdgari *et al*., 2009). It has a wide distribution from the Red Sea and eastern shores of Africa to the Philippines and Japan. It is one of the major species in the southern Red Sea (Ben –Yami, 1964) and in the Gulf of Suez (Ben-Tuvia and Grofit, 1973). The present of this fish in the Mediterranean is evidently due to migration from the Red Sea via the Suez Canal (Golani and Sonin, 2006). Six nemipterid species belonging to two genera were recorded in the Gulf of Suez (Breikaa, 1996). The stock assessment of *N. japonicus* in the Gulf of Suez was studied by Breikaa (1992 and1996) and EL-Ganainy *et al*. (2003). Also, its population dynamics in the Indo Pacific region was studied by Krishnarnoorthi (1976); Ingles and Pauly (1984); Edward, Bakhader and Shaher (1985); Vivekanandan and James (1986); Murty (1987); Devaraj and Gulati (1988); Khan and Mustafa (1989); Iqbal (1991); Mostafa (1994); Lavapie ,Gonzales and Gayanilo (1997); Al-Sakaff and Esseen (1999); Rajkumar *et al.* (2003) and Joshi (2010). Furthermore, the biology and fishery of *N. japonicus* in the Indian Ocean region, South China Sea, Arabian Sea and Red Sea were described by Kuthalingam

(1969); Krishnamoorthi (1971, 1973,1974); Eggleston (1972); Vinci and Nair (1974); Fursa (1979);Vine (1982); Murty (1984); Nair and Jayaprakash (1986); Vivekanandan and James (1986); Bakhsh (1996); Rajkumar *et al.* (2003); Manojkumar (2004); Kerdgari *et al*. (2009).

The present work aims to study the spawning season and seasonal change in GSI and provides information on growth parameters and mortality rates which used in management for *Nemipterus japonicus* in the Gulf of Suez.

MATERIALS AND METHODS

Monthly samples of *Nemipterus japonicus* were collected during the period from September 2010 to July 2011. A total of 569 individuals (274 males, 231 females and 46 immature) were caught by bottom trawlers at Attaka harbor. Length measurements of specimens were taken to the nearest centimeter and weighed to the nearest gram. Sex was determined and maturity stages of *Nemipterus japonicus* were identified based on the scale of Nikolsky (1963) (I immature, II resting stage, III mature, IV nearly ripe, V ripe, and VI spent). Gonads were weighed to the nearest milligram.

The gonado-somatic index of each sex was calculated using the following formula of De Viaming *et al*. (1982); GSI=GW*100/ BW

Where: GW=gonad weight and BW=body weight.

The relationship between body weight (W) and total length (L) was estimated by Ricker (1973): $W = aL^b$

The Condition Factor (K) was calculated after Pauly (1983) where $K = W_* 100/ L^3$ (W= gutted body weight in gm, L=total length in cm).

The FISAT software (Gayalino *et al.*, 1995) was used with the monthly length-frequency distributions for determination of age and growth rates by applied Bhattacharya (1967) method and the analysis of the population parameter estimates were done.

The estimates of the von Bertalanffy growth parameters, the asymptotic length ($L\infty$) and the growth coefficient (K), were obtained using the ELEFAN I routine of FISAT which allows the estimation of growth parameters without knowing the age of the individuals (Pauly and David, 1981).

The theoretical age at length zero (t_o) was estimated using Pauly's empirical equation (1979): $\text{Log}(-t_o) = -0.3922 - 0.2752 \log L_\infty - 1.038 \log K$

The growth performance index, Φ' of the species was estimated after Pauly and Munro (1984): $\Phi' = \text{Log10 } K + 2 \text{ Log10 } L\infty$

The longevity (t_{max}) was obtained after Pauly (1983) by the following equation:

$$t_{max} = t_0 + 3/k$$

Where t_{max} is the approximate maximum age of a fish in a given population.

The total mortality (Z) was estimated from the length converted catch curve method described by Pauly (1983). Natural mortality was computed by applying Rikhter and Efanoves (1976) equation: M=(1.52 /(t(mass)^0.72) – 0.16.

The fishing mortality coefficient (F) was calculated directly: where F= Z-M.

The current exploitation rate (E_{cur}) was estimated by the formula of Gulland (1971): E =F /Z.

