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# FISHERY AND REPRODUCTIVE BIOLOGY OF *SARDINELLA LONGICEPS* VALENCIENNES, 1847 LANDED ALONG VERAVAL COAST OF GUJARAT

**Motivarash Yagnesh B.[1], Kardani Hitesh K.[2]*, Katariya Kinjal[1], Bhatt Ashish J[1] and Abdul Azeez[3]**

[1]College of Fisheries science, Veraval - 362 265, India.
[2]Fisheries Research Station, JAU, Sikka, India.
[3]Central Marine Fisheries Research Institute, Veraval, India.
*e-mail : hiteshkardani@gmail.com

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**ABSTRACT : The present study on the biology of *Sardinella longiceps* was carried out at the Veraval coast of Gujarat. The observed length of species was in the range of 145 to 236 mm and weighing from 37.54 to 122.35 gm. The highest mean length of 206 ± 9 mm was observed in the month of December. Females showed overall dominance with the average sex ratio of 1 male: 1.45 females with highest ratio in month of October. The observed length-weight relationship of males, females and combined sexes was BW = 0.00005493 x (TL) $^{2.677}$, BW = 0.00008770 x (TL) $^{2.591}$ and BW = 0.00007407 x (TL) $^{2.622}$, respectively. There was no significant difference between the slopes of males and females at 1% or 5% level. Fifty percent of the individual of the species in the population attained sexual maturity as their body measured a total length of 155 mm. They spawned throughout the year with the peak in October. The combined Gonadosomatic Index was highest during September. The combined Gastrosomatic Index was highest during December. The estimated size of the ova ranged up to 600 ìm. Absolute fecundity of the species was 21,364-77,957.**

***Key words :*** *Sardinella longiceps*, mean length, sex ratio, length-weight relationship, gonadosomatic index, gastrosomatic index, maturity, fecundity, Veraval.

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## INTRODUCTION

The clupeoids comprise a major group of fishes among the pelagic resources of India. Among the clupeoids, the Indian oil sardine (*Sardinella longiceps* Valenciennes) known as 'Mati/Aed' in Gujarati, 'Boothai' in Kannada, 'Mathi/Nalla Mathi' in Malayalam, 'Tarli/ Haid' in Marathi, 'Noone-kavallu' in Telugu, 'Nonali/ Paichalai' in Tamil was the most dominant species among the pelagic resources of India in 2017 but in 2018, it fell to the 9$^{th}$ spot in the country (Anonymous, 2018).

Indian Oil Sardine (IOS) shows a wide distribution along the Indian coast extending from Gujarat in the west coast to West Bengal in the east coast including the Andaman and Nicobar Islands. Occasionally it had been reported that they occur in estuaries too (Anonymous, 2005). However, commercial exploitation was confined mainly to the southwest coast comprising the states of Kerala, Karnataka and Goa. The oil sardine contributes dominantly in the fishery of this region and specific gears are used to effectively harvest the shoaling oil sardine. The Indian Oil Sardine is a small-sized fish found in the nearshore waters within a distance of 25 – 30 km and up to 50 m depth. It is an 'r' strategist of growth/reproductive strategy with short life, small body size, early maturity, fast growth and high fecundity.

The total marine fish landings of India were recorded as 3.49 million tonnes in the year 2018. The highest capture production of oil sardine was in 2012 that is of 7,20,270 tonnes. The contribution of different categories in the total marine catch had been pelagic fishes 54%, demersal fishes 26.8%, crustaceans 12.6% and molluscs 6.6%. Indian oil sardine contributes 4.44% of the total marine fish landings in India. It was the topmost contributor to the country's total fish capture production with the catch of 3.37 lakh tonnes in 2017 but in 2018 production was 1.55 lakh tonnes. *i.e.* its landings decreased by 54%, the Kochi-headquartered Central Marine Fisheries Research Institute (CMFRI) reported in its annual marine fish landing estimation. There has

been an overall decline of 9% in country's fish landings from 3.83 million tonnes in 2017 to 3.49 million tonnes in 2018. Gujarat captured the top most spot with total catch of 7.80 lakh metric tonnes. In Kerala, the oil sardine fish landing was 1.26 lakh tonnes during 2017 but it was 77093 tonnes in 2018. *i.e.* decline by 39% (Anonymous, 2018).

In India, an array of crafts and gears are used to exploit the Indian oil sardine (IOS). Mechanized, motorised and non-motorised craft operating with various types of gears with varying dimensions of seines, trawls, gillnets and bagnet are used to catch the IOS. The most effective gears are ring seine and purse seine, while gillnets, bagnets and trawls are used extensively. The IOS formed a small, incidental and erratic fishery in Gujarat. It formed part of gillnet based fishery especially in Saurashtra and south Gujarat. The larger size with higher oil content in the IOS occurs along the Gujarat coast, which yield higher unit price for the fish in southern states.

There is some information about the length - weight relationship and maturity stages of *S. longiceps* landed at Porbandar coast by Gopal and Kabli (1991). But very little or negligible amount of information is available on biology of *S. longiceps* from Veraval coast.

