Reproductive Biology of *Synodus saurus* (Linnaeus, 1758) in the Marine Waters of Syria (Lattakia District)

Amir Ibrahim[1], Chirine Hussein[1] and Afraa darweesho[1]
Department of Marine Biology, High Institute of Marine Research, Tishreen University, Lattakia, Syria

Abstract

This study was performed to assess growth characteristics and reproduction of the Atlantic lizardfish (Synodus saurus) from the Syrian marine waters off Lattakia coast. Fish samples (136 individuals) were collected monthly during the period 17/2/2015 - 9/12/2015, using trawl nets. Length and weight ranges were 12.8-25.78cm and 20.89-164.51g, respectively. It was found that the spawning season took place between may through to July. The average of absolute and relative fecundity were 64968 egg/individual and 930 egg/g respectively. The average length at first maturity was 18 cm for males and 17.6 cm for females. Length-Weight relationship was $W=0.0113*L^{2.9371}$ and the ratio of females to males was (1.5:1). The values of the Condition factor (Kf) and the Hepatosomatiic factor (HSI) increased as the Gonadosomatic Index (GSI) increased.

Keywords: *Reproductive biology, Absolute fecundity, Synodus saurus, Relative fecundity.*

I. INTRODUCTION

Fish meat is one of the most important food sources necessary to cover the human needs, because of its high nutritional value. Exploitation and depletion of fishery resources lead to increased fish mortality, lower survival rates, relocation and changes in fertility and age & length at first sexual maturity [12]. Therefore, the reproductive biology of marine fish has long been regarded as a very important issue in fisheries management. This is related to the environmental conditions (such as heat, abundance of food, etc.) which affect fertility, gonad maturity and the amount of produced eggs during the spawning season [5,6,7].

S. saurus (Synodontidae) is a benthic carnivorous fish [5,6], living in both Mediterranean and Black seas as well as eastern coast of the Atlantic [16], and is one of the most economically important fish and has not been studied biologically in the Syrian marine waters yet. The aim of this research is to study the reproductive biology of *S. saurus* in the Syrian marine waters in regards of gonad maturity, fertility and reproduction. Knowing the reproduction parameters of this species in our waters is useful in enhancing the implementation of its management plan.

II. MATERIALS AND METHODS

This study was done on 136 individuals of *S.saurus* collected from the marine waters of Lattakia (Albasit and Afamia) between February and December 2015. Individuals were caught from 20-100 m water depth using trawl nets, then transported to the Marine Biology Laboratory of the High Institute of Marine Research, where morphometric measurements (total length, standard length and weight) were taken to the nearest 1mm and 0.01g respectively. Sex determination and gonads maturity stages were recorded for each individual after dissection [11].

The Length Weight Relationship LWR was calculated using the formula $W=a*L^b$ given by [10] were "a" is constant and "b" is the regression coefficient; they were estimated by the least squares regression method.

In order to estimate the spawning season, Gonadosomatic Index (GSI) values were calculated as GSI=(Gw/Ew)*100, where Gw is Gonads weight and Ew is body weight [3]. Condition Factor (Kf) was calculated as $KF=(Ew/L^3)*100$, were Ew is empty body weight and L is total length [9]. Hepatosomatic Index (HSI) values were calculated as HSI=(Lw/Ew)*100, as were Lw is liver weight, Ew is empty body weight [19], to assess the maturity and the condition of Atlantic Lizardfish.

Length at first sexual maturity was determined by dividing the samples into various length groups and observing the maturation of their gonads. This length was reached when 50% of the individuals reached full sexual maturity [8].

Absolute and Relative fecundities were calculated as Fa=Gw*D and Fr=Fa/Ew respectively were D is number of eggs per 1 gram of Gonad weight and Ew is body weight [1].

III. RESULTS AND DISCUSSION

Length-Weight Relationship

Length and weight values were 12.8 to 25.78cm and 20.89 to 164.51g respectively and the equation was $W=0.0113*L^{2.9371}$: $r^2=0.962$ (figure 1). When the "b" value (2.9371) was taken into account, the individuals showed negative allometric growths, which means that growth in length is faster than growth in weight.

