Abbassa Int. J. Aqua., V0l.10 No.(1) 2017. *194-206*

BIOLOGY AND FISHERIES MANAGEMENT OF RABBITFISH, *Siganus rivulatus* IN BARDWIL LAGOON, EGYPT

Mohamed salem[1] and Attia El_Aiatt[2]

[1] Faculty of Environmental Agriculture Sciences, Arish – University

[2] National Institute of Oceanography and Fisheries NIOF

Received 20/ 9/ 2017 *Accepted 13/ 11/ 2017*

Abstract

Rabbitfish, *Siganus rivulatus* in Bardawill lagoon has considerable commercial important species. This study aims to identify some of the biological properties of this species and supply management catches this information to preserve this kind of fish. Length-based methods were used to study the growth of the rabbit fish *Siganus rivulatus*, in Bardawill lagoon. Samples (ranged from 7 to 21.6cm total length and 4 to 116g total weight) were collected from April to December 2016. Age was determined from otoliths measurements and the results showed that the maximum life span is 5 years. Back calculation length at the end of each year were calculated as 10.19, 13.51, 16.59, 18.02 and 19.49 cm. Total length- weight relationship was estimated as $w=0.0152L^{2.8406}$. Length at first capture Lc was 13.5 cm and age at first capture was 1.99717years. Size group 13-13.9 cm (about 19.5% of the total frequencies), is the domination in the size groups. Growth parameters were $L\infty$ = 23.09 cm, K = 0.3191 y^{-1} and t_0 = -0.7571 y^{-1}. The growth performance index was 2.23. The instantaneous total, natural and fishing mortality are 0.9684, 0.4495 and 0.5189 $year^{-1}$ respectively. Exploitation rate (E) was 0.54 $year^{-1}$. The results indicated that the *S. rivulatus* resource in Bardawill lagoon is moderate exploited but the juvenile was dominated in landing. The higher values of yield per recruit (10.28, 10.75, 11.47, 11.7014 and 11.849) were with Tc = 1.25, 1.5, 1.99717, 2.25 and 2.5 years at fishing mortality 0.9, 1.2, 2.1, 3.2 and 6 respectively. All indications are that mesh sizes needs to be increases or must be fished by the legal trammel nets only.

INTRODUCTION

Bardawill lagoon is a hyper saline lagoon, neighbouring of eastern Mediterranean coast, North Sinai. The lagoon covers an estimated area of 136,318 Feddan with a maximum length of 95 Km and a maximum width of 22 Km, the water depth ranges from 0.5 m to 3 m (GAFRD, 2015). Rabbitfish,

Siganus rivulatus has a wide geographical distribution in the tropical and subtropical areas. This fish is popular to consumers, considered as excellent seafood and sold at an acceptable price (Mehana and Abdallah, 2002). Siganus fishes are caught mainly by the trawls, trammel, gill nets and beach seines. Some biological studies were done on Siganus fishes in many countries (Wray, 1979; Hashem, 1983 and Ali 2015).

This work aimed to assess the status of this fish which are exploited in the Bardawil lagoon to providing information required for resource management purposes.

MATERIALS AND METHODS

Total length and total weight of 2721 specimens of Rabbitfish, *Siganus rivulatus* were recorded monthly during the fishing season 2016. The length–weight relationship described as $W = a * L^{b}$ where W = total weight (g), L = total length (cm) and a & b constants. The values of $L\infty$, K and t_0 were estimated by Ford, 1933-Welford method, 1946 where growth rate is plotted against the mean length during the corresponding year.

Otoliths for 570 samples were removed, cleaned and stored dry in labeled vials. Annual rings on otoliths were counted using an optical system consisting of Nikon Zoom-Stereomicroscope focusing block, Heidenhain's electronic bi-directional read out system VRX 182, under transmitted light. The total radius of the otolith "S" and the distance between the focus of the otolith and the successive annuli were measured to the nearest 0.01 mm. The otolith's measurements from specimens were used to describe the relationship between the total length and the otolith radius. Lengths by age were back-calculated using **(**Lee's, 1920**)** equation as follows:

$$L_n = (L - a)\, S_n / S + a$$

Where: L_n equals length of fish at formed of ring *n* (*age at n year*), *L* equals the fish length at capture, S_n equals the scale radius at fish length L_n and

S is the total radius of scales (a: constant). The calculated weight at the end of each year was estimated by applying length-weight equation.