## MATERIALS AND METHODOLOGY

A total 700 specimens of *S. longiceps* were collected from the Veraval fish landing center which is situated in the Gir-Somnath district along the western coast of Gujarat state. The present study was conducted from September 2019 to March 2020. The length (total length and standard length) and the weight of the individual specimens were measured. The fishes were dissected to obtain their gut and gonad and then obtained material were preserved (gut in Lugol's solution and gonad in Formalin). Lugol's solution is used to preserve gut of herbivores fishes because the phytoplankton content in the gut gets dissolved if preserved in other chemicals such as alcohol. The length, weight, sex and maturity stages of individual fish in each sample were noted. For the weight measurement, an electronic balance was used with accuracy of 0.01gm. The gut was cut opened with the help of scissors for the identification, recording the number of items in each category and their weights. All food items in the stomachs were identified to the most precise taxonomic level, *i.e.*, genera, whenever possible it was depending on the state of digestion. The identification of individual items was not always possible in generic level due to the semi-digested condition and the advanced state of digestion of food inside the stomach. Ovaries of female fishes (*i.e.* stage III & above) were collected and preserved in 5% formalin for determining the fecundity. The ova diameter (ìm) in each sub-sample of the ovary was studied under a digital microscope (Leica – model).

For estimation of length-weight relationship, the allometric formula proposed by Le Cren (1951), separately for both the sexes was applied and significant differences in the slopes of the regression lines for males and females were ascertained by ANOVA (Snedecor and Cochran, 1967).

$W = a L^b$ or $\log W = \log a + b \times \log L$

Where, W is the total body weight (g), L is the total length (mm), a and b are the coefficients of the functional regression between W and L.

Sex determination could not be done by external characters. Sexual dimorphism was absent in this species. So, sex ratio was recorded after dissecting the fish and examining its gonad. Month wise sex ratio of the species was determined and Chi-square test was performed to test the homogeneity of male and female distribution (Narsimham, 1994) in the population.

The maturity stages of male and female gonads was classified as per the ICES scale and adopted with suitable modifications (Antony Raja, 1964). The gonads were classified into seven stages where stage I and II will be grouped as immature, III & IV as maturing, V and VI as mature and VII (a & b) as partially and fully spent stages.

The fecundity was estimated by taking out the preserved ovary and then the ovary was cut into three parts mainly anterior, middle and posterior portions. Three pieces of ovary weighing 1 g each from the above three cut parts of the ovary was taken and examined under Leica digital microscope for counting the number of ova. The obtained number of ova was multiplied by the total weight (g) of gonad to obtain the actual fecundity.

The most common means to express the differential body size in relation to that of gonad is by expressing gonadal weight as a percentage of body weight. The gonadosomatic index (GSI) was calculated by the formula of Kume and Joseph (1969).

$$GSI = \frac{\text{Weight of the gonad}}{\text{Total weight of fish}} \times 100$$

For estimation of Gastrosomatic Index (GaSI), the total weight of the fish and the stomach was measured and then the Gastro-Somatic Index was calculated by the formula given by Desai (1970).

$$GaSI = \frac{\text{Weight of the stomach}}{\text{Total weight of the fish}} \times 100$$

## RESULTS AND DISCUSSION

### Length composition

During this study period a total of 700 *S. longiceps* specimens ranging from 145 to 236 mm total length and weighing from 37.54 to 122.35 gm were collected. The mean total length of the species was higher in months of December (206 ± 9 mm) and November (206 ± 7 mm), while it was lowest in March (194 ± 15 mm). The modal lengths were highest in the months of October and November (210 mm) and lowest in month of March (198 mm). The smallest (145 mm) specimen was observed in January and largest (236 mm) in March (Table 1).

**Table 1 :** Range, mean and mode length of *S. longiceps.*

| Month | No. of fishes observed | Body length (mm) | | |
|---|---|---|---|---|
| | | Range | Mean | Mode |
| Sep-19 | 100 | 179-220 | 205 ± 8 | 208 |
| Oct-19 | 100 | 180-222 | 204 ± 9 | 210 |
| Nov-19 | 100 | 185-222 | 206 ± 7 | 210 |
| Dec-19 | 100 | 175-232 | 206 ± 9 | 208 |
| Jan-20 | 100 | 145-226 | 195 ± 18 | 204 |
| Feb-20 | 100 | 151-228 | 197 ± 15 | 203 |
| Mar-20 | 100 | 152-236 | 194 ± 15 | 198 |
| **Annual** | **700** | **145-236** | **201 ± 14** | **208** |

The largest size recorded for *S. longiceps* along the Indian coast that measured 272 mm in total length and weighed 159 g (wet weight) was from the Malpe Fisheries Harbour landings in Karnataka (Rohit, 2003). The total length ranged from 101 to 203 mm of *S. longiceps* from the coastal waters of Parrangipettai (Kumar and Balasubramanian, 1987). The mean modal length had increased from 75 mm in October – November to 155 mm in February – March along Porbandar coast of Gujarat (Gopal and Kabli, 1991).

### Length-weight relationship

For the present investigation, a total of 351 (143 males and 208 females) specimens in total length range of 145-236 mm were used to determine the length weight relationship separately for males (Fig. 1), females (Fig. 2) and combined (Fig. 3). The equation arrived at was:

**Male**: $BW = 0.00005493 \times (TL)^{2.677}$ ($r = 0.893$)

**Female**: $BW = 0.00008770 \times (TL)^{2.591}$ ($r = 0.948$)

There was no significant difference (Table 2) between the slopes of males and females at 1% or 5% level, a combined relationship was obtained.

**Combined:** $BW = 0.00007407 \times (TL)^{2.622}$ ($r = 0.934$)

The present study establishes that the slope of regression equation for *S. longiceps* was not significantly (1% or 5%) different from the isometric value of 3, indicating a negative allometric growth for the species.

