

Some Aspects of Reproductive Biology of European Pilchard, *Sardina Pilchardus* in Derna Coast, Eastern Libya

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ABSTRACT

The reproductive biology of 700 specimens of *Sardina pilchardus* were collected monthly from the catch of trawling net and lampara fishery operating on the Derna coast on the Mediterranean Sea from August (2017) to July (2018). There were monthly variations in sex ratio between males (280 fish = 40.0 %) and females (420 fish = 60.0%). The overall sex ratio was 1: 1.50 in favor of females. The breeding season extended from October to May with a peak in November till February. The length at first maturity was L50 for males 14.5cm and L50 for females 15.5cm. The average absolute fecundity ranged from 11467±4097 to 90463±10123. Overall average absolute fecundity was 47989±7994, whereas overall relative fecundity was 2551±349/cm for total length ranging from 10.5 to 24.4cm.

الملخص

تم دراسة 700 عينة أسماك من أسماك السردين بولشارد تم تجميعها باستخدام شبك الصيد بالجر والصيد باللمبارة خلال الفترة من اغسطس 2017 وحتى يوليو 2018م من ساحل درنة شرق ليبيا المطل على البحر المتوسط ، وكان للسمة موسم تكاثر طويل يمتد من اكتوبر وحتى مايو ويصل للذروه في شهور نوفمبر وديسمبر ويناير وفبراير. وكانت الاناث هي السائدة عن الذكور طوال شهور العام فقد كانت نسبة الاناث بعدد 420 بنسبة 60.0% والذكور بعدد 280 بنسبة 40.0% ، و النسبة الجنسية للذكور والاناث ما بين 1 : 1.50 ، ومن النتائج توضح بداية بالنضج الجنسي 50% من الافراد الناضجة L50 للذكور عند طول 14.5 سم ، والاناث L50 عند طول 15.5 سم . والسمة كان لها خصوبه مطلقه تتراوح ما بين 11467-90463 بمتوسط 47989 ، وايضا الخصوبة النسبية 2551 حوالى لكل سم للاسماك التي يتراوح طولها بين 10.5 - 24.4 سم .

INTRODUCTION

Introduction" Species-specific life history data (age, growth, maturity sex ratio, time of spawning, fecundity, feeding, and mortality) are very important in the context of fisheries management, as they constitute the supporting material for the technical management regulations (Winemiller, 2005). The European sardine (sardine) *Sardina pilchardus* (Walbaum, 1792) is a small pelagic fish with moderate commercial value that accounts for

around 15-20% of the total marine captured production in the Mediterranean Sea (Tsikliras and Koutrakis, 2013). It has a temperate distribution and its abundance is highly dependent upon environmental and climatic conditions (Katara *et al.*, 2011).

In the Mediterranean, sardine grows quickly but to a lower maximum length compared to the Atlantic, has a lifespan of about 5 years (Silva *et al.*, 2008) and its extensive spawning occurs during the winter (Tsikliras *et al.*, 2010). Sardine has been extensively studied across its

Mediterranean distribution including Libyan waters (Laskaridis, 1948; Tserpes and Tsimenides, 1991; Akyol *et al.*, 1996; Voulgaridou and Stergiou, 2003; Ganias *et al.*, 2007; Giannoulaki *et al.*, 2011; Antonakakis *et al.*, 2011).

Derna coast has an important fishery for small pelagic fish, particularly anchovy and sardine (Abziew, 2016). However, according to Libya Sardines Prices (FAO, 2018), the sardine in Libya coast has experienced a decrease during the last decade in both tones of catches and biomass, and its population has reached a critical state. Beside results from reproductive biology of *sardine pilchardus* may have direct implications for fisheries management.

The present work is the first study on the reproductive biology of *Sardina pilchardus* in the eastern coast of Libya.

MATERIALS AND METHODS

A total of 700 specimens of *Sardina pilchardus* were collected monthly from the catch of trawling net and lampara fishery operating on the Derna coast 32°46'00"N 22°38'00"E (Fig.1) on the Mediterranean Sea from August to July 2018.