The length at first capture L_C was estimated by Pauly(1984a,b). The Relative yield and biomass-per recruit analysis were used to assess the fishery. Growth parameters (K and L_∞), mortality (M), and length at first capture (L_C) were used as model inputs, and the knife-edge selection was assumed. The Beverton and Holt

(1966) yield per recruit model modified by Pauly and Soriano (1986) was used to estimate the size at maximum yield per recruit and to predict the effects of increasing the mean size at first capture (L_C) at which yield per recruit would be maximized.

RESULTES

Length- weight relationship

The total length of females *Nemipterus japonicus* ranged from 8.5-25cm, and that of males from 10-29cm. The corresponding total weight ranged from 12.42 - 159.28gm, and 17.34-219.92gm. The length-weight relationship was computed and the obtained equation was in the form of $W=0.025*L^{2.733}$ ($R^2=0.94$)
This relationship is shown in Fig. (1).

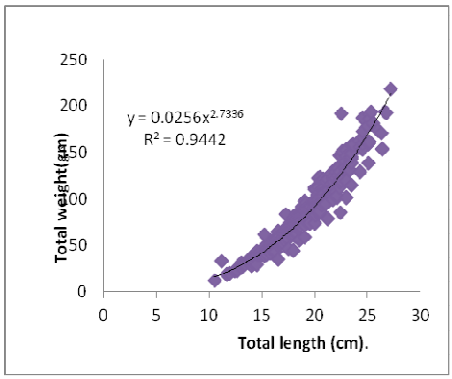

Fig. 1: Length -weight relationship of *N. japonicus* in the Gulf of Suez.

The condition factor (k)

The mean values of condition factor ranged between 0.9577-1.728 and 1.007-1.622 for males and females, respectively (Fig. 2).

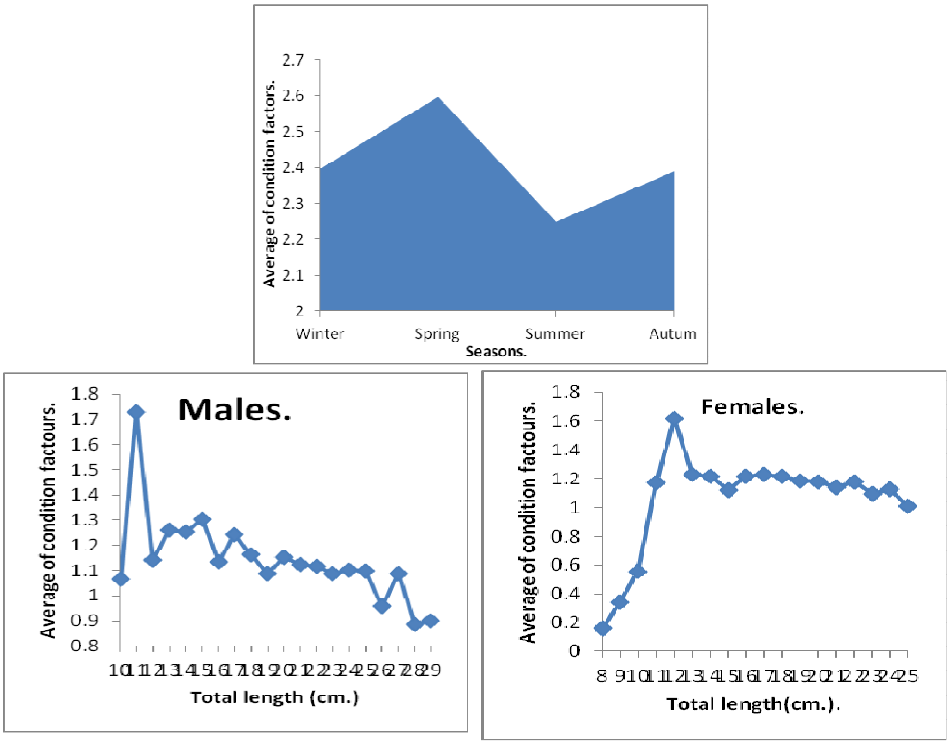

Fig. 2: Average of condition factors for males and females of *N. japonicus* in the Gulf of Suez.

The maximum values (11cm for males and 12 cm for females) were recorded in spring. There was a decline in values of K at summer, followed by an increase in autumn and winter for combined sexes.

Sex ratio

From Fig. (3), it was obvious that the over all sex ratio (M/F) was1:1.19. Males were dominant in January (87%), while females were dominant in February (69%), while they had the same percent age (50%) in July.