The length (L) - weight (W) relationships of male and female *S. longiceps* caught along Saurashtra coast were W = 4.514 + 2.744 L and 4.237 + 2.617 L, respectively (Gopal and Kabli, 1991). Along Ratnagiri coast of Maharashtra, the length weight relationships equations for males, females and indeterminants were $W = 0.0350L^{2.4918}$, $W = 0.0536L^{2.3410}$ and $W = 0.0200L^{2.7021}$ respectively and for combined sexes were $W = 0.0321L^{2.5225}$ indicating that there is no significant difference between the sexes of *S. longiceps* (Deshmukh *et al*, 2010). Rohit (2003) reported that the combined length weight relationship of *S. longiceps* along Malpe coast of Karnataka was $W= 0.1189L^{2.86}$. Annigeri *et al* (1992) stated that the combined length-weight relationship of Indian Oil sardine along west coast of India was $W = 0.00000347194L^{3.163582}$.

Shah *et al* (2014) noted negative allometric growth in *S. longiceps* caught along Ratnagiri coast of Maharashtra. Length-weight relationship was established as $W = 0.000066L^{2.604}$ for males, $W = 0.000056L^{2.638}$ for females and $W = 0.000054L^{2.654}$ for pooled data. Coefficient of correlation (r) for the length-weight relationship was estimated at 0.721, 0.739 and 0.740 for the males, females and pooled data, respectively. It also indicated that the regression of co-efficient of length-weight relationship of both the sexes showed no significant variation at 1% or 5% level.

### Sex ratio

Sex ratio was estimated in every month for males and females. The overall sex ratio was 1:1.45. The results indicated dominance of males only in February, 2020 whereas the females dominated in all remaining months (Table 3 and Fig. 4).

Dhulkhed (1968) reported the overall sex ratio of *S. longiceps* of Mangalore coast from year 1960 to 1964 and stated that in year 1960-61 the female dominated over male with ratio of 1 Male: 1.09 Female, in 1961-62 was 1:1.22 (Male : Female) and in 1963-64 it was 1:1.18 (Male : Female). In 1962-63, the male dominated with ratio of 1:0.96.

Kumar and Balasubramanian (1987) reported that the sex ratio of *S. longiceps* of Parangipettai coast was 1 : 1.01 (Male : Female). Rohit (2003) reported the sex ratio of *S. longiceps* caught off Mangalore-Malpe and stated that the females dominated over both pre-adults (0.97 male : 1 female) and adults (0.92 male : 1 female). Deshmukh *et al.* (2010) reported that the sex ratio of *S. longiceps* along Ratnagiri coast was 1 : 1.1696 (Male : Female).