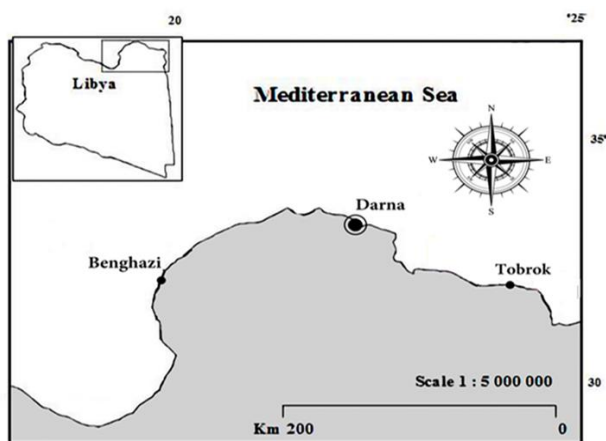


Fig. (1). Derna coast, on the Mediterranean, eastern Libya

A total of 700 *Sardina pilchardus* were used for studying the reproductive biology of the fish. Each fish was wet weighed in grams, its total length measured in cm and dissected to determine sex, then the gonads were removed and wet weighed to the nearest mg.

The monthly Gonado-somatic index (G.S.I.) was calculated according to the following formula: $G.S.I. = \frac{\text{wet weight of gonad (g)}}{\text{wet weight of fish (g)}} \times 100$ (Buxton, 1989).

Oocyte diameters were measured each month to the nearest 0.01 mm by using a microscope fitted with an eyepiece micrometer. Oocytes of individual fish comprising the monthly samples were separated from the ovarian tissue and put in separate containers containing saline solution (0.9% NaCl) for 24 hours, Fecundity was estimated by counting all ripe eggs found in the female ovary just prior to spawning.

Individual ovaries were put in small divided Petri-dish; ova were separated from the ovarian tissue with the aid of a dissecting needle, and all ripe ova were counted under a binocular microscope.

RESULTS AND DISCUSSION

Sex Ratio:

Generally, there is a tendency for more females (420 fish = 60.0 %) than males (280 fish = 40.0%) for the whole population, Overall sex ratio was 1: 1.50 for males to females (Table 1). The sex ratio was not constant throughout the different months; the numbers of females exceed males in all months.

Table (1). Monthly variations in sex ratio of 700 *Sardina pilchardus* from Derna coast, eastern Libya during the period from August 2017 till July 2018.

Months	No. of fish	Males		Females		Sex ratio
		No.	%	No.	%	
Aug. (2017)	77	37	48.1	40	51.9	1: 1.08
Sep.	72	32	44.4	40	55.6	1: 1.25
Oct.	64	22	34.4	42	65.6	1: 1.19
Nov.	65	23	35.4	42	64.6	1: 1.83
Dec.	57	15	26.3	42	73.7	1: 2.80
Jan. (2018)	57	16	28.1	41	71.9	1: 2.56
Feb.	58	20	34.5	38	65.5	1: 1.90
Mar.	58	27	46.6	31	53.4	1: 1.15
Apr.	56	25	44.6	31	55.4	1: 1.24
May	53	21	39.6	32	60.4	1: 1.52
Jun.	45	20	44.4	25	55.6	1: 1.25
Jul.	38	16	42.1	22	57.9	1: 1.38
Total	700	280	40.0	420	60.0	1: 1.50

The maximum percentage of females was recorded in October (65.6%), November

(64.6%), December (73.7 %), January (71.9%) and February (55.5 %).

Gonado-Somatic Index (G. S. I):

The monthly changes in G. S. I. was represented Figures (2). *Sardina pilchardus* have a long spawning season which extends from October to May with a peak in November till February. G. S. I. male was lower than that of female. In male, gradual increase was 0.77 % recorded in August reaches 1.49 in October and it recorded the maximum in January (2.43) and February (2.98). In female, gradual increase was 0.84 % recorded in August reaches 1.69 in October and it recorded the maximum in December (2.78), January (2.83) and February (2.99).

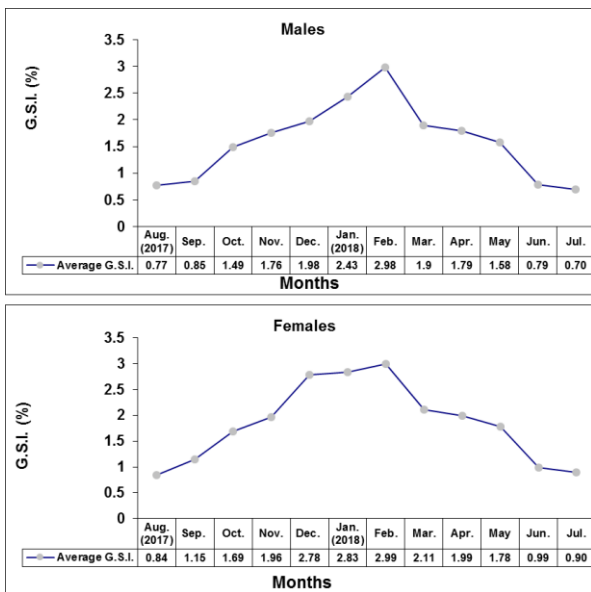


Fig. (2). Monthly variation in the average gonado somatic indices of 700 *Sardina pilchardus* from Derna coast, eastern Libya during the period from August 2017 till July 2018.