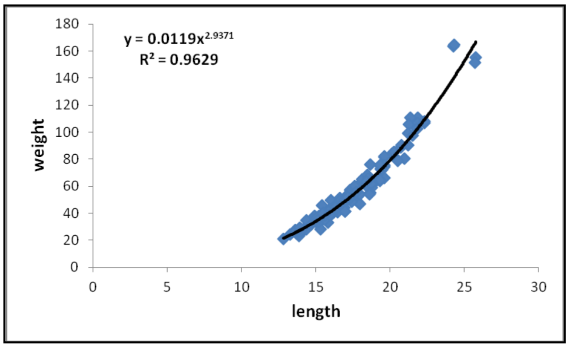

Figure 1: Length-weight relationship

Reproduction:

As shown in table 1, sexual maturation in both sexes of Atlantic lizardfish in the Syrian marine waters appeared to begin in May. Male individuals sexually matured in July and released their sperms throughout August and September, while females became fully mature in May and June, and releasaed eggs in July and August. The pattern of GSI values suggest that both sexes rest during late autumn through to winter months.

Spawning period for the species, was reported to be between April and July in the Turkish coasts [13,15], and between February and August in the Oman Gulf [14]. It appears that the spawning period for the Atlantic lizardfish is different in various geographical regions and that this might be due to different factors in these regions.

Monthly changes in Kf values (table 2) indicates a similar trend to those of GSI, which shows a little fluctuation which was more obvious in females than males. These values reflects the changes in the environmental conditions and food availability. These changes are more pronounced in females than in males, due to the changes that occur during the reproduction period and subtraction of eggs weight [4].

Monthly changes of HSI values (table 3) indicate relatively high values during the period preceding the stage of eggs release (i.e. from February to July) which can be explained by the consumption the liver nutritive substances and directing the body's energy to egg production. The highest value of HSI was obtained in June, as the fish stored excess food in the liver, which increased the values of HSI. Similarly, the lowest value was in March (table 3). The value of HSI increases prior to egg-laying season and begins to decline afterward.

Table (1): Gsi changes of *s. saurus* during the study period

Date	All Individuals		Females		Males	
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD
January	0	0	0	0	0	-
February	9	1.71±0.81	6	2.14±0.61	3	0.85±0.21
March	13	1.10±0.94	6	1.49±0.90	7	0.76±0.90
April	8	2.81±1.74	6	3.15±1.85	2	1.80±1.18
May	17	5.96±3.91	10	8.66±2.71	7	2.11±0.68
June	16	7.64±4.42	13	8.95±3.80	3	1.94±0.38
July	15	8.00±3.78	11	9.79±2.40	4	3.06±1.76
August	3	3.98±0.66	0	0	3	3.98±0.66
September	2	3.41±3.23	1	5.708	1	1.126
October	24	3.74±3.27	11	6.05±2.53	13	0.58±0.20
Npvember	14	2.80±2.83	6	5.54±2.27	8	0.76±0.20
December	15	0.52±0.17	10	0.61±0.11	5	0.33±0.11

Table (2): Kf changes of *s.saurus* during the study period

Date	All Individuals		Females		Males	
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD
January	0	0	0	0	0	0
February	9	0.7±0.05	6	0.70±0.06	3	0.69±0.04
March	13	0.64±0.04	6	0.63±0.01	7	0.65±0.06
April	8	0.67±0.05	6	0.68±0.05	2	0.65±0.01
May	17	0.67±0.04	10	0.65±0.04	7	0.69±0.04
June	16	0.65±0.03	13	0.64±0.03	3	0.69±0.03
July	15	0.67±0.03	11	0.67±0.03	4	0.67±0.01

August	3	0.65±0.05	0	0	3	0.65±0.05
September	2	0.72±0.01	1	0.71	1	0.73
October	24	0.65±0.02	11	0.63±0.02	13	0.67±0.02
Npvember	14	0.66±0.03	6	0.66±0.02	8	0.67±0.03
December	15	0.64±0.02	10	0.64±0.02	5	0.64±0.01

Table (3): Hsi changes of *s. saurus* during the study period

Date	All Individuals		Females		Males	
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD
January	0	0	0	0	0	-
February	9	3.40±1.25	6	2.14±1.24	3	3.77±1.45
March	13	1.75±0.34	6	1.49±0.16	7	1.90±0.39
April	8	2.80±1.54	6	3.15±1.75	2	2.23±0.67
May	17	3.07±0.90	10	8.66±0.87	7	2.46±0.54
June	16	3.16±1.16	13	8.95±1.07	3	1.84±0.22
July	15	3.03±0.82	11	9.79±0.43	4	1.97±0.67
August	3	2.39±0.26	0	0	3	2.39±0.26
September	2	1.98±0.61	1	5.70	1	1.54
October	24	2.03±0.95	11	6.05±1.11	13	1.70±0.29
Npvember	14	1.93±0.82	6	5.54±0.86	8	1.62±0.68
December	15	1.87±0.33	10	0.61±0.3	5	1.91±0.43