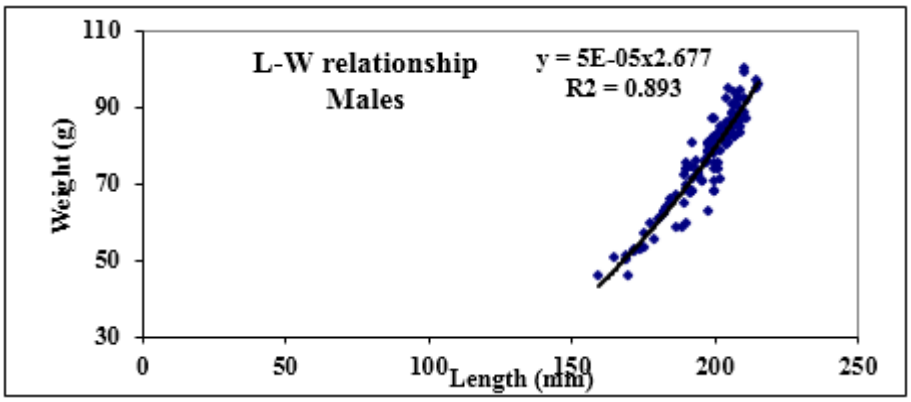


**Fig. 1 :** Length-weight relationship of males of *S. longiceps* landed at Veraval.

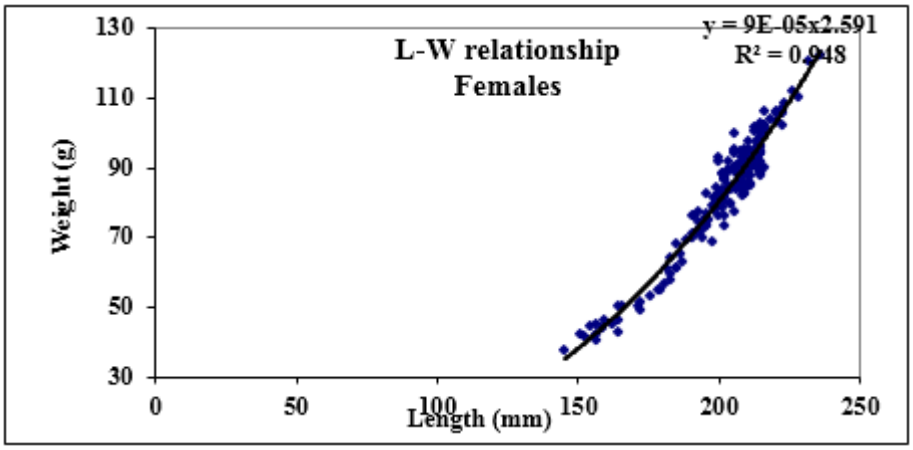


**Fig. 2 :** Length-weight relationship of females of *S. longiceps* landed at Veraval.

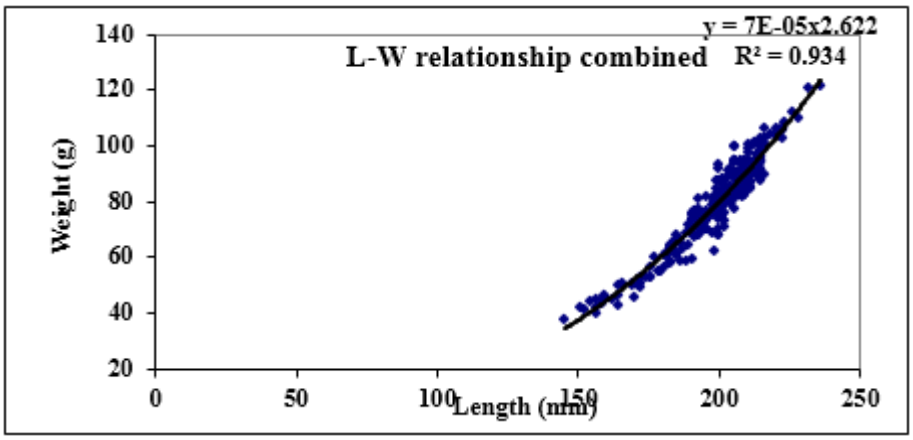


**Fig. 3 :** Combined length-weight relationship of *S. longiceps* landed at Veraval.

## Maturity

The maturity of individuals was studied by observing the different developmental stages of gonad, which were distinguished by microscopic and macroscopic stages. Immature stages (I & II) was observed in October 2019 and January – March, 2020, maturing stages (III & IV) were observed in all the months except December, 2020 and mature stages (V & VI) were observed in all months. The spent condition (VII) was observed in all months except March (Fig. 5).

Deshmukh *et al* (2010) studied the maturity stages of oil sardine along Ratnagiri coast and stated that the maturity stages I, II and III occurred in November to February. The stages IV and V occurred in month March to May. VI and VII stages were observed in August and September. Gopal and Kabli (1991) had reported the maturity stages of oil sardine along the Porbandar coast of Gujarat and stated that the majority of the female population was immature (stage II) during October - November while the maturing stages (stage III, 60%; stage IV, 31%) were observed in December - January. In February – March most of the females were in stage

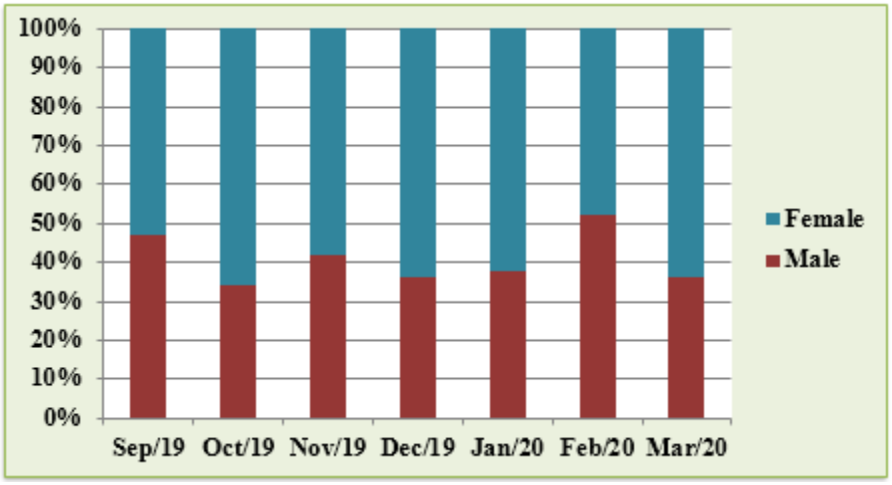


**Fig. 4 :** Monthly variations in the sex ratio of *S. longiceps.*

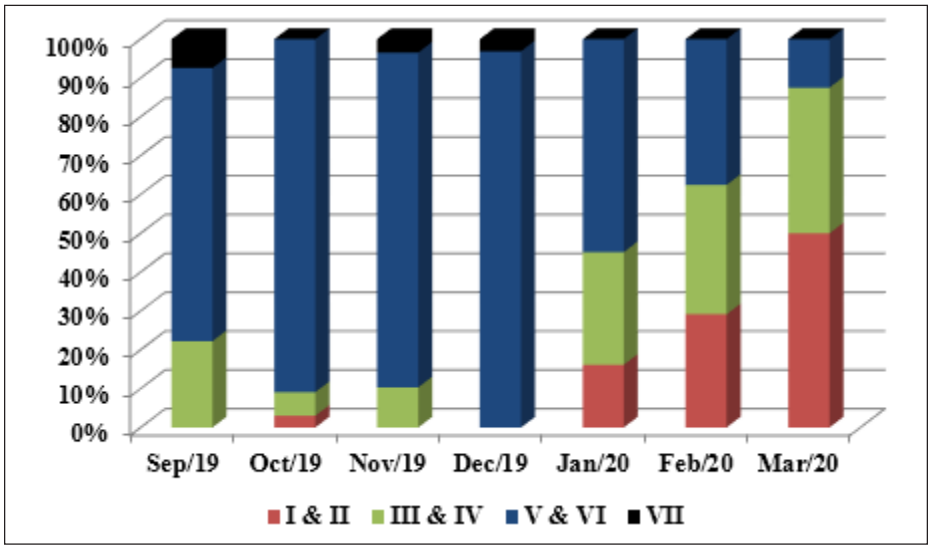


**Fig. 5 :** Monthly variations in maturity stages of female *S. longiceps.*

IV (66.6%). Anthony Raja (1964) reported the maturity stages of Indian oil sardine of Calicut coast and stated that the maturation was first seen in May with increased activity during June-July which reaches the maximum in August. The stage Ila and III were available only in May and from June to August, stage IV was available in typical condition or a bit advanced further as stage. IV+ while stages V or VI were usually found only during August and September.

## Length at maturity

Fifty percent of the individual of *S. longiceps* in the population attained sexual maturity as their body measured a total length of 155 mm (Fig. 6). Individuals with this body length were observed in all the months.