The length at first sexual maturity:

The length at first maturity was L50 for males 14.5cm and L50 for females 15.5cm. (Figure 3 and Table 2). Mature males were recorded in length group (10.5-12.4cm) by 32.7% increase in the following length groups to 87.9% in length group (18.5-20.4cm) and all fish were mature (100%) in the males with total length from 20.5 till 24.4cm.

Mature females were recorded in length group (10.5-12.4cm) by 22.7% increase in the following length groups to 81.3% in length group (18.5-20.4cm) and all fish were mature (100%) in the females with total length from 20.5 till 24.4cm.

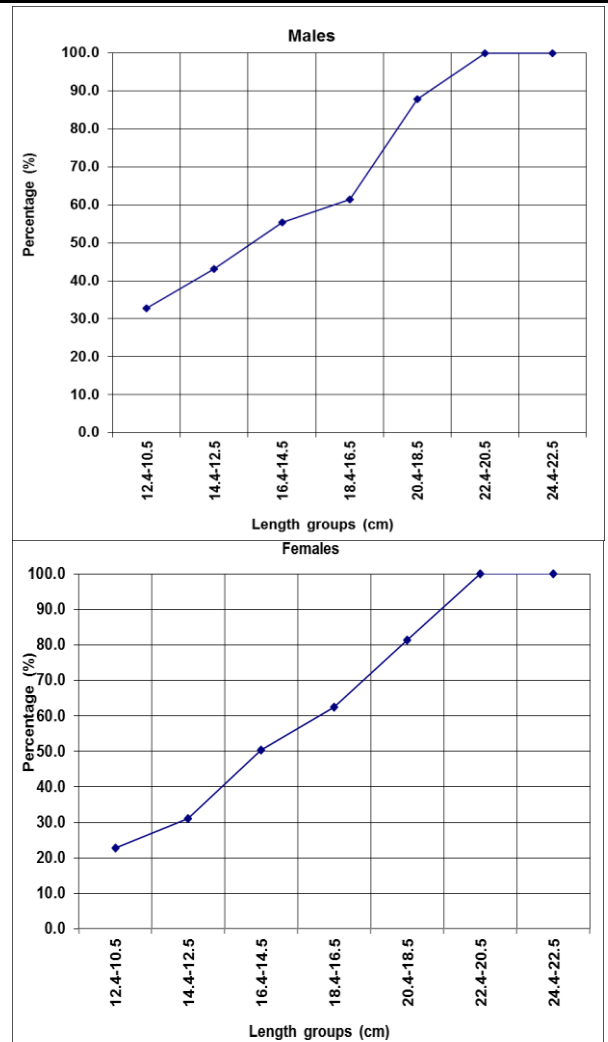


Fig. (3). Length at first maturity of 700 *Sardina pilchardus* from Derna coast, eastern Libya during the period from August 2017 till July 2018.

Table (2). Length at first maturity of 700 *Sardina pilchardus* from Derna coast, eastern Libya during the period from August 2017 till July 2018.

Total length (cm)	Males		Females	
	Immature	Mature	Immature	Mature
10.5-12.4	67.3	32.7	77.3	22.7
12.5-14.4	56.9	43.1	68.9	31.1
14.5-16.4	44.6	55.4	49.6	50.4
16.5-18.4	38.5	61.5	37.5	62.5
18.5-20.4	12.1	87.9	18.7	81.3
20.5-22.4	-	100.0	-	100.0
22.5-24.4	-	100.0	-	100.0

Fecundity:

Ovaries of 400 *Sardina pilchardus* were examined (Table 3). The average absolute fecundity ranged from 11467±4097 to 90463±10123. Overall average absolute fecundity was 47989±7994, whereas overall relative fecundity was 2551±349/cm for total length ranging from 10.5 to 24.4cm.

Table (3). Relation between fecundity and total body length (cm) of females 400 *Sardina Pilchardus* from Derna coast, eastern Libya during the period from August 2017 till July 2018.