Fecundity:

Monthly changes of fecundity values are shown in table 4. Fecundity characterized higher in fish compared to other vertebrates, and vary depending on the environmental conditions in terms of availability of food. We found that, where nutrients are available in environments, the fecundity becomes higher compared to that of the poor areas. Fecundity is also related to the size, length and age of the fish, where it increases to a certain age and decreases afterward [2]. Absolute and Relative Fecundity were calculated as 64967.5 egg/individual and 929.6egg/g respectively. Standard length and weight of these individuals ranged from 13.7 to 25.7cm and 25.01 to 164.51g respectively.

Table (4): Relative and absolute fecundity changes of female *s. saurus* during the research period

Date	Standard length	Empty weight	Absolute Fecundity	Relative Fecundity
February	21.158	105.3	55791.66	340
April	19.873	82.952	67594.5	662
May	18.958	68.133	109742.44	1349
June	20.3	85.065	79686.77	803.73
July	18.195	61.84	85929.5	1328.06
September	16.3	45.9	37990.00	827.67
October	16.376	41.929	39498.22	923.41
November	15.503	37.185	43507.33	1203.59
Average	**17.77**	**61.61**	**64967.5**	**929.6**

Female fish constituted 58.8% of the total number of individuals (table 5). The average females weight and standard length were 57.337±28.484g and 16.508±5.776 cm respectively. The percentage of males was 41.2%, and the average males weight and standard length were 52.433±20.354g and 16.881±2.124cm respectively, and there were no morphological differences (size and color) between males and females.

Table (5): Percentage of males and females of *s. saurus* during the study period

Date	Total number	Females				Males			
		Average Standard length	Average Weight	No.	%	Average Standard length	Average Weight	No.	%
January	0	0	0	0	0	0	0	0	0
February	9	18.46±0.93	58.75±8.22	6	66.7	17.32±0.80	50.338±8	3	33.3
March	13	19.87±1.60	82.95±19	6	46.2	18.43±2.71	63.77±24.47	7	53.8
April	8	18.95±1.58	68.13±15.94	6	75.0	16.72±1.95	51.714±17.83	2	25.0
May	17	20.3±3.04	85.06±38.17	10	58.8	18.06±1.25	63.08±13.46	7	41.2
June	16	18.19±2.09	61.84±20.57	13	81.3	15.73±0.77	39.62±6.02	3	18.8
July	15	0	0	11	73.3	18.50±0.03	66.36±1.55	4	26.7
August	3	16.3±0	45.9±0	0	0.0	14.75±0	35.52±0	3	100
September	2	16.37±1.67	41.92±13.63	1	50.0	15.11±0.68	36.45±4.69	1	50.
October	24	15.50±0.92	37.18±7.43	11	45.8	14.20±0.87	30.02±6.11	13	54.2
Npvember	14	16.45±0.84	43.64±7.16	6	42.9	15.43±1.15	39.26±8.22	8	57.1
December	15	21.15±2.48	105.3±46.20	10	66.7	21.38±0.45	100.60±17.62	5	33.3
Total	**136**			**80**	**58.8**			**56**	**41.2**

Determination of length at sexual maturity have a great importance in determining the net openings size which should be used. The results showed that, in the length group 15.6 to 17.5 cm, 50% of the females were sexually mature, while in males 47% of individuals were sexually mature in the length group 16 to 17.9cm (table 6). Therefore we can note that females mature at lower lengths than males .

Table (6): Number and percentage of mature individuals of each longitudinal groups of *s. saurus* males and femals

Gender	Longitudinal groups (cm)	No.	Average standard length (cm)	No. Mature Individuals	%Mature Individuals
Females	13.5-15.5	7	14.737	3	42.86
	15.6-17.5	30	16.540	15	50
	17.6-19.5	21	18.663	14	66.67
	19.6-21.5	13	20.264	9	69.23
	21.6-25.8	9	23.318	9	100
Males	12.5-14.5	13	13.811	0	0
	14.6-15.9	16	15.324	1	6.25
	16-17.9	17	17.103	8	47.06
	18-21.9	10	19.816	8	80

IV. CONCLUSION

In this study, spawning periods for this species appeared to take place from May until August. It might be that the resting period of the Atlantic lizardfish begins during late autumn through to winter months, and it is different in various geographical regions and that this might be due to different factors in these regions

ACKNOWLEDGEMENTS

The authors thank Tishreen University and the High Institute of Marine Research, Lattakia -Syria who provided financial and logistic supports to this work.