At a total length of 15.7 and 15.2 cm for male and female respectively, the 50% of oil sardine along southwest coast of India were found to be mature (Nair *et al*, 2016). Dhulkhed (1964) had reported that the size at first maturity of oil sardine of Mangalore coast was 165 - 169 mm. Length at first maturity of oil sardine of Mangalore-Malpe coast was found to be a total length of 160 mm (Rohit and Bhat, 2003). Kumar and Balasubramanian (1987) worked on the oil sardine of Parangipettai coast and stated that the 50% of females attained maturity at 156 mm and males at 158.5 mm. Hornell and Nayudu (1924) and Devanesan (1943) had stated that the oil sardine of Malabar coast attained first maturity at a size of 150 mm. Radhakrishnan (1968) had shown that the oil sardine of Karwar coast attained first maturity at the size of around 120 -139 mm. Pillai *et al* (2003) reported that oil sardine of west coast of India had grown rapidly during the first few months and the length at first maturity was 15 cm. Our result also indicates the same size of fish at the time of first maturity.

## Spawning

The spawning was determined on the basis of occurrence of individual in mature, running and spent stage of maturity in each month. *S. longiceps* spawned

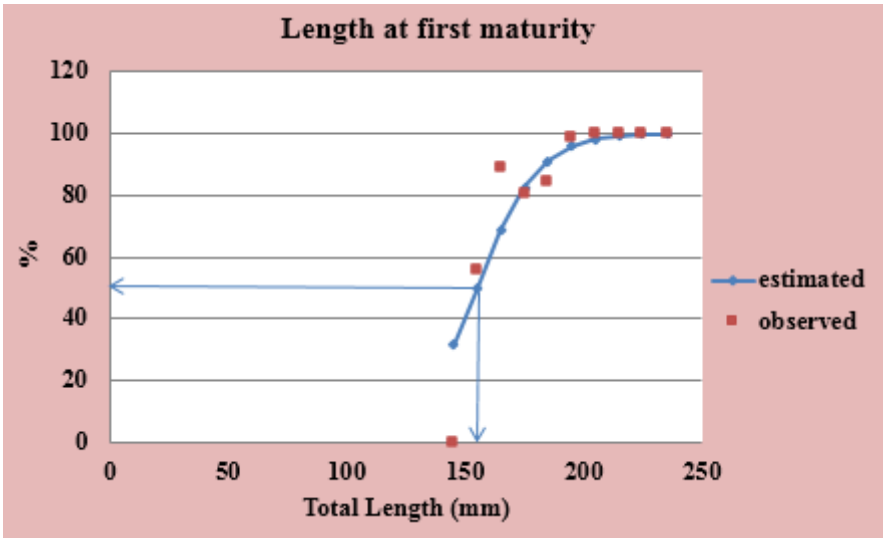


**Fig. 6 :** Length at first maturity of *S. longiceps.*

**Table 2 :** Comparison of regression line of male and female *S. longiceps.*

| | | | | | | Deviations from regression | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source** | **Degree of freedom** | **Sum of square of X variable** | **Sum of square of Y variable** | **Spxy** | **Regression coefficient** | **df** | **Sum of square** | **Mean square** | **F value** | **P value** |
| Within | | | | | | | | | | |
| Males | 142 | 0.485513 | 3.893392 | 1.299892 | 2.67736 | 141 | 0.413114 | 0.00293 | | |
| Females | 207 | 1.507161 | 10.66718 | 3.905908 | 2.591566 | 206 | 0.544761 | 0.002644 | | |
| | | | | | | **347** | **0.957874** | **0.00276** | | |
| Pooled W | 349 | 1.992674 | 14.56057 | 5.2058 | 2.612469 | 348 | 0.960577 | 0.00276 | | |
| **Difference between slopes** | | | | | | **1** | **0.002703** | **0.002703** | **0.979234** | **0.323075543** |
| Between B | | | | | | | | | | |
| W+B | 350 | 2.016832 | 14.84615 | 5.28886 | | 349 | 0.976853 | | | |
| **Between adjusted means** | | | | | | **1** | **0.016275** | **0.0016275** | **5.896268** | **0.015679267** |
| **L-W relationship** | | | | | | | | | | |

| | **a** | **b** | **Regression square** | Note: |
|---|---|---|---|---|
| **Males** | **0.00005493** | **2.67736** | **0.893894** | If Prob < 0.05 then significant at 5% level |
| **Females** | **0.00008770** | **2.591566** | **0.948931** | If Prob < 0.01 then significant at 1% level |
| **Pooled** | **0.00007407** | **2.62236** | **0.934202** | |

throughout the year with the peak in October (Table 4 and Fig. 7). The average 57.71% of spawning were observed during study. The spawning percentage was higher in September to December then it exponentially decreased in later months.

Hornell (1910) reported that the spawning season in *S. longiceps* along the Malabar coast extended from the end of June to the end of August. He also stated that the spawning was little earlier in north than in south. Nair (1959) reported that the spawners of *S. longiceps* along Calicut coast enter the coastal waters after the starting of monsoon generally during June and July. Intensive spawning generally taken place during August and September. Deshmukh *et al* (2010) stated that the peak spawning of *S. longiceps* along Ratnagiri coast of Maharashtra was observed during the months of July – September due to short monsoon period from June to September. The spawning season of *S. longiceps* along the west coast of India had been reported by several researchers as May - August (Hornell and Nayudu, 1924), June – August (Kumaran *et al*, 1988), June - October (Raja, 1969), June – September (Dhulkhed, 1964) and June - December (Prabhu and Dhulkhed, 1970). Nair *et al* (2016) reported that there were two peak recruitment