The growth performance index (ø) was estimated using Pauly and Munro, 1984 formula as ø = Log K + 2 Log L∝.

Total mortality were obtained by using two methods (Beverton and Holt's, 1957 as $Z=K*((L\infty-\bar{Lc})/(\bar{Lc}-Lc))$ and Chapman and Robson, 1960 as Z= -Ln S)

Natural mortality coefficient was estimated by using two methods: (Alverson and Carney, 1975 as $M = 3 * K / [\exp (t_{max}* 0.38 * K) – 1]$ and Hewitt and Hoenig, 2005 as $M=4.22/t_{max}$), where t_{max} is the maximum age of the fish in the sample. Fishing mortality F=Z-M. The exploitation rate (E) by Gulland, 1971 E= f/z. Survival rate from age composition data using Ricker, 1975 equation found $S=e^{-Z}$.

Length at first capture (Lc) was calculated from the plot of the probability of capture against size. The method of Gulland, 1969 was used to predict the yield per recruit as follows:

$$Y`/R = F*e^{(M (Tc –Tr))} *W\infty*[(1/Z) –(3S/Z+K)+ (3S^2/Z+ZK) – (S^3/Z+3K)]$$

Where $S = e^{(-k (Tc - t_0))}$. L_∞, K, and t_0 = Bertalanfy, 1934 growth parameter, Tc is age at first capture, Tr is age at recruitment, W∞ is asymptotic body weight, F is fishing mortality, M is a natural mortality and Z = F+M, is a total mortality.

RESULTS

The length–weight relationship of 2721 specimens was illustrated in Fig. 1. This relation indicates positive allometric growth as the value of *b*=2.8406 in the power equation: $W= 0.0152*L^{2.8406}$.

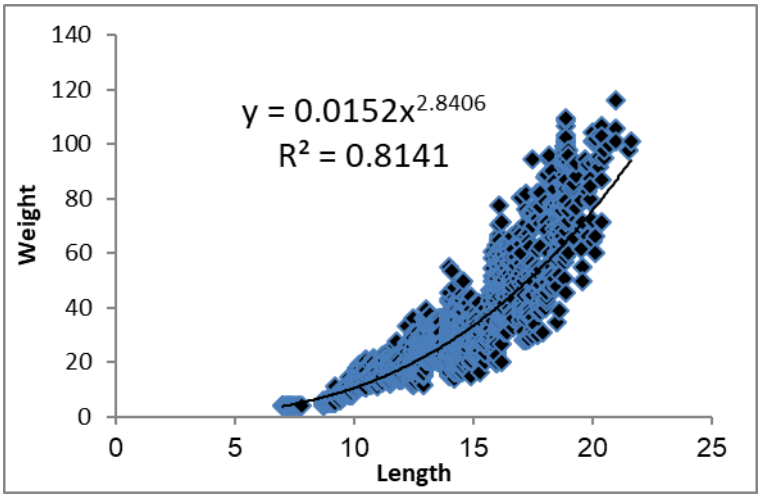

Fig. 1: Length – weight relationship of Rabbitfish, *S. rivulatus* in Bardwell lagoon Egypt.

Back-calculated length is 10.19, 13.51, 16.59, 18.02 and 19.49 cm for age 1, 2, 3, 4 and 5 years respectively (Fig. 2). The results found that the highest increment in length at the first year of life (10.19 cm) and then declined rapidly thereafter.