REFERENCES

[1] Bagenal, T.B.,(1987). "*Methods for assessment of fish production in fresh water*". 3rd Eds, Blackwell Scientific, London,pp 365.
[2] Billard, R.,(1987). "*Spermatogenesis and spermatology of some teleost fish species*", Reprod.Nuts, Deuelop.26,(4):877-882.
[3] Bougis, P.,(1952). "*Recherchs biometriquea surles rougetes (Mullus barbatus et mullus sumuleus) Arch* ". Zool, exp.gen.89(2):57-174.
[4] Dutta, D & Banerjee, S.,(2016). "*Studies on length weight relationship, condition factor and hepatosomatic index of one stripe spiny eel acrognathus aral (Bloch and Schneider, 1801) in West Bengal*", International Journal of Scientific and Research Publications,6,8, 34-43pp.
[5] Froese, R & Binohlan, C.,(2000). "*Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit*

in fishes, with a simple method to evaluate length frequency data", J Fish Biol 56: 758-773.

[6] Froese, R & Binohlan, C.,(2003). "*Simple methods to obtain preliminary growth estimates for fishes*", J Appl Ichthyol 19: 376-379.

[7] Froese, R & Pauly, D., "*Fishbase(2000), concepts, design and data sources*".

[8] Gunderson. D.R.,(1977). "*Population biology of Pacific Ocean peach Seabastes alutus stocks in the Washington Queen Chaloote sound region and their response to fishing*", Fish Bull, 75(2):369 -403.

[9] Hile, R.,(1936). "*Age and growth of the cisco, Leucichthys artedi (Le Sueur), in the lakes of the north eastern highlands, Wisconsin. Bulletin of the Bureau of Fisheries*",48,19,1936,211-317pp.

[10] Le Cren, ED.,(1951). "*The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis).The Journal of Animal Ecology*", 201-219pp.

[11] Nikolskii, G.V.,(1963). "*The ecology of the fishes*". Academic press London and Newyork, 352 p.

[12] Olsen, E.M., Heino, M., Lilly, G.R., Morgan, M.J., Brattey, J., Ernande, B & Dieckmann, U.,(2004). "*Maturation trends indicative of rapid evolution preceded the collapse of northern cod*", Nature 428: 932-935.

[13] Aksiray, F.,(1987). Turkiye Deniz Basliklari ve Tayin Anahtari (Turkish Marie Fishes and their Identifications Sheets).Istabul Univ. Rektorlugu Yyayinlari NO: 3490, Istanbul, 811.

[14] Golani, d.,(1993). "*The biology of the red sea Migrant, Saurida undosquamis, in the Mediterranean and comparison with he Indigenous Confamilial Synodus saurus (teleostei: Synodontidae)".* Hydrobiologia 271:109-117.

[15] Manasirli, M., Avsar, D., Yeldan, H., Cicek, E(2008). "*Population dynamical parameters of the Atlantic lizardfish (Synodus saurus) from the Babadillimani Bight (Silifki-Mersin) in Turkey*". 2(4): 645-652.

[16] Cengiz, O & Tuncer,(2015). "*Second recored of Atlantic lizardfish, Sunodus saurus (Linnaeus, 1758), from the northern agean coast of Turkey.Acto zool*". Bulg., 67(3),447-450.

[17] Esposito, V., Battglia, P., Castriota, L., Finoia, M.G., Scotti, G & Andalora, F,(2009). "*Diet of Atlantic lizared fish, Synodus saurus (Linnaeus, 1758)(Pisces: Sunodontidae) in the Central Mediterranean sea*". Scientia, Vol37, No 2.

[18] Narvaez, P., Barreirose, J.P & Soares, M.C,(2015). "*The parasitic isopod Anilorca physodes, as a novel food source of the Lizaredfish Synodus saurus (Synodontidae)*".Cybium: International Journal of Ichthyology. 39(4):313-314.

[19] Pravdin, G.V,(1966). "*Methods in Ichthyology*", Moscow,Highschool.256.