

SPAWNING PATTERN OF INDIAN OIL SARDINE, *Sardinella longiceps* Valenciennes, 1847 OF OMAN SEA, MUSCAT, SULTANATE OF OMAN**Ibrahim Said Al-Anbouri^{1*}, Mohd Azmi Ambak¹, Shama Zaki Abdul Haleem²**¹ Department of Agrotechnology, Faculty of Agrotechnology and Food Science, Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia² Marine Science and Fisheries Center, Ministry of Agriculture and Fisheries wealth, Muscat, Sultanate of Oman, P.O 427, P.C 100 Muscat

Abstract: The spawning seasons of *Sardinella longiceps* of Indian oil sardine was investigated based on examining gonads along the area of Oman Sea, Muscat, Sultanate of Oman. The length at first maturity (L50%) and Gonado-somatic index (GSI) of females were considered. Length at first maturity was estimated as 182 mm (TL). The GSI shows two spawning seasons: the minor one from December to March and the major once from June to September. The maximum GSI attained between 5.0 and 5.2 during June and September respectively, suggesting a spawning peak occurred during that period.

Keywords: Spawning season, Oman Sea, Gonado-somatic index (GSI)

Özet: **Umman Sultanlığı, Muskat, Umman Denizinden Yağlı Hint Sardalyası'nın *Sardinella longiceps* Valenciennes, 1847 Üreme Şekli**

Yağlı hint sardalyasının (*sardinella longiceps*) üreme sezonları, Umman Sultanlığı-başkenti Maskat, Umman Denizi boyunca gonadların incelenmesi temel olarak değerlendirilmiştir. Dişilerin ilk erişkinlikteki uzunluğu (L 50 %) ve gonadosomatik indeks (GSI) değerleri dikkate alınarak, ilk yetişkinlikteki uzunluk 182 mm olarak hesaplanmış, Aralık' tan Mart' a kadar olan dönemde küçük bir dönem, ve Haziran' dan Eylül' e kadar olan büyük bir dönem olarak, GSI iki üreme sezonunu göstermektedir. Bu dönemde bir üreme pikinin oluşmasıyla birlikte, maksimum GSI, Haziran ve Eylül boyunca sırayla 5.0 ve 5.2 arası değerlere ulaşmıştır.

Anahtar Kelimeler: Üreme sezonu, Umman denizi, Gonadosomatik indeks

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Introduction

The Indian oil sardine *Sardinella longiceps* is a commercially important small pelagic resource in the Indo-Pacific region. It is widely distributed along the coast of Omani waters. This species forms a considerable proportion in the fish catches of Oman. In fact, no more studies in terms of spawning pattern on this fish have been conducted in Oman. Hence, a study was carried out to investigate the spawning patterns based on gonado-somatic index analysis. Studies of ovaries on a monthly basis considered as appropriate method for biological analysis including indicating the spawning season and length at first maturity of commercial species. Studies of spawning patterns of oil sardine based on GSI have been investigated by different scientists. Al-Jufaili *et al.* (2006) observed two major spawning peaks of *S. longiceps* in Oman; Muscat to be during March to April and August. The length at first maturity (L50%) was estimated between 125-135 mm in Oman and Arabian Sea (Dorr III, 1990). Recent reviews in India were also reported by Rohit and Bhat (2003) identified the spawning season during June to August, peaking in July along Manglore-Malpe coast. Banerji (1973) observed two spawning seasons in India, one in early season and the other at the end of season during June to October.

Oman has a long coastline of 3,165 km bordered by Arabian Gulf, Oman Sea and Arabian Sea and is rich in biodiversity of species. Fisheries resources in the Sultanate of Oman are one of the significant renewable resources and support the country's economy to a greater extent. Fisheries sector of Oman supports the second national economy after oil and gas. The total fish production of the Sultanate for the year 2009 stood at 158,000 tons of which the artisanal fisheries sector contributed to about 84% of the total fish production and the rest by industrial fleet (MOFW, 2000-2009). The total value of fishery production increased in 2009 to RO 104 million, up by 9% from the previous year 2008 and about 51% of the total fish produced had been exported to other countries. The small pelagic fishes contributed to about 34% of the artisanal production; while demersal fishes formed 32% and the large pelagics about 23% and crustaceans and mollusks 5%, sharks 3% and rest others. Of the small pelagic fisheries resources of Oman, the clupeids are the most dominant group in the landings. Alt-

hough 19 species of clupeidae have been reported, only three species, such as *Sardinella longiceps*, *S. gibbosa* and *S. sindensis* are common in the catches. These clupeids are coastal water species and occur in large schools. They are mainly targeted by the beach seine which lands up to 59% of the total sardine catches of the country.