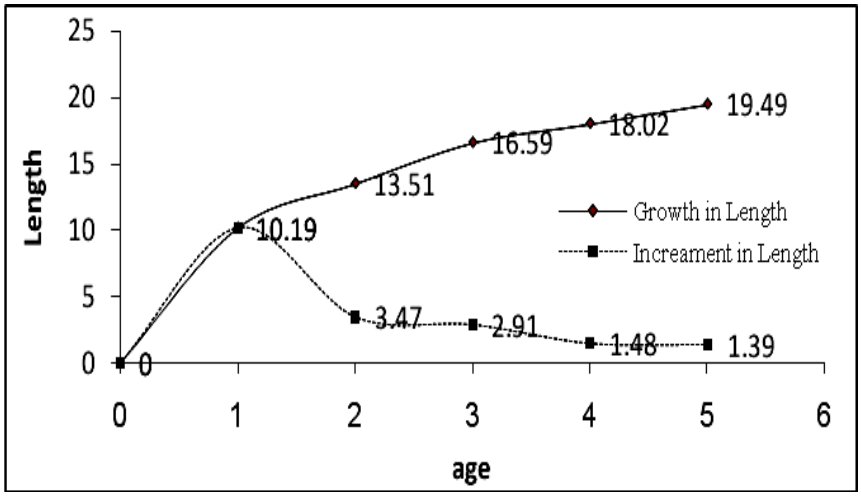

Fig. 2. Increment in length of Rabbitfish, *S. rivulatus* in Bardwell lagoon Egypt.

The highest increment in weight occurred at the end of third year of life as increment was (19.8 gm) and then declined rapidly thereafter (Fig. 3). The

back-calculated weight was 11, 24.7, 44.5, 56.5 and 70.7 gm, for age 1, 2, 3, 4 and 5 years, respectively.

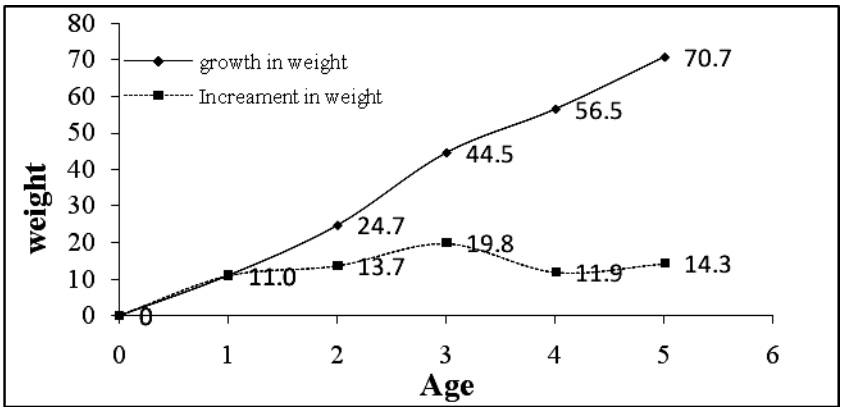

Fig. 3. Increment in weight of Rabbitfish, *S. rivulatus* in Bardwell lagoon Egypt.

Growth parameters L∞, K and t_0 were estimated as 23.09, 0.3191 and -0.7571 respectively. The equations obtained were follows as:

For length $Lt = 23.09(1-e^{(-0.3191\ (t+0.7571))})$

For weight $Wt = 113.39\ (1 - e^{(-0.3191\ (t + 0.7571))})^{2.8406}$

The growth performance index (Φ and Φ') defined as 2.23 for length and 0.87 for weight.

Maximum length with the highest biomass L_{opt} was 17.25cm and maximum age (T_{max}) was 9.4. The length at first capture (Lc) was estimated to be 13.5 cm corresponding 1.997 year (Fig 4).

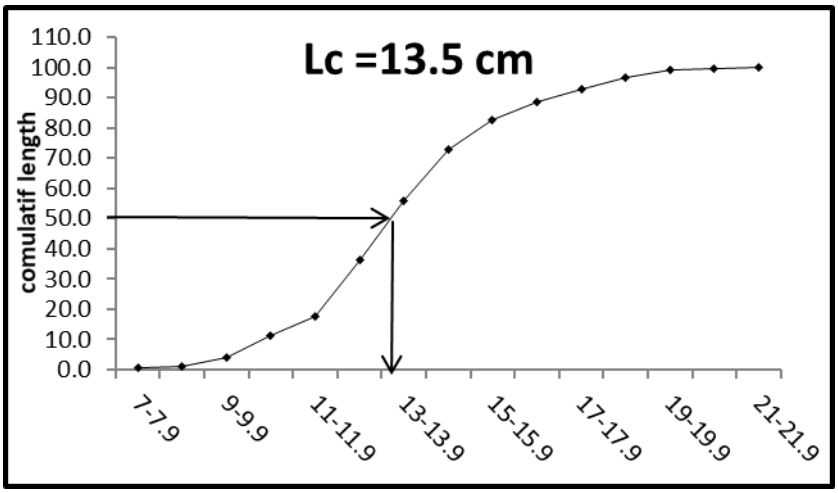

Fig. 4. Length at first capture Lc of Rabbitfish, *S. rivulatus* in Bardwell lagoon Egypt.

