*Libyan Journal of Ecological & Environmental Sciences and Technology*
(LJEEST)

LJEEST
www.srcest.org.ly/jou

**DOI:** https://doi.org/10.63359/yc3g6936

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

Ez-Al-Naser A. Farag. Abziew

ARTICLE INFO

***Vol. 2 No. 1 June, 2020***

Pages (27 - 32)

***Article history:***
Revised form 1 June2020
Accepted 30 June 2020

***Authors affiliation***
*Department of Forest and Rangeland, Faculty of Natural Resources and Environmental Sciences, Omar Al Mukhtar University, Derna, Libya*
*Ebziow1975@gmail.com*

***Keywords:***
Reproductive biology, Sardina pilchardus, eastern coast, Mediterranean Sea, Derna, Libya



**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.

**بعض جوانب البيولوجيا التناسلية للبلشارد الأوروبي ، سردينا بيلشاردوس في ساحل درنة ، شرق ليبيا**

عز النصر عاشور ابزيو

تم دراسة 700 عينة أسماك من أسماك السردين بولشارد تم تجميعها باستخدام شباك الصيد بالجر والصيد باللمبارة خلال الفترة من اغسطس 2017 وحتى يوليو 2018م من ساحل درنة شرق ليبيا المطل على البحر المتوسط ، وكان للسمكه موسم تكاثر طويل يمتد من اكتوبر وحتى مايو ويصل للذروه فى شهور نوفمبر وديسمبر ويناير وفبراير. وكانت الاناث هى السائده 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 مابين 1 : 1.50 ، ومن النتائج توضح بداية بالنضج الجنسى 50 % من الافراد الناضجة L50 للذكور عند طول 14.5 سم ، والاناث L50عند طول 15.5 سم . والسمكة كان لها خصوبه مطلقه تتراوح مابين 11467-90463 بمتوسط 47989 ، وايضا الخصوبة النسبية2551 حوالى لكل سم للاسماك التى 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.

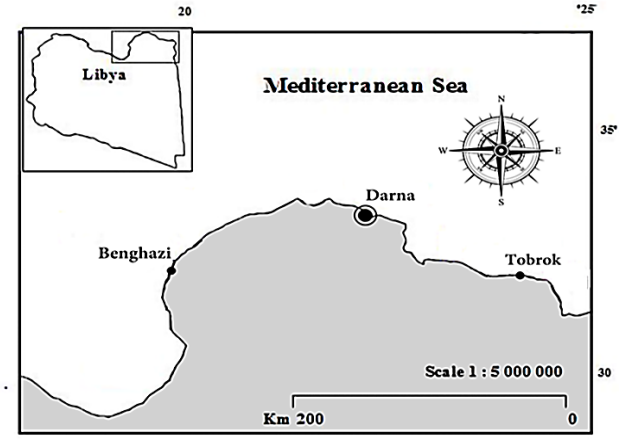


**Fig. (1). Derna coast, on the Mediterranean, eastern Libya**

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. = wet weight of gonad (g) / wet weight of fish (g) X 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, these 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.**

| | | Males | | Females | | |
|---|---|---|---|---|---|---|
| Months | No. of fish | No. | % | No. | % | Sex ratio |
| 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).

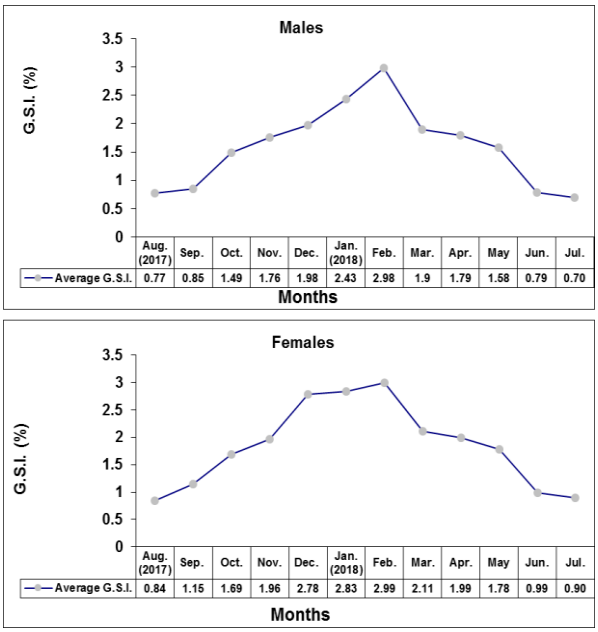


**Fig. (2). Monthly variation in the average gonado somatic indices of 700 *Sardina pilchardus* from Derna coast, eastern Libya during the period from August 2017 till July 2018.**

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.