There was a dramatic decline in landings in *S. longiceps* from 58,960 in 2001 to 32,092 tons in 2005. This decrease could be the reasons of heavy fishing pressure during that period. The market price of the species was probably high and was more preferred by fishermen to increase the catch. Further, other small pelagic and sardine species might not be present during that period and eventually Indian oil sardine appeared to be highly targeted. As a result, some of mature fishes may have been reduced during the spawning season in certain areas. According to that, GSI study is established to investigate spawning peak which helps to provide some information on spawning season's period as well as the gonad analysis is aiming to determine length at first maturation of Indian oil sardine in Oman Sea, Muscat, Sultanate of Oman.

Materials and Methods

Sample Collection

Samples of *S. longiceps* were collected at random twice a month from artisanal catches mainly by beach seine of 47 mm stretched mesh size along the Muscat coast (Figure 1) for a period of one year from October 2008 to September 2009. A total of 830 fish were collected for biological analysis. The fishes were brought to laboratory in icebox, washed and prepared prior to biological measurements. The total length (TL), standard length (SL) and body depth were measured to the nearest 1 mm. The weight of each fish was taken to the nearest 1 g. Then the fish was dissected out to record the sex and maturity stage. The gonad was removed and weighted to the nearest 0.01g.

Study of Maturity Stages

The maturity stages of *S. longiceps* were studied on monthly basis. The gonad stages for female were examined. Seven stages of maturity were identified according to external appearance, color, shape and size of gonads shown (Table 1). Gonado-somatic index (GSI) was calculated for

each fish on monthly basis in Muscat region using the formula $GSI = \text{mass of gonad (g)} / \text{fish mass (g)}$ in order to indicate the spawning season.

Estimation of Length at First Maturity (L50%)

The size at which 50% of the fish reach reproductive maturity (L50) was estimated by plotting cumulative maturity percentages versus total length (mm). Once that made, the length at first maturity was determined by corresponding length at first maturity (L50%) with the maturation percentage.

Results and Discussion

A total of 830 fish were obtained for reproductive study. The length at first maturity of female (L50%) of *S. longiceps* is determined as 182 mm (TL) (Figure 2). In addition, the GSI of female was calculated on a monthly basis from October 2008 to September 2009. High GSI values were observed during June and September with 5.0 to 5.2 respectively and moderately high values is occurred in March, April, May and August, suggesting spawning season occurred twice a year, the minor one from December to March and the major one from June to September (Figure 3).

Length at first maturity (L50%) was estimated as 182 mm (TL). Siddeek *et al.* (1994) concluded the species appeared to spawn earlier at 159.3 mm (TL) in Omani waters. In the present study, the species reached maturity later at 182 mm which was appropriately reasonable as this species tend to shift their spawning and habitat seasonally due to biological and environmental events.

According to GSI, the species appeared to spawn twice a year. The first minor spawning was observed during December to March and the major once from June to September. This could be interpreted that species may attain spawning more than once in a year or during its lifespan in the tropical waters. This biological behavior was due to the species capability to shift back from stage 7 to stage 3 and resume spawning again.

Al- Barwani (1989) identified the spawning season of *S. longiceps* in Oman occur in two spawning seasons during September to February in Muscat and May to October in Eastern region of Oman Sea, whereas in Arabian Sea the spawning activity was observed to be from May to September. Al-Jufaili *et al.* (2006) also observed two major spawning peaks of *S. longiceps* in Oman; Muscat to be during March to April and with peak during August where the GSI value attained 3.95, 4.07 and 4.41 respectively. Edward and Shafer (1986) observed the spawning season of Indian oil sardine in the Gulf of Aden while GSI of *S. longiceps* did not increase more than 1% of body weight during November to May and GSI increased to 7.5% of body weight during May to July. It appeared to begin spawning during a period from August to November and peaked during July to September. Hence, it was suggested that the spawning peak in the Gulf of Aden was during the period of upwelling and growth increased due to the abundance of plankton in the surface water. Those reviews were almost agreed with the findings in the present study.