Age distribution ranged from 0-group to v-group years based results of the otoliths reading (Fig. 5). The age group Π was dominant (29.6%) followed by groups I (24.9%), Ш (16.3%), 0 (13%), IV (12.1%) and V (4%) respectively.

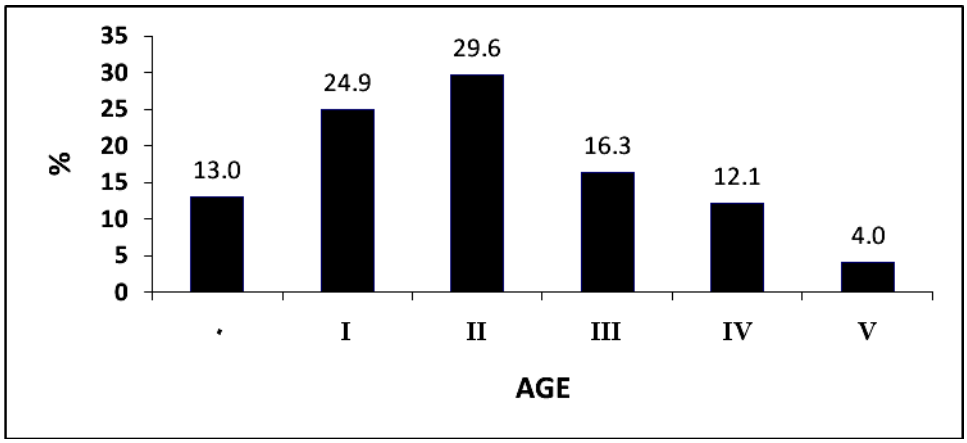

Fig. 5. Age composition distribution of Rabbitfish, *S. rivulatus* in Bardwell lagoon**,** Egypt.

Total motility (Z) equals 0.9684 year^{-1}, natural mortality (M) equals 0.4495 year^{-1} and fishing mortality (F) equals 0.5189 year^{-1}. Exploitation rate (E) was 0.54 year^{-1}.

The yield per recruit (Y/R) and biomass per recruit (B/R) were found to be 9.93 gm and 11.47 gm at the actual fishing mortality 0.5189 and 2.1 year^{-1} respectively. Biomass per recruit was decreased with the increasing of fishing mortality where it maximum (60.317 gm) at F=0.0 (Fig. 6).

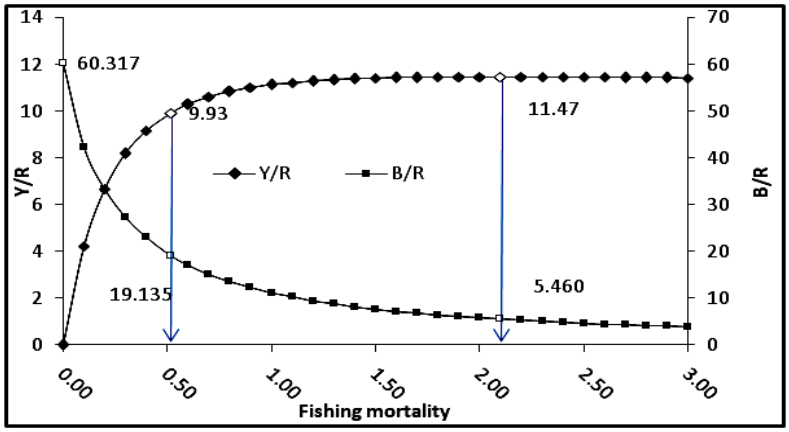

Fig. 6. Yield per recruit and biomass per recruit of Rabbitfish, *S. rivulatus* in Bardawill lagoon during season 2016.

The yield-per-recruit as a function of fishing mortality with age at first catch (Tc), was calculated using different values of Tc as1.25, 1.5, 1.99717(the present age at first capture), 2.25 and 2.5 year (Fig.7). The results indicated that the maximum yield per recruit increases when the age at first capture increases. The higher values of yield per recruit (10.28, 10.75, 11.47, 11.7014 and 11.849) were with Tc = 1.25, 1.5, 1.99717, 2.25 and 2.5 years at fishing mortality 0.9, 1.2, 2.1, 3.2 and.6 respectively.