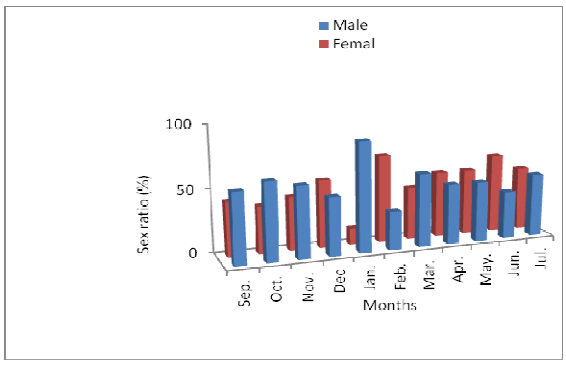

Fig. 3: Monthly variation in sex ratio of *N. japonicus* in the Gulf of Suez.

Gonad Somatic Index (GSI)

Monthly average variation in GSI of both sexes of *Nemipterus japonicus* was quite apparent in Fig. (4). Females had the maximum values in September (2.3) and May (2.6) then gradually decreased to reach a minimum value in February (0.87). The maximum values of GSI for males were recorded in September (0.42) and May (0.49) and reached minimum value in February (0.25). Also, another peak was found in May for both sexes followed by a lower record of GSI in July (Fig.4).

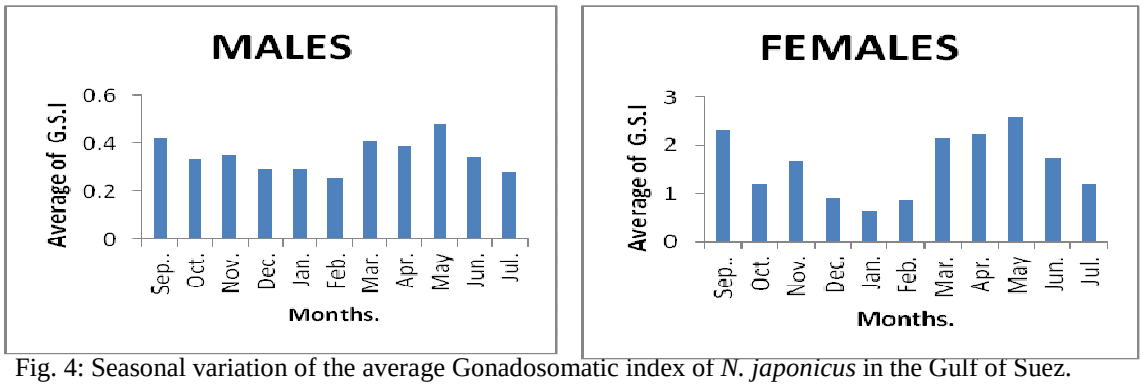

Fig. 4: Seasonal variation of the average Gonadosomatic index of *N. japonicus* in the Gulf of Suez.

Length at first maturity

The length of the smallest mature female was 10 cm. About 50% of females and males were mature at lengths of 11.4 cm and 12.5 cm, respectively (Fig. 5).

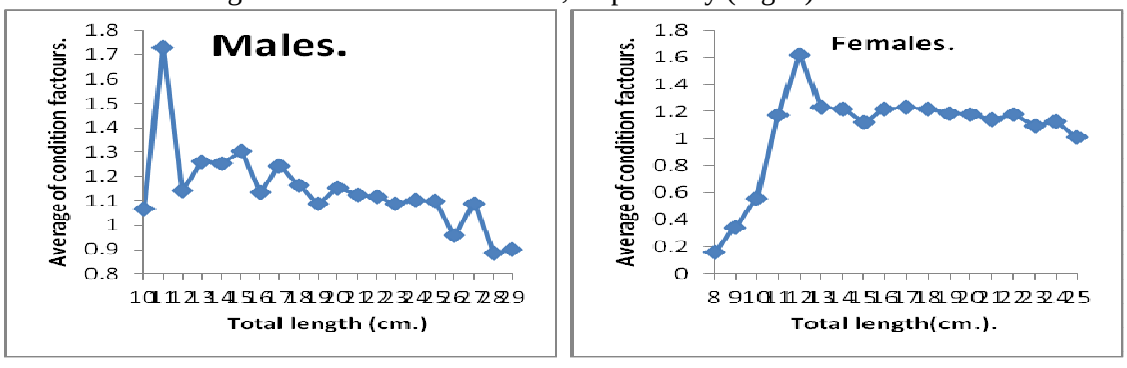

Fig. 5: Length at first sexual maturity of males and females *N. japonicus* in the Gulf of Suez.