The GSI shows some indications of spawning peaks during June and September in the present study. This spawning peak was the period of upwelling which improves the abundance of plankton in Arabian Sea as Oman Sea may have been influenced by South-west monsoon seasons. It was suggested there was a correlation between temperature rise and fall in Oman Sea (Al-Jufaili *et al.* 2006). This period of spawning peak was considered as a summer season and rising in temperature would develop and increase the spawning activities. This was agreed as well by Siddeek *et al.* (1994), as he stated there was a relationship between sardine spawning pattern and oceanographic changes in Muscat. Reviews of reproductive pattern of *S. longiceps* were identified in Table 2. The reproductive biology observations obtained by recent reviews in Table 2 were almost agreed with the present study.

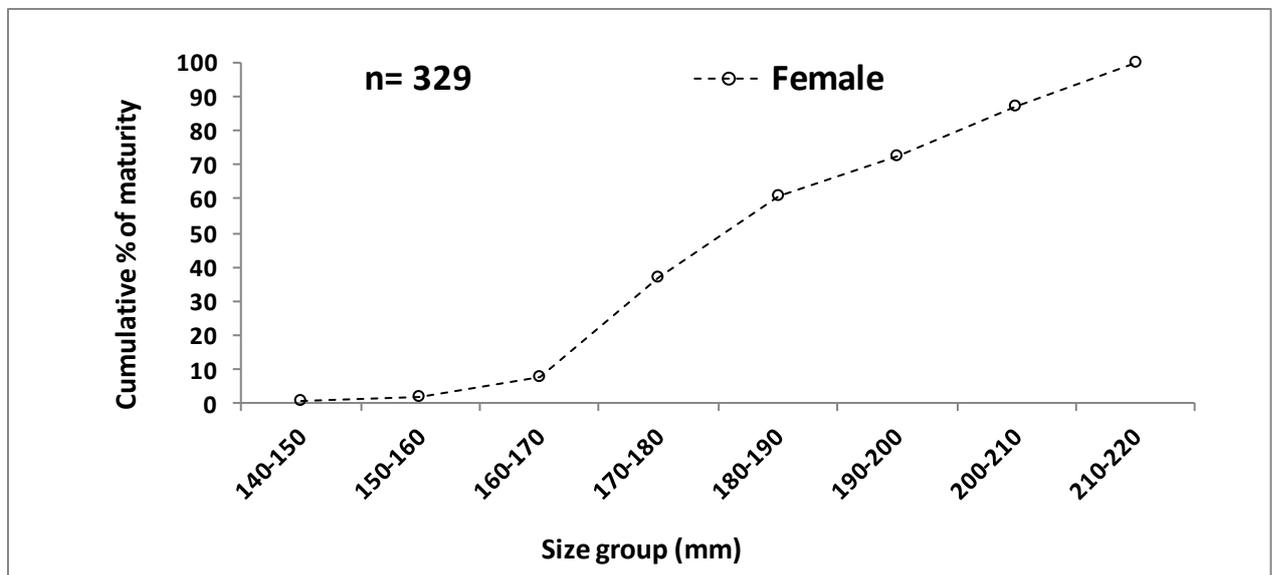


Figure 1. The Study area of *Sardinella longiceps* in Muscat.

Source: <http://www.atfp.org.ae/english/countries/oman/oman.htm>

Table 1. Maturity stages of female *S. longiceps* by macroscopic analysis (Raja, 1966).

Stage	Macroscopic of appearance of ovary
Immature	Ovaries soft, cylindrical, pink and completely transparent. Extend to about half of body cavity.
Maturing (2a)	Ovaries soft, cylindrical, pink and extend more than half of body cavity. Ova not visible to naked eye.
Spent resting (2b)	Dark red or brownish red. Oviducts wider but shorter, extend more than half of body cavity.
Maturing (3)	Turgid, opaque and yellow with granular appearance. Oviduct very much reduced. Extend to more than half of body cavity.
Maturing (4)	Compact, vascular, bright yellow ovaries. Oviduct not distinct. Occupy more than three-quarters of body cavity.
Mature (5)	Orange yellow and fully vascular. Extend more than the length of body cavity.
Ripe (6)	Appear as cream coloured cellophane bag filled with boiled sago. At a slight prick gelatinous mass of transparent ova flows out. Extend more than the length of body cavity.
Spent (7a)	Dark red, either throughout or at the posterior half. A bit flaccid, shrunken with wrinkle on the tunica. Occupy about three-quarters of body cavity.
Spent (7b)	Elongated, honey-coloured, bloodshot, flabby, limb, flattened and gelatinous with wrinkles on the surface. Wide oviduct now discernible. Occupy to more than half of body cavity.