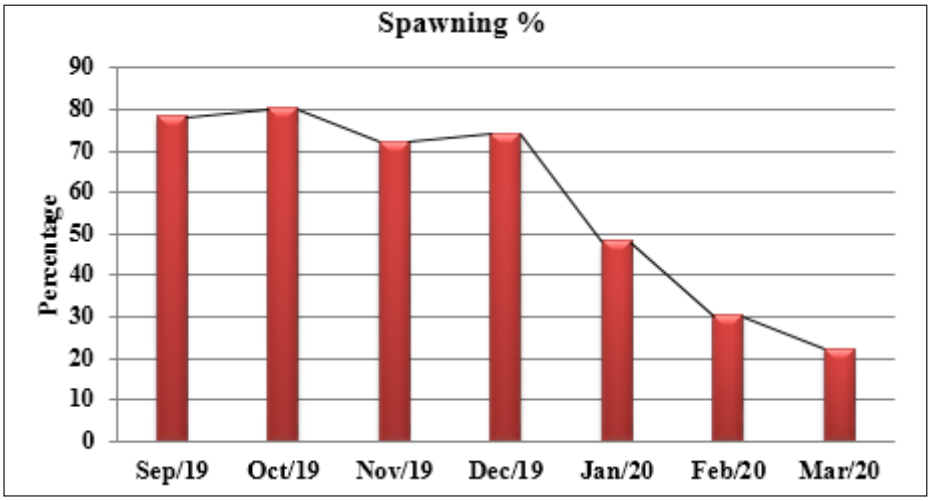


**Fig. 7 :** Monthly variations in the spawning percentage of *S. longiceps.*

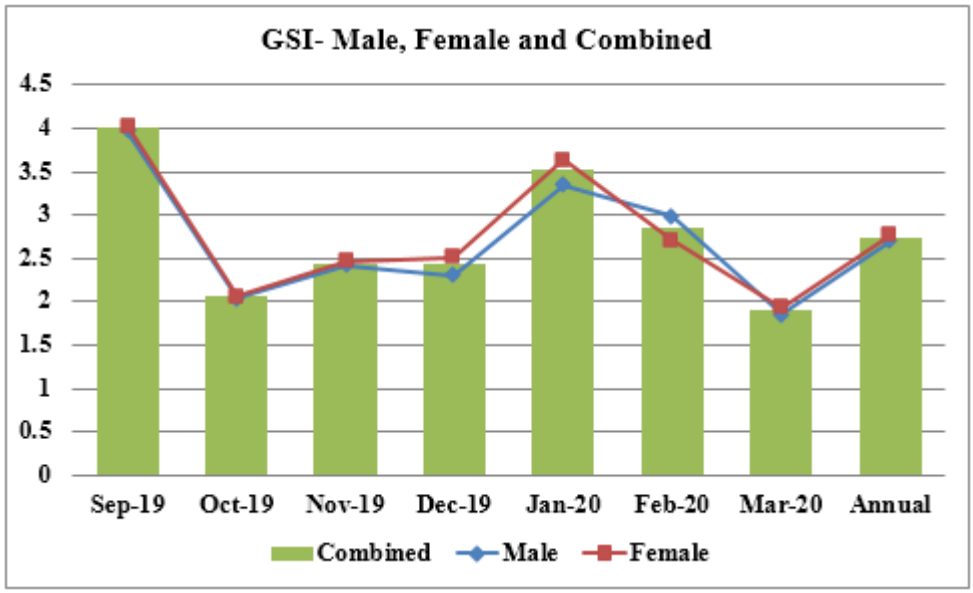


**Fig. 8 :** Variations in mean GSI of *S. longiceps.*

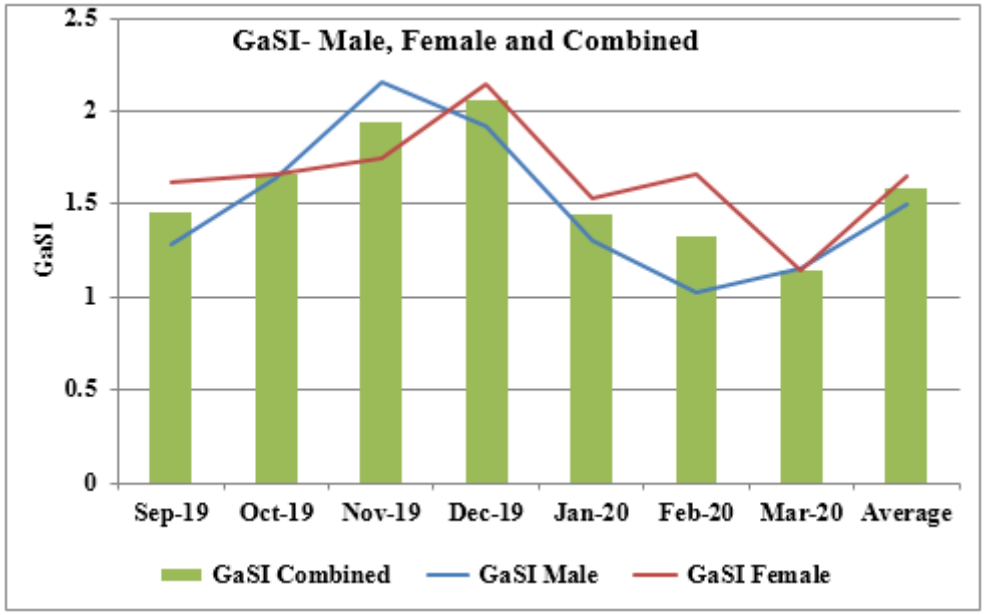


**Fig. 9 :** Monthly variations in GaSI of *S. longiceps.*

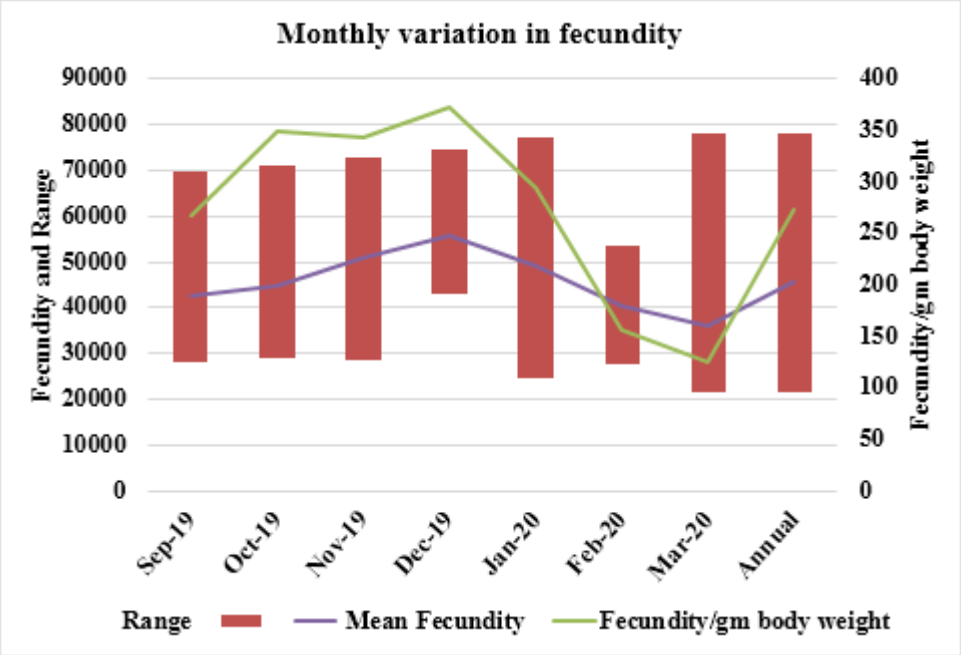


**Fig. 10 :** Monthly variations in fecundity of *S. longiceps*.

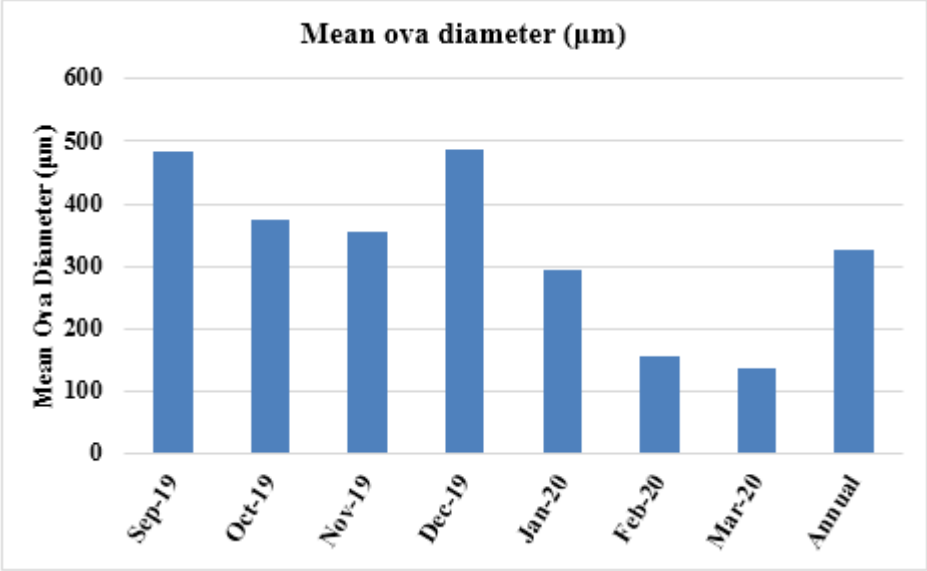


**Fig. 11 :** Monthly variations in mean ova diameter of *S. longiceps*.

periods in South-west coast of India, one in February or March and the other from in May - August, which indicated spawning during these months or just before these months.

**Gonadosomatic Index (GSI)**

The GSI values of *S. longiceps* were calculated month wise and it was different in male and female. The GSI values varied between 1.84 and 3.97 in case of male. In case of female, the GSI values fluctuated between 1.93 and 4.02 (Fig. 8). The higher GSI observed in all months except in March (1.90), which is lowest. This suggests that the ovaries were very much in ripe condition and ready for spawning. Compared to male higher GSI was observed in female which can be due to more weight of ovary compared to testes.

Deshmukh *et al* (2010) reported that the female specimens of oil sardine found along the Ratnagiri coast had maximum GSI of 5.4962 in the month of September and minimum GSI observed was 4.299 in October. Deshmukh *et al* (2016) reported that in the female *S. longiceps* found along the coast of Goa and Karwar, maximum GSI was 5.8073 during the month of June and minimum was 3.73 in the month of August in case of Goa. In Karwar, maximum GSI was 7.557 and minimum was 4.094 in months of August and September. Zaki *et al* (2012) reported that in both the sexes of *S. longiceps*