Age and growth

Age was determined based on length frequency analysis using Bhattacharya's method represented in Fig. (6) and Table (1). The life span was about 5 years with a predominant of age group two in the catch (42.5%) with mean lengths of 12.65cm, 16.46cm, 19.90cm, 23.72cm and 26.99cm, respectively, while zero group was calculated at 9.50cm.

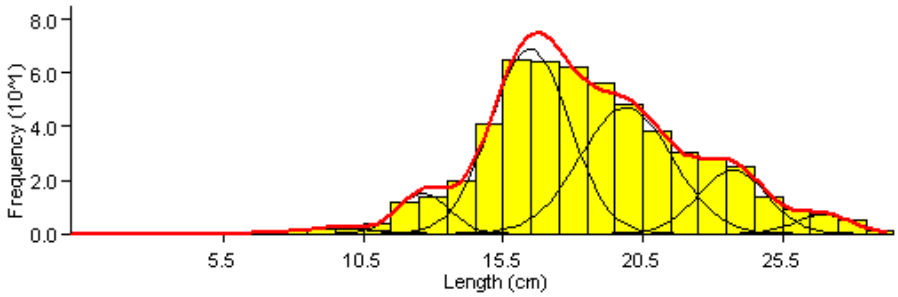

Fig. 6: Age determination by the Bhattacharya method.

Table 1: Summary of the calculated spawning time of *Nemipterus japonicus* in different regions.

Locality	Date of spawning	Source
South China	May-October	Krishnamoorthi (1971)
Eastern part of Arabian Sea	Year round (peak October)	Eggleston(1972)
Off Waltair	September-November	Weber & Jothy (1977)
East Malaysian	November-February	Fursa (1979)
At Waltair	December-February and June-July	Dan (1980)
In WS Hoar	In Summer	Nagahana (1983)
Kakinada	August-April(Peak February-December	Murty (1984)
Madras	June-March(Peak December-March)	Vivekanandan & James (1986)
Jizan area	Year round (peak November-May)	Bakhsh(1996)
Off Cochin	July-August	Joshi (2010)
Gulf of Suez	September-May	Present study

Theoretical growth in length

The von Bertalanffy growth equation for growth in length for *Nemipterus japonicus* were estimated as follow:

$$Lt = 33.65\ (1\text{-}e^{-0.450\ (t+0.132)})$$

Theoretical growth in weight

The von Bertalanffy growth in weight for *Nemipterus japonicus* were predicated as follows:

$$Wt = 372.55\ (1\text{-}e^{-0.450\ (t+0.123)})^{2.733}$$

The longevity

The longevity (t_{max}) was calculated as 6.5 years.

Growth performance index

Growth performance index (Ø) is the best index for expressing the fish growth and it was estimated as 2.71for of *N. japonicus* in the Gulf of Suez.

Mortality

Total mortality rate ($Z=1.750\ year^{-1}$) was represented in Fig. (7). The natural mortality was estimated as (M) = $0.529\ year^{-1}$ and the fishing mortality was (F) =$1.221\ year^{-1}$.

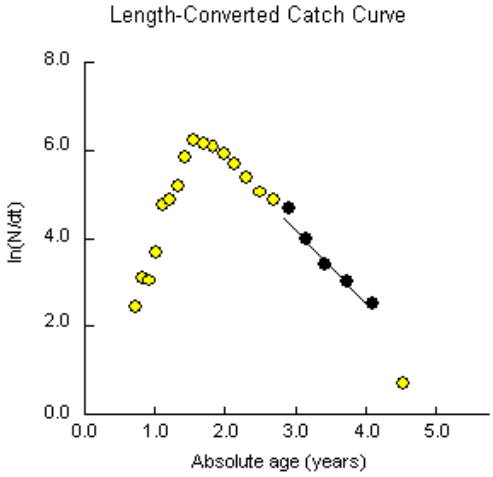

Fig. 7: Length converted catch curve of *N. japonicus* in the Gulf of Suez.

Exploitation rate

The exploitation rate (Ecur) was found to be 0.697.