**Figure 2.** Length at first maturity (L50%) of *S. longiceps*

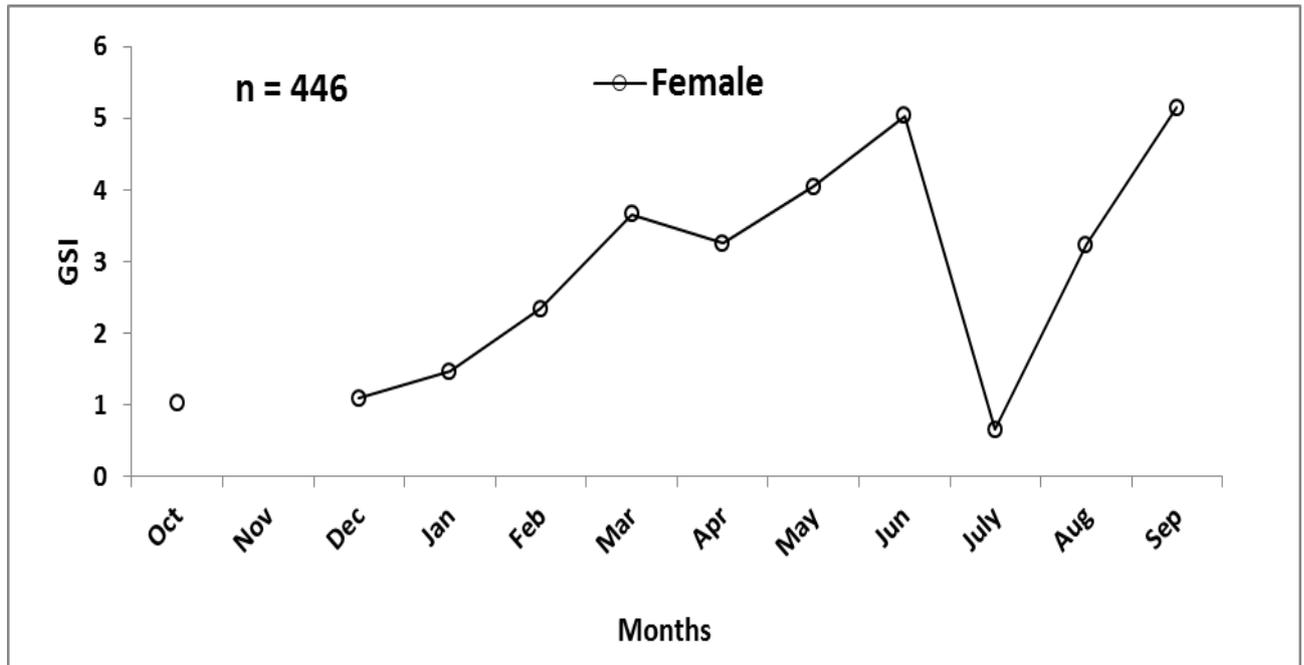


Figure 3. Mean gonado-somatic Index (GSI) of *S. longiceps* against months.

Table 2. Reproductive biology in *S. longiceps* in various regions compared with present study.

Spawning season	L50 % (TL)	Area	Author
September to February March to April	125-135 mm	Oman, Muscat	Dorr III (1990)
September to October	159.3 mm	Oman, Muscat	Siddeek <i>et al.</i> (1994)
March to April and August	-	Oman, Muscat	Al-Jufaili <i>et al.</i> (2006)
July to September	16-20 cm	India	Deshmukh <i>et al.</i> (2010)
December to March June to September	182 mm	Oman, Muscat	Present study

Conclusions

According to the examination of the ovaries, the *S. longiceps* species seemed to spawn generally along the year. However, the spawning peaks were observed during June and September where GSI obtained as 5.0 to 5.2 respectively. The length at first maturity (L50%) suggested being 182 mm in the commercial catch along Muscat area which was more reasonable and representative considered as short lived species that indi-

cated this fish managed to spawn more than once of its life span. These biological key observations would help to provide some management utilities for the decisions maker in the future, suggesting that spawning areas should be identified and protected as well as the allowable size of the catch should be determined.

Acknowledgment

My great appreciation goes to the Ministry of Agriculture and Fisheries Wealth, Marine Sci-

ence and Fisheries Centre and the Directorate of Agriculture and Fisheries Developmental Fund for giving me the opportunity to work on the fish samples of *Sardinella longiceps* species in Sultanate of Oman and to provide the appropriate financial support. I gratefully acknowledge assistance in samples collection, processing and measurements by: R. A-Sanaidi, J. Jaffary and H. Busaidi.

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