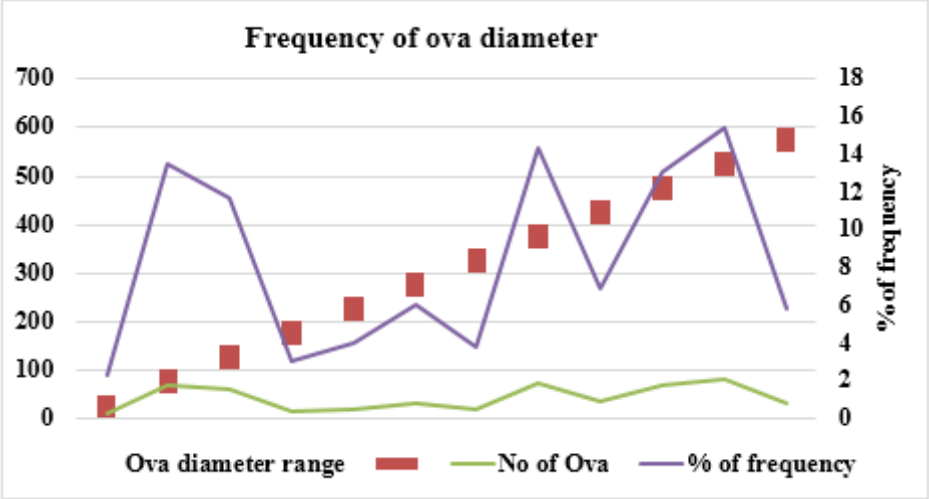


**Fig. 12 :** Frequency of ova diameter of *S. longiceps*.

**Table 3 :** Monthly variations in the sex ratio of *S. longiceps.*

| Month | Number of individuals | | | Sex ratio (M:F) | Chi square value |
|---|---|---|---|---|---|
| | Male (M) | Female (F) | Total | | |
| **Sep-19** | 24 | 27 | 51 | 1:1.13 | 0.18 |
| **Oct-19** | 17 | 33 | 50 | 1:1.94 | 5.12 |
| **Nov-19** | 21 | 29 | 50 | 1:1.38 | 2 |
| **Dec-19** | 18 | 32 | 50 | 1:1.78 | 3.92 |
| **Jan-20** | 19 | 31 | 50 | 1:1.63 | 2.88 |
| **Feb-20** | 26 | 24 | 50 | 1:0.92* | 0.08 |
| **Mar-20** | 18 | 32 | 50 | 1:1.78 | 3.92 |
| **Annual** | 143 | 208 | 351 | 1:1.45 | 12.04 |

* = Female population lower.

**Table 4 :** Monthly variations in spawning percentage of *S. longiceps.*

| Month | No. of fishes | | Spawning % |
|---|---|---|---|
| | Observed | Matured | |
| **Sep-19** | 51 | 40 | 78 |
| **Oct-19** | 50 | 40 | 80 |
| **Nov-19** | 50 | 36 | 72 |
| **Dec-19** | 50 | 37 | 74 |
| **Jan-20** | 50 | 24 | 48 |
| **Feb-20** | 50 | 15 | 30 |
| **Mar-20** | 50 | 11 | 22 |
| **Annual** | 351 | 203 | 57.83 |

from Sohar coast of Oman, the GSI increased from January to March and declined during April and May. The GSI then increased and reached at peak both in males (5.94) and females (6.0) during September. The GSI values were higher during February, March, August-October. Compared to other studies we have observed lesser GSI in present study.

## Gastrosomatic Index (GaSI)

Monthly GaSI values of *S. longiceps* were calculated by formula given by Desai (1970). The higher GaSI was observed during February (2.06) and March (1.94), while minimum in October (1.14). In male, peak GaSI value was observed in March (2.16) and minimum in November (1.02). In female, peak value was observed in February (2.15) whereas minimum in October (1.14) (Fig. 9).

Ahirwal *et al* (2018) reported the monthly GaSI of *S. longiceps* from Mumbai waters of Maharashtra and revealed that the highest values observed in May for both sexes, 1.41 for males and 1.60 for females. The lowest value was obtained in November (0.80), for male and February (0.72), for female.

## Fecundity

In the present study, average monthly fecundity ranged from minimum of 36003 to maximum 55830 with an annual fecundity of 45625 (Fig. 10). Lowest individual fecundity (Absolute fecundity) of 21364 and highest of 77957 both observed during March. The average monthly fecundity per gram of body weight (relative fecundity) was highest in the month of December (373) and the least in March (125). The annual relative fecundity was 272. There were two peaks in the average fecundity i.e.,

the first in November and the second in December.

Deshmukh *et al* (2010) reported that the fecundity of oil sardine ranged from 45000 to 75000 along the Ratnagiri coast. Shah *et al* (2018) reported that the maximum fecundity of *S. longiceps* along Ratnagiri coast of Maharashtra was 77820 and minimum 26885 with relative fecundity of 508 – 942 eggs per gram of body weight. They also stated that the fecundity was directly proportional to the weight of ovary. Jaiswal (1969) and Balan (1984) reported that the fecundity of *S. longiceps* of Kerala-Karnataka coast was 70 – 75 and 37 – 80 thousand eggs respectively. Raja (1971) reported that the *S. longiceps* along Karwar coast had an average fecundity of 37000 – 38000. Nair (1959) reported that the fecundity of *S. longiceps* of Calicut coast was up to 78000. During the present study, similar range was observed.

### Ova diameter

The estimated size of the ova of *S. longiceps* ranged up to 600 µm. The percentage frequency of the ova diameter was estimated and it revealed that the maximum number of ova were in the size category of 501-550 µm and minimum frequency was in size category of 1-50 µm (Figs. 11,12). The highest mean size (486 µm) was observed in December and the lowest (139 µm) in March.

## CONCLUSION

The present study was conducted along the Veraval coast, which is situated in the Gir-Somnath district of Gujarat, India. As in Southern India, Purse Seine and Ringe Seine are widely used fishing gear, the *S. longiceps* in Gujarat is mainly catch by gill netters. The fishes show highly variation in catches so proper biology and the environment factors affecting to planktonic diversity should be studied deeply to support the very important fishery. More intensive study on the occurrence of plankton, its relationship with fishery, other environmental factors and nutrient loads and nutrient cycle can be useful for sustainable fishery.

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