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Reproductive biology of the Ribbonfish, *Lepturacanthus savala* (CUVIER, 1829)

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Abstract

Ribbonfish, *Lepturacanthus savala* is one of the important fish caught off the Konkan coast of Maharashtra, India. The reproductive biology of this fish was studied from February 2012 to March 2013. The study showed that *L. savala* exhibited two spawning peaks annually along the Ratnagiri coast from March to May and October to December. GSI showed wide variations between sexes and it was higher for female throughout the sampling period. Higher GSI for females during March (3.7448) and November (3.9850) and for males, during April (1.3277) and November (1.4590), also confirmed the two spawning peaks. The overall male: female ratio in the catches was found to be 1:1.3. There was an overall predominance of females in all the months during the present study. The fecundity of *L. savala* ranged from 1,421 to 25,535 eggs with an average of 12757.68 eggs and the fecundity increased with increasing length.

Keywords: Ribbonfish, *Lepturacanthus savala,* Maharashtra, reproductive biology

Introduction

Ribbonfish, also called savali hair-tail or cutlass fishes elsewhere, occupy an important place among the food fishes of India. The ribbon-fishes belong to the family Trichiuridae and are represented in Indian waters by four species namely, *Trichiurus lepturus, Lepturacanthus savala, Eupleurogrammus intermedius* and *E. muticus*, the first two species being the most dominant. Ribbonfishes are schooling, pelagic and migratory fishes. During maturation period, they move away from the coastal areas to deeper regions (Lazarus *et al*.1992). Occurrence of *L. savala* in high numbers was recorded during October – December in nearshore waters along the Konkan coast of Maharashtra. Hence the study of reproductive biology of *L. savala* was undertaken to understand the gonado-somatic index (GSI), fecundity, sex ratio, development of gonads, maturity cycle and spawning season. The study was carried out from February 2012 to March 2013.

Reproduction is the process by which species are perpetuated. It is also a continuous developmental process throughout ontogeny, requiring energetic, ecological, anatomical, biochemical and endocrinological adaptations. An understanding of the reproductive biology of a species is a central aspect of providing sound scientific advice for fisheries management. Reproductive parameters such

as size at first maturity, spawning frequency, fecundity, sex ratio, and recruitment are of great value in fishery prediction and formulation of management measures (Morgan, 2008).

Materials and methods

Specimens of *L. savala* were collected weekly from February 2012 to March 2013 except in the month of June and July due to traditional ban on monsoon fishing. The specimens of the different size groups were randomly collected from fishermen from Mirkarwada landing centre and main fish market at Ratnagiri.

Gonadosomatic index

They were dissected to remove the gonads. The two lobes of gonad fused at their base in the body cavity were separated by a horizontal cut. For calculating the gonadosomatic index, the weight of the individual fish was noted and the gonads were removed carefully and weighed on a electronic balance after removing the excess moisture using a blotting paper. Following equation (Bal and Rao, 1984 and Sivakami, 1995) was used in statistical calculations.

$$GSI = \frac{\text{Gonad weight}}{\text{Total body weight}} \times 100$$

Sex ratio

Sex ratio was studied with respect to months and size groups of fish collected at randomly from Mirkarwada landing centre, by dissecting the fish to examine the gonads for a period of eleven months from February 2012. Data on sex ratio were analysed by $\chi 2$ (Chi square) test to find out whether dominance of either sex was significant.

Maturity stages

The fish were dissected for visual observation of testes and ovaries which indicated maturity and spawning season. Maturity stages of males and females were identified based on macroscopic characteristics of testes and ovaries respectively. The observations were based on fresh gonads. The male and female maturity stages of *L. savala* were classified as per James (1967).The stages were I) Immature, II) Maturing, IIIA) Early mature, IIIB) Late mature, IVA) Early ripe, IVB) Late ripe, V) Spawning, VIA) Partially spent and VIB) Fully spent. The smears and sections of the gonads were observed under microscope and the various stages were noted down.

For histological study, the ovaries and testis were kept in normal saline and cut into small pieces of 4-5 mm in size. Initially they were fixed in Mossman's fixative (10 ml formalin, 10 ml glacial acetic acid, 30 ml of 95% alcohol and 50 ml distilled water). Permanent slides were prepared as per Weesner (1960). Sectioning of the paraffin blocks was carried out at 6 µ using a Rotary microtome. The paraffin sectioned thin tissues were spread on slides wherein egg albumin was used for sticking the sectioned tissues to the slides. The slides were stained by haematoxylene.

Fecundity

For the determination of fecundity, fresh, ripe ovaries were used. The excess moisture was removed by using blotting paper and the ovaries were weighed to the nearest milligram. A sub sample of 1 mg piece of mature ovary from anterior, middle and posterior region was weighed with an electronic balance of 0.1 mg accuracy. The subsamples were then taken in a watch glass and number of mature ova in the sub-samples were counted physically. The average reading was taken for calculation. Fecundity was determined as per Sinha (1995).

$$F = \frac{TW}{SW} \times \text{number of ova counted in the sub-sample}$$

Where,
F= Fecundity
TW= Total weight of the ovary
SW = Sub-sample weight

Results

Gonadostomatic index

The gonadosomatic index (GSI) was calculated for each individual and grouped into sex and averaged for each month. Monthly variation of GSI is given in Table 1. The average gonado-somatic index of males and females was plotted against months to show monthly variations (Fig. 1). GSI showed wide variations between sexes and it was higher for female throughout the sampling period. GSI was highest for females during March (3.7448) and November (3.9850), showing occurrence of more ripe individuals. For males GSI is highest during April (1.3277) and November (1.4590).

Sex ratio

To study the sex ratio of *L. savala*, a total of 538 specimens belonging to a wide size range were examined during February 2012 to February 2013. Sex ratio was tabulated for each month and for different size groups. The average sex ratio of the males and females was found to be 1:1.3 for the entire period of study (Table 2). Females were dominate for all the months. Chi-square test applied for monthly sample indicate that no significant difference was noticed at 5 % probability level in all months of study periods (Table 3).

Maturity stages

In all 680 specimens at different stages were examined. Out of these 233 were males, 305 females and 142 were indeterminants. The maturity cycles in males and females are given in Table 9. It was seen that in females, immature stages I occurred from February to March and again from August to September, maturing stage II occurred from February to March and again from August to September, stage III from March to May and again from August to January, stage IV occurred from April to May and again from October to January. Stages V occurred in April to May and again from October to January, spent stage VI was observed in January to February (Table 4). Thus peak spawning season generally appears to be from March to May and October to December (Fig.2).

In males, immature stages I occurred from February to March and again from August to September, maturing stage II occurred from February to March and again from August to September, mature(Stage III) was reported during March to May and August to January. The percentage of males in ripe stage IV was observed to be increasing from April to May and October
to January. Majority of males in spent stage (VI) were recorded from January to February. Recovering males were observed from March to February during the study period. (Table 5, Fig.3).

From the histological studies of the gonads of *L. savala*, different stages of gonad development could be identified. The stages were identified are: I) Immature, II) Maturing, IIIA) Early mature, IIIB) Late mature, IVA) Early ripe, IVB) Late ripe, V) Spawning, VIA) Partially spent and VIB) Fully spent. Table 4 and 5 show the frequency percentage of various maturity stages in *L. savala*. The data is represented by Plates 1 to 18.

Stage I: Immature - At immature stage of the ovary, oogenesis showed changes from oogonia to primary oocytes and then secondary oocytes. The oogonia were small rounded cells with relatively clear zone of cytoplasm. The oogonia were densely packed along the walls of the follicles. Lumens with clear zone in the central part of the follicles were seen. In late immature stage, oocytes attached to the connective tissues were observed. The testes at this stage were flat, leaf-like but slightly thick. They had spherical nucleus with distinguishable nuclear membrane. The follicles were observed to be containing spermatocytes, but no spermatozoa were seen.

Stage II: Maturing - In early maturing stage, the ovaries were translucent. Developing oocytes were seen to be increasing in numbers and occupying the middle zone of the follicles. In late maturing stage, the ovary became thick and transparent and occupied half of the body cavity. At this stage, the follicles were completely packed with the oocytes.

Stage III A and B: Early mature and Late mature - In the females, ovaries became oblong transparent and showed opaque eggs during early mature stage. At this stage oocytes and their nuclei increased in size. Oocytes were surrounded by isolated layer of follicular epithelium. In late mature stage, in some follicles loose ova were also observed. The ova were seen to be arranged in descending order from the lumen to the follicular walls. Testis were slightly swollen and extended to 3/4 of the body cavity in the mature stage. Spermatogonia, primary and secondary spermatocytes were detected at mature stage. The follicles were seen to be densely packed with spermatogonia.

Stage IV A and B: Early ripe and late ripe - In early ripe stage, ovary became turgid occupying the body cavity fully. Large translucent ova with single oil-globule, opaque, yolked and separated from the follicular wall were observed. Some small transparent ova were also present. The largest ova were occupying the periphery of the lumens. The yolk granules and nucleus appeared intermingled with cytoplasm was observed in ripe stage. The testis at this stage were dull whitish and with lobules. In ripe stage, the testis were observed with full the entire body cavity and flabby.

Stage V: Spawning - In spawning stage, the ovary became flabby and loose. Loose ova scattered in the follicles were seen. Most of the middle zone of the follicles was empty and with connective tissue. In case of males, the lobules were seen with spermatozoa arranged along the lumen. Streams of spermatozoa with their heads towards the lumen were observed in this stage.

Stage VIA: Partially spent - In partially spent stage, the ripe ova were discharged from the ovary. Ovary became shrunken, partially withered with blood vessels and having a hollow appearance. Large, free rounded to ovate oocytes were seen with distinct nucleus. Collapsed follicles were closely packed without interspaces. Fully grown eggs with reduction in connective tissue were seen. In partially spent stage, testis were loose, the follicles collapsed, residual sperms and phagocytes were present.

Stage VIB: Fully spent - In fully spent stage, the follicular walls were found to be breaking. In females, the gonads were observed to be loose, follicles were collapsed, residual eggs and phagocytes were present. Empty follicles with

connective tissue were observed. In males, the sperm cells were discharged from seminiferous tubules which were reduced in size and the spermatogenesis was completely discontinued.

In case of ovary during spent recovering stage new generation of cytoplasmic growth cells were observed. The cytoplasmic yolk was subjected to phagocytosis, and gradually the yolk vesicles became empty vacuoles. Then the yolk contents were completely reabsorbed and disappeared, empty follicles were observed in the ovary. New generation of spermatogonia were recorded at the periphery of many tubules in males.

Fecundity

To get an idea of number of mature eggs that are likely to be spawned in *L. savala*, fecundity was estimated by considering the stages prior to spawning. The study consisted of the randomly selected 25 ovaries, presented in the table 12. Three sub-samples from the anterior, middle and posterior sections of the ovary were weighed and the ova were counted. From their averages, fecundity per ovary was estimated. The fecundity of *L. savala* ranged from 1,421 to 25,535 eggs with an average of 12757.68 eggs. Higher values of fecundity were recorded from females having higher weights.

Discussion

Reproductive parameters such as sex composition, size at first maturity, maturity stages, gonado-somatic index (GSI), fecundity, spawning frequency and recruitment are of great importance in the prediction of a fishery (Bal and Rao, 1984). Fecundity varies with the species, size and age
of the fish (James *et al.*, 1983).

Gonadosomatic index

Higher gonado-somatic index were reported in females during March (3.7448) and November (3.9850), showing occurrence of more ripe individuals. For males GSI was highest during April (1.3277) and November (1.4590). Several researchers have shown that fluctuations occurring in the condition of fishes during different months are directly related to the cycle of sexual maturity. The gonadosomatic index is an indicator of the state of gonadal development.

Table 1: Monthly variation in the GSI values of males and females of *L. savala* along Ratnagiri coast during February 2012 to February 2013.

Sex	February	March	April	May	August	September	October	November	December	January	February
Male	0.8541	0.956	1.3277	1.0043	0.5468	1.0285	1.3665	1.459	1.519	1.3406	0.923
Female	1.4696	3.7448	3.2285	2.547	2.023	1.8137	3.8137	3.985	3.1684	2.765	1.678

*No sampling during June, July due to fishing ban.

Table 2: Month wise sex ratio of *L. savala* along Ratnagiri coast.

Sr. no.	Month	Male	Female	Sex ratio (M:F)
1	February 2012	17	25	1:1.4
2	March	21	28	1:1.3
3	April	21	27	1:1.2
4	May	31	37	1:1.1
5	August	12	12	1:1
6	September	29	38	1:1.3
7	October	32	50	1:1.5
8	November	20	25	1:1.2
9	December	18	20	1:1.1
10	January 2013	13	16	1:1.2
11	February	19	27	1:1.4
	Total	**233**	**305**	**1:1.3**

Table 3: Result of Chi-square test applied to test the no significance of observed differences in the sex ratio in monthly samples of *L. savala* from February 12 to February 2013 in Ratnagiri.

Month	Total Number	