Total length (cm)				Relative
Range	Average	No.	Average absolute fecundity	F/T.L. (cm)
10.5-12.4	11.6±0.08	24	11467 ± 4097	989
12.5-14.4	13.4±0.09	36	23418 ± 6732	1748
14.5-16.4	15.5±1.02	67	39491 ± 7639	2548
16.5-18.4	17.6±1.09	92	48341 ± 8342	2747
18.5-20.4	19.6±1.12	127	55421 ± 9121	2828
20.5-22.4	21.4±1.34	37	67325 ± 9908	3146
22.5-24.4	23.5±1.56	17	90463 ± 10123	3849
Average		400	47989±7994	2551±349

DISCUSSION

the study of the reproductive biology of fish species remains a subject of continuous research, because it constitutes the basis for development of a successful fisheries management on fish capture and culture (oronsaye and nakpodia, 2005).

analysis of reproductive cycle could provide useful information on positioning of the fishes in their environment and estimation of spawning season (tsikliras and koutrakis, 2013). *s. pilchardus* being a commercially important fish needs special attention and the study of its reproductive biology is important.

beside results from reproductive biology of sardine *pilchardus* may have direct implications for fisheries management. the present work is the first study on the reproductive biology of *sardina pilchardus* in the eastern coast of libya which was observed from samples obtained during the four seasons of 2017-2018.

the european sardine like most clupeids reproduces at sea, after which fry undertake a trophic migration shoreward to continue their development (khadija *et al.*, 2006 (in food rich lagoons, rivers and even lakes.

although the importance of this species with increasing of its number and reproduction in libyan water on the mediterranean sea, it was found that few works have been published on the reproduction biology (perez *et al.*, 1992).

a total of 700 specimens of *sardina pilchardus* were sampled for were sampled for studying the reproduction during the study period from august 2017 to july 2018. in the present work overall sex ratio was 1: 1.50 for males to females these results are agree with those results of *sardina pilchardus* in northeastern mediterranean (tsikliras and koutrakis, 2013).

the sex ratio is not constant throughout the different months, particularly during the breeding season of each species (perez *et al.*, 1992). females are dominant sex in sardine populations (khadija *et al.*, 2006). it is possible that the females are heavy and get caught in the gear in large numbers, resulting in an unbalanced sex ratio (broadhead, 1953).

unbalanced sex ratios are natural in fishes and are generally related to sexual differences in growth, mortality, or reproduction (marshall *et al.*, 1998). in a recent review the sex ratio in 72% of the examined clupeids stocks was skewed towards females (tsikliras *et al.*, 2010).

skewed sex ratios in favor of females are quite common in clupeid fishes with few exceptions especially during spawning months when males prevail *sardinella aurita* (tsikliras & antonopoulou, 2006).

in the present work, the length at first maturity was 150 for males 14.5cm and 150 for females 15.5cm. in the previous study, in the mediterranean sea that range from 14-15cm (khadija *et al.*, 2006) and 150 for males and females was 15.8cm in northeastern mediterranean sea (tsikliras and koutrakis, 2013). for the central aegean are slightly these variations in the beginning of maturity sign may be depend on the water temperatures or the different of fishing methods in all different stations (finucane *et al.*, 1978).

in the present study, from the average gonadosomatic indices (g. s. i.) of males and females *s. pilchardus* have a definite breeding season, which extends from october to may with a peak in november till february. this is on agreement with the spawning season of *sardina pilchardus* in moroccan atlantic coast (khadija *et al.*, 2006) in northeastern mediterranean sea the target species breed during the period from october till july (tsikliras and koutrakis, 2013).

the number of eggs produced by females varies greatly according to species, size, age, region, period and used techniques, thus a considerable

variability has been shown in different populations of sardine (perez *et al.*, 1992).

khadija *et al.*, (2006) in moroccan atlantic coast found that the absolute fecundity ranged from 11666 to 923423 for female ranging from 12.5 to 25.4 cm total length. in the present work, the average absolute fecundity ranged from 11467±4097 to 90463±10123. overall average absolute fecundity was 47989±7994, whereas overall relative fecundity was 2551±349/cm for total length ranging from 10.5 to 24.4cm.

CONCLUSION

In the present study the reproductive biology of 700 specimens of *Sardina pilchardus* were collected monthly from the catch of trawling net and lampara fishery operating on the Derna coast on the Mediterranean Sea from August (2017) to July (2018).

The overall sex ratio was 1: 1.50 in favor of females. The breeding season extended from October to May with a peak in November till February. The length at first maturity was L50 for males 14.5cm and L50 for females 15.5cm. The average absolute fecundity ranged from 11467±4097 to 90463±10123.

Overall average absolute fecundity was 47989±7994, whereas overall relative fecundity was 2551±349/cm for total length ranging from 10.5 to 24.4cm.

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