Length at first capture:

In the present study length at first capture was 11.48cm

Relative yield per recruit, relative biomass per-recruit:

Nemipterus japonicus is the most dominant species in the nemipterid catch from the Gulf of Suez. The relative yield per recruit and the biomass per recruit (B/R) as a function of exploitation rate (E) are shown in Fig. (8). It is indicated that the maximum yield per recruit was obtained at (E_{max}=0.543). The economic exploitation rate $E_{0.1}$ equals 464 and at which the marginal increase in Y /R reaches 1/10 of the marginal increase computed at very low value of E. E_{50}=0.323 where E_{50} is the exploitation level which will result in a reduction of unexploited biomass by 50%.

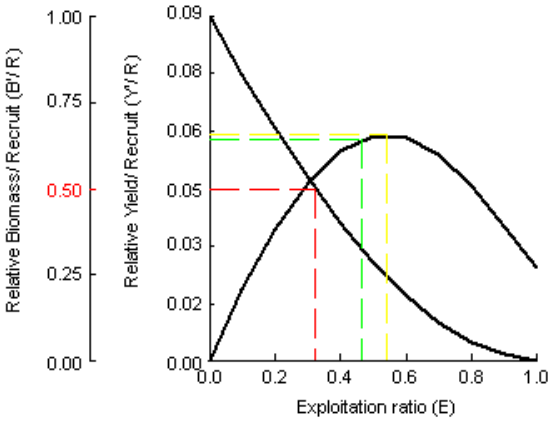

Fig. 8: Current yield per recruit analysis of *N. japonicus* in the Gulf of Suez. at (LC = 11.48)

DISCUTION

The value of the condition factor (K) have been used to measure various ecological and biological factors such as degree of fatness, gonadal development and the suitability of the environment with regard to the feeding condition (Mac Gregoer, 1959). In the present study the maximum values of K were recorded at 11cm for males and 12 cm for females, and were obtained at spring followed by decline at

summer and increased again in autumn and winter for combined sexes. This may be attributed to sexual maturation.

The highest values of the monthly GSI for both sexes of *N. japonicus* in the Gulf of Suez were in September and May, while the minimum values were reported in February and July which may indicate that *N. japonicus* in the Gulf of Suez had prolonged spawning season extending from September to February and from May to July.

The estimated spawning time of *Nemipterus japonicus* in different regions of the world is given in Table (2). Nagahana (1983) demonstrated that peaks of spawning occur in Summer which was similar to the present observation. However, Eggleston (1972), Weber and Jothy (1977), Dan (1980) and Murty (1984) found that spawning season varies from region to another according the environmental factors.

Table 2: Mean assigned lengths, standard deviation for *N. japonicus* from the Gulf of Suez estimated by Battacharya method.

Age group	Mean	S.D	Population	S.I.
Zero	9.50	1.200	7	n.a.
1	12.65	0.910	34	2.190
11	16.46	1.400	242	2.220
111	19.90	1.650	195	2.040
1V	23.72	1.230	73	2.090
V	26.99	1.020	18	2.080

The length and age at first sexual maturity are very important parameter in fisheries research to assess the optimum age of first capture of a species and to determine minimum legal size that may be needed to maintain the suitable spawning stock and to ensure at least one spawning for the mature individuals. Length at first sexual maturity of *Nemipterus japonicus* was 11.4 cm for male and 12.5 cm for females. The obtained result was similar with that of Murty (1987), Bakhsh (1996) and Rajkumar *et al.* (2003) who reported Lc at 12.5cm, 11cm and 128 mm, respectively. On the other hand, Manojkumar (2004) determined sexual maturity of females *Nemipterus japonicus* at length 14.0 cm and 50 % maturity at 18.3 cm and Krishnamoorthi (1971) found the above limit at 16.5 cm. The differences in values of Lc and age at first sexual maturity can be attributed to variations in food and water temperature and stock density which may influence the growth of fish and length at maturity (Tormosova, 19 83).

Based on the present results, length at first capture was 11.48 and lengths at first maturity were 11.4cm for males and 12.5 for females for *Nemipterus japonicus* from the Gulf of Suez. This indicats that these individual do not have the chance to reproduce before they are removed from the population. Similar results were obtained by Berikaa (1996) and El-Ganainy (2003) who estimated the length at first capture for *Nemipterus japonicus* from the Gulf of Suez as 12.66cm and 11.68cm for males and females, respectively.

The values of growth parameters of *Nemipterus japonicus* in the present study from the Gulf of Suez compared with those recorded for the same species from other Indo-Pacific regions are shown in Table (3). It is hoticed the presence of agreement with most of the previous studies, except those of Khan and Mustafa (1989); Mustafa (1994); Mustafa (1998). The differences may be due to variation in population structure and environmental condition.

The longevity (t_{max}) of *Nemipterus japonicus* was estimated to be about 6.5 years in the Gulf of Suez, however the maximum number of fishes caught was

recorded at age group two which indicated that they caught before they grow large enough to add significantly to the stock biomass, and this cause growth overfishing.

Table 3: Summary of the estimated growth parameters of *Nemipterus japonicus* in different Indo- Pacific reigons.

Locality	L∞ (cm)	K year^{-1}	t_o	Ø	Source
Philippine	30.00	0.700		2.800	Ingles and Pauly (1984)
Gulf of Aden	29.10	0.310	0.048	2.420	Edward *et al* (1985)
India	30.50	1.004	0.226	2.970	Vivekanandan and James (1986)
India	33.90	0.520	-0.160	2.776	Murty (1987)
India	29.80	0.821		2.860	Devaraj and Gulati (1988)
Bangladesh	24.16	1.060		2.791	Khan and Mustafa (1989)
Pakistan	28.80	0.460		2.580	Iqbal (1991)
Gulf of Suez	28.64	0.495	-0.122	2.609	Breikaa (1992)
Bangladesh	24.50	0.940		2.750	Mustafa (1994);
Gulf of Suez	29.27	0.462	-0.198	2.597	Breikaa (1996)
Philippine	28.30				Lavapie *et al* (1997)
Bay of Bengal	25.60	0.940		2.790	Mustafa (1999)
Gulf of Suez	28.35	0.63	-0.435	2.794	El-Ganainy and Mehanna**.** (2003)
Gulf of Suez	33.65	0.450.	-0.123	2.71	Present study

The current exploitation rate Ecur = 0.697 was higher than that required to give the maximum yield per recruit (Emax = 0.543) and also higher than the optimum exploitation rate (E_{50}=0.323) which maintain 50% of the stock biomass. This indicated that *Nemipterus japonicus* in the Gulf of Suez are exposed to over-exploitation, so that E_{cur} must be reduced by about 28 %. These results confirm the results of El-Ganainy (2003) who reported that there was over-exploitation by the trawl fishing in the Gulf of Suez and E=0.696.

Briekaa (1996) estimated the maximum sustainable yield and found that the fishing pressure extracted in the Gulf of Suez for nemipterid catch must be reduced by about 44%.

The present and previous studies recommended that to mange *Nemipterus japonicus* in the Gulf of Suez, the adults must be protected during the major spawning season. A seasonal closer from May to September can be provide better breeding opportunities for adults and will provide a good fishery management measure for this species. Also, the length at first capture of *Nemipterus japonicus* must be increased to maintain the stock and to give the chance to mature animals to breed at least once through its live-span. Moreover, the trawl fishery operating the Gulf of Suez must be managed by reducing effort (number of boat, and number of landings). Finally, the nursing ground of this economically important species must be protected from pollution to reduce the rate of natural mortality of this species in the Gulf of Suez.

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ARABIC SUMMARY

بيولوجية وتنظيم اسماك الصرع (*Nemiptrus japonicus*) في خليج السويس . مصر

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تنتج مصايد خليج السويس اجود انواع الاسماك والقشريات. ومن الاسماك الاقتصادية التي تصاد بحرفة الجر اسماك الصرع. يهدف البحث الي دراسة بيولوجية وديناميكية هذا النوع في خليج السويس لتنظيم مصايده والحفاظ علي انتاجة عن طريق تحليل ودراسة 569 عينة من اسماك الصرع المصادة من خليج السويس خلال موسم صيد 2010-2011 واتضح من الدراسة ان هذا النوع يصل الي عمر خمس سنوات ، واقصي طول نظري ممكن ان تصل الية السمكة L∞=33،65 سم .بمعدل نمو yr450=k تم تعيين الطول عند اول نضج جنسي وكان للاناث عند 12,5 سم اما الذكور عند 11,4 سم بينما الطول عند اول مصيد 11,48 سم. كما شملت الدراسة تعين معاملات النفوق الكلي والطبيعي والناتج عن الصيد وبدراسة معدلات الاستغلال وتطبيق نموذج بفرتون وهولت لدراسة الانتاج اتضح ان اسماك الصرع في خليج السويس تعاني من عمليات صيد جائر وتحتاج مصايده الي تنظيم وتخفيض جهد الصيد حتي نصل الى الانتاج الامثل والمستمر.