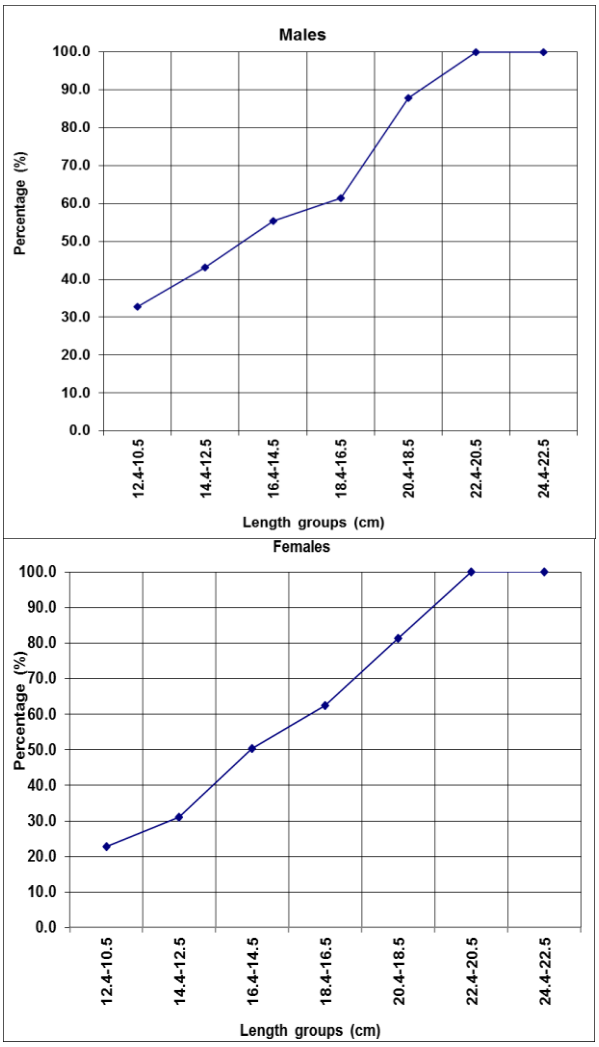


**Fig. (3). Length at first maturity of 700 *Sardina pilchardus* from Derna coast, eastern Libya during the period from August 2017 till July 2018.**

**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 | |
|---|---|---|---|---|
| Range | 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 Fecundity |
|---|---|---|---|---|
| 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. pichardus 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 l50 for males 14.5cm and l50 for females 15.5cm. in the previous study, in the mediterranean sea that range from 14-15cm (khadija *et al*., 2006) and l50 for males and females was 15.8cm in northeastern mediterranean sea (tsikliras and koutrakis, 2013). for the central aegean are slightlythese 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 gonado-somatic 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 (tsikiras 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.

## ACKNOWLEDGEMENT

Acknowledgements As Well As Information Regarding Funding Sources Should Be Provided On A Separate Page And Will Appear At The End Of The Text (Before References).

## REFERENCES

Akyol O., Tokaç A. and Ünsal S. (1996). An investigation on the growth and reproduction characteristics of the sardine (Sardina pilchardus Walbaum, 1792) in the bay of Izmir (Aegean Sea) Turkish Journal of Fisheries and Aquaculture, 13: 383-394.

Antonakakis K., Giannoulaki M., Machias A., Somarakis S Sanchez S., Ibaibarriaga L. & Uriarte A. (2011). Assessment of the sardine (Sardina pilchardus Walbaum, 1792) fishery in the eastern Mediterranean basin (north Aegean Sea) Mediterranean Marine Science, 12: 333-357

Abziew E.A.F. (2016). Fisheries statues in Derna coast, Eastern Libya. Int. J. Adv. Res. Biol. Sci. 3(4): 109-116.

Broadhead, G. C.(1953). Investigations of the black mullet( Mugil cephalus) in northwest Florida. Fla. State Bd. Conserve., 71: 1-33

Finucane, J. H., Collins, L. A. and Barger, L. E.. 1978. Spawning of the striped mullet, Mugil cephalus in the northwestern Gulf of Mexico. N.E. Gulf Sci. 2: 148-150.