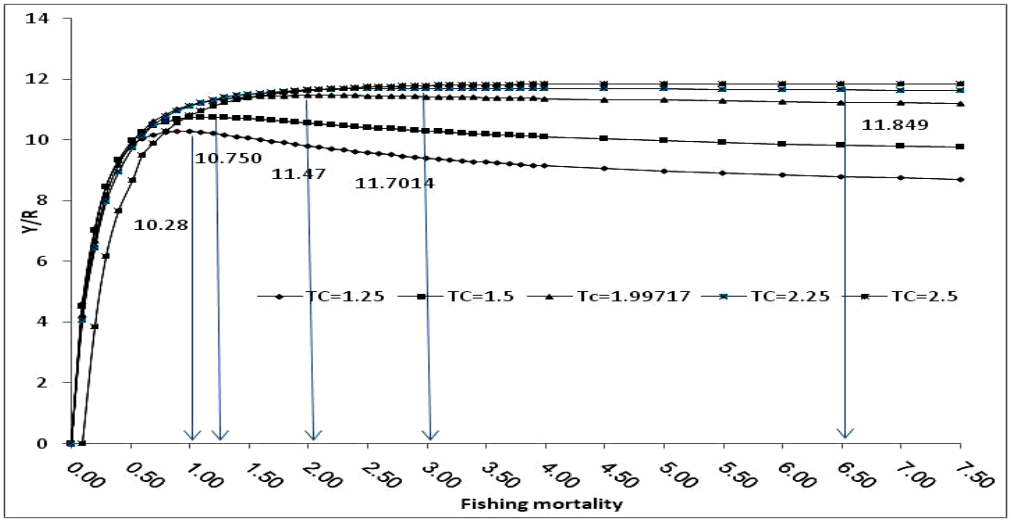

Fig. 7. Yield per recruit with different values of (F and Tc) of Rabbitfish, *S. rivulatus* in Bardawill lagoon during season 2016.

DISCUSSION

The length-weight relationship is used for converting weight data to length and vice-versa. Length-weight relationship parameters are used to estimate weight of fishes from their lengths, b value is useful to calculate condition indices, life history and fish morphological differences in different regions (Petrakis and Stergiou, 1995). The exponent (b) tends to have a value of around 3. In our study, b value showed slight negative allometry (≈ 2.84); this means that the fish becomes lighter for its corresponding length. It is noted that, obtained value of (b) is lower than those obtained by previous studies as Mehanna and Abedallah, 2002 and EL Drawany, 2015 were recorded a positive allometry growth of *S. rivulatus* in the Red Sea. On the other hand, El-Gammal, 1988; Mohammed, 1991; EL Far, 2008 and Ali 2015 were recorded a negative allometry growth in different region of Mediterranean water which is in agreement with our study. Slightly lower of b in this results were due to body shape of samples are more elongated and gonadal non development where this species is native in Red sea but it invasive species in Mediterranean Sea. b values reliant on biological and environmental conditions, geographical, temporal and sampling factors (Froese, 2006).

In the present study, the highest annual increment in length of Rabbitfish, *S. rivulatus* was occurred during the first year of life, while a noticeable decrease is observed in the second year, reaching its minimal value during the fifth year of life. These results agree by El-Ganainy and Ahmed, 2002; EL- Far, 2008 and Ali, 2015.

There is a possibility of damage to the Rabbitfish stock in future, where the fishers appear to be catching all ages. Six age groups were identified, 1st age group and less (0-age group) were dominated (37.9%), followed by 2nd age group (29.6%), while larger groups represented by 32.4% (16.3, 12.1 and 4%) only.

In the present study the annual rates of total, natural and fishing mortality of *S. rivulatus* is the lower than those obtained by various authors and in different locations. It must be mention that total and fishing mortality rates are an area specific parameters and not a species specific parameters, which may change over time according to variations in fishing effort. Concerning mortality estimates, comparison is difficult because of scarcity of data and the total mortality coefficient is not a species-specific parameter, but an area specific parameter. The lower values of Z because this fish is no target species in the lagoon. The exploitation rate (E) was lower than 0.54.These results are important for fisheries management authorities as they suggest that, the resource under moderately exploitation but be required revision of mesh size regulations where small fishes were dominated of landing, a substantial reduction in fishing effort would also be required if management objectives are to be achieved.

To investigate the variation in yield per recruit with changing of age at first capture Tc, this is closely related to the estimation of the optimum mesh size. Yield per recruit of *S. rivulatus* was calculated using Tc = 1.25, 1.5, 1.99717 (current age at first capture), 2.25 and 2.5 years. Results indicated that, the maximum yield per recruit will be achieved at Tc = 1.99717 year with current fishing mortality (F = 0.5189) in a long time. In addition, with the

increasing of fishing mortality F = 2.1 at Tc = 1.99717 year, the maximum yield per recruit will be increase. Increasing of effort (F = 0.5189) to F_{max} (F =2.1) associated with negligible increase in the yield per recruit (11.47 – 9.93 = 1.54)=1.54/9.93*100=15.47%.That meaning of, the increase in fishing effort by = (2.1-0.5189)/0.5189*100 = 304.7% over production as much as 15.47% only, this is unacceptable biologically. Also, higher yields that obtained by increase in effort cannot be maintained, and they will have to be followed by a period of much lower yield. In this study, the value of Tc (which is a proxy of mesh size) and the current exploitation rate (which is a proxy of effort) indicated that the small fish are caught at higher effort level.

RECOMMENDATION

We can recommend that the current efforts Rabbitfish, *Siganus rivulatus* should be stabilized at the present level and catching small rabitfish which less than 2 years age most be prohibited to be able to spawn at least once. Also, we can recommend that, the mesh size of fishing gears should be increased as gill nets and trawls. If this is not carried out, must be caught this species by the legal trammel nets only.

REFERENCE

Ali, S.M., 2015. Studies on biological and dynamics of siganidae family in the Bardawil lagoon. M.Sc. in Environmental Agricultural Sciences Suez Canal University.

Alverson, D.L. and M.J. Carney, 1975. A graphic review of the growth and decay of population cohorts. Journal du Conseil International pour l' Exploration de la Mer, 36:133–143.

Beverton, R.J.H., S.J. Holt, 1957. On the dynamics of exploited fish populations. Fish. Invest. Minist. Agric. Fish. Food (Great Britain) Ser, 2 (19).

Chapman, D.G. and D.S. Robson, 1960. The analysis of a catch curve. Biometrics, 16:354-368.

EL Drawany, 2015. On the Biology of Siganus rivulatus inhabits Bitter Lakes in Egypt, J Aquac.Res Development 2015,6:6/1000342.

EL-Far, A. M. M., 2008. Artisanal fishery off Alexandria costal area with special reference to the fishery biology of Siganus Spp . M.Sc. Thesis faculty of Science Zagazig University.

El-Gammal, F.I., 1988. Age, growth and mortality of the Rabbitfish Siganus rivulatus (Forsskål, 1775), from the Red Sea. Bull. Inst. Oceanography. Fish. A. R. E., 14: 13–21.

El-Ganainy, A.A. and A.I. Ahmed, 2002. Growth, mortality and yield -per-recruit of the Rabbitfish, Siganus rivulatus, from the eastern Sid of the gulf of Suez, Sinai Coast, Red Sea. Egypt. J. Aquat. Biol. & Fish., 6 (1): 67-81.

Ford, E., 1933. An account of the herring investigation conducted at plymouth. J. Marin. Biol. Ass. U.K.,Vol. 19 : 305 – 384p.

Froese, R., 2006. Cube law, condition factor and length-weight relationships: History, meta-analysis and recommendations. Journal Applied Ichthyology 22: 241-253.

GAFRD, 2015. Report of General Authority for Fish Resources Development on Bardawil lagoon.

Gulland, J.A., 1969. Manual of method for fish stock assessment par ,1 fish population analysis FAO Man . fish Sci .,4 : 154.

Gulland, J.A., 1971. The fish resources of the Ocean. West Byfleet, Surrey, Fishing News (Books), Ltd.. for FAO: 255pp.

Hashem, M.T., 1983. Biological studies on Siganus rivulatus (Forsk.) in the Red Sea. Journal of the Faculty of Marine Science (Jeddah), 3:119-127.

Hewitt D.A., J.M. Hoenig, 2005. Comparison of two approaches for estimating natural mortality based on longevity. Fishery Bulletin., 103: 433–437.

Lee, R., 1920. A review of the methods of age and growth determination in fishes by means of scales. Fishery investigations, Series 2, Marine fisheries, Greet Britain Ministry of Agriculture,Fisheries and food 4 (2)

Mehanna, S.F. and M. Abdallah, 2002. Population dynamic of the rabbitfish, Siganus rivulatus, from the Egyptian sector of the Red Sea. J. K. A. U. Mar. Sci., 13: 1-170

Mohammed, N. I., 1991. Biological and biochemical studies of some siganid fishes from the Mediterranean waters off Alexandria. M. Sc. Thesis, Fac. Sci., Alex. Univ.

Pauly, D. and J.L. Munro, 1984. once more on the comparison of growth in fish and invertebrates. ICLARM Fishbyte, 2 (1): 21.

Petrakis, G. and K.I. Stergiou, 1995. Weight-length relationships for 33 fish species in Greek waters. Fish. Res. 21: 465-469.

Ricker, W. E., 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Canada, 191:382 p.

Von Bertalanffy, L., 1934. Undersuchungen uber die Geselzlichkeit des wachstums. 1. Allgemeine Grundlag der theorie. Wilherm Rouse. Arch.Entumech. Org., 131: 613 – 653.

Walford, L.A., 1946. A new graphic method of describing the growth of animals. Mar. Biol. Bull., 90 (2): 141 – 147.

Wray, T., 1979. Commercial fishes of Saudi Arabia. Saudi Fisheries Company, Ministry of Agriculture and Water Resources. Saudi Arabia.

بيولوجية وإدارة مصايد اسماك السيجان فى منخفض البردويل – مصر

محمد سالم[1] ، عطيه العياط[2]

[1] كلية الاستزراع المائى والمصايد البحريه – جامعة العريش.
[2] المعهد القومي لعلوم البحار والمصايد فرع الاسكندريه.

الملخـص العربـى

تهدف الدراسة إلى تحديد بعض الخصائص البيولوجية لسمكه السيجان(*Siganus rivulatus*) في بحيرة البردويل، مصر وذلك لإدارة المصيد بشكل علمى. تم تجميع عينات اسماك السيجان من بحيرة البردويل في الفترة من ابريل إلى ديسمبر 2016 وكانت الأطوال من 7 إلى 21.6 سم واستخدمت عظمة الأذن لتحديد العمر وكانت النتائج أن فى المنخفض خمس مجموعات عمريه من الأسماك. وتم حساب طول الأسماك عند نهاية كل سنه عمريه وهو 10,19، 1,51، 16,59، 18,02 و19,49سم من السنة الأولى إلى الخامسة على الترتيب. وتم حساب العلاقة بين الطول والوزن وكانت ($w=0.0152L^{2.8406}$) وكان الطول عند بداية الصيد 13,5 سم عند عمر 1,99 سنه وان المجموعة الطولية 13–13.9 هي المجموعة السائدة وتمثل 19.5% والعمر في السنة الثانية هو الأكثر تواجد في المصيد (29.6%) تم حساب ثوابت فون برتلانفى للنمو ($L\infty = 23.09$ cm, $K= 0.3191$ yer^{-1} and $t_0= -0.7082$ yer^{-1}). وكانت معدلات النفوق النحو التالى: النفوق الكلى يساوى 0,9648 والطبيعي يساوى 0,4495 والنفوق بالصيد يساوى 0,5189 فى السنه. معدل الاستغلال يساوى 0,54 سنويا. أعلى إمداد لأسماك السيجان في البردويل كان 10,28، 10,75، 11,47، 11,70 و11,85 جرام عند الاعمار 1,25، 1,5، 1,997، 2,25 و2,5 سنه على الترتيب. وهذا يعنى أن السمكة شبه مستقره بالنسبة لمعدل الاستغلال ولكن يجب البحث عن طريقة لصيد الأسماك في السنه العمريه الثانيه والثالثه والبعد عن صيد الأسماك الصغيرة مع ثبات جهد الصيد الحالي .