Frederiksen M., Edwards M., Richardson A.J., Halliday N.C., Wanless S. (2006). From plankton to top predators: bottom-up control of a marine food web across four trophic levels. J. Anim. Ecol75: 1259-1268

FAO-FIES.( 2018) . Aquatic Sciences and Fisheries Information System (ASFIS) species list.

Giannoulaki M., Pyrounaki M.M., Liorzou B., Leonori I Valavanis V.D., Tsagarakis K., Bigot J.L., Roos D., De Felice A., Campanella F., Somarakis S., Arneri E Machias A.( 2011). Habitat suitability modelling for sardine juveniles (Sardina pilchardus) in the Mediterranean Sea Fisheries Oceanography, 20: 367-382.

Ganias K., Somarakis S., Koutsikopoulos C. and Machias A.(2007) Factors affecting the spawning period of sardine in two highly oligotrophic Seas. Marine Biology, 151: 1559-1569.

Katara I., Pierce G.J., Illian J. & Scott B.E.( 2011). Environmental drivers of the anchovy/ sardine complex in the Eastern Mediterranean. Hydrobiologia, 670: 49-65.

Khadija, A; Ferhan, F and Kifania, S. (2006). Analysis of the cycle of reproduction of Sardina pilchardus (Walbaum, 1792) off the Moroccan Atlantic coast Animal biology and pathology / Biologie et pathologie animals. C. R. Biologies 329 (2006) 892–901

Laskaridis K.( 1948). Study of the biology of the sardine (Clupea pilchardus Walb.) in Greek waters. Proceedings of the Hellenic Hydrobiology and Fisheries Bulletin, 85: 561-568

Marshall C.T., Kjesbu O.S., Yaragina N.A., Solemdal P Ulltang Ø. 1998. Is spawner biomass a sensitive measure of the reproductive and recruitment potential of

northeast 1766-1783- Arctic cod? Canadian Journal of Fisheries and Aquatic Sciences 55:

Nikolioudakis N., Palomera I., Machias A., Somarakis S. 2011 Diel feeding intensity and daily ration of the sardine Sardina pilchardus. Mar. Ecol. Prog. Ser. 437: 215-228.

Nikolioudakis N., Isari S., Pitta P., Somarakis S. 2012. Diet of sardine Sardina pilchardus and end-to-end' field study. Mar Ecol. Prog. Ser. 453: 173-188.

Oronsaye, C. G., Nakpodia, F. A. 2005. A comparative study of the food and feeding habits of Chrysichthys nigodigitatus (Lacepede) and Brycinus nurse in a Tropical River. Pakistan Journal of Scientific and Industrial Research 48,2, 118 – 121

Perez, A. G.; Rı´os, J. J.; Sanz, C.; Olı´as, J. M. Aroma.1992. components and free amino acids in strawberry variety. Chandler during ripening. J. Agric. Food Chemistry 2232-42:2235.

Silva A., Carrera P., Massé J., Uriarte A., Santos M.BOliveira P.B., .Geographic variability 2008. Soares E., Porteiro C. & Stratoudakis, Y. of sardine growth across the northeastern Atlantic and the Mediterranean Sea. Fisheries Research, 90: 56-69..

Tserpes G. & Tsimenides N. (1991). Evaluation of growth rate differences in populations of Sardina pilchardus (Walbaum1792)( Clupeidae) from the Aegean and Ionian Seas. Cybium15:15 -22

Tsikliras A.C., Antonopoulou E. & Stergiou K.I. (2010). Spawning period of Mediterranean marine fishes. Reviews in Fish Biology and Fisheries, 20: 499-538.

Tsikliras, A.C., Antonopoulou, E.( 2006). Reproductive biology of the round sardinella (Sardinella aurita) in the northeastern Mediterranean Sea. Scientia Marina, 70, 231-240

Tsikliras, A.C., Koutrakis, E.T.( 2013). Growth and reproduction of European sardine, Sardina pilchardus (Pisces: Clupeidae) in northeastern 365-54:374 Mediterranean. Cahiers de Biologie Marine

Voulgaridou P. ,and Stergiou K.I.( 2003). Long-term trends in various biological parameters of the European sardine, Sardina pilchardus (Walbaum, 1792), in the Eastern Mediterranean Sea. Scientia Marina, 67: 269-280

Winemiller K.O.( 2005). Life history strategies, population regulation, and implications for fisheries management. Canadian Journal of Fisheries and Aquatic Sciences, 62: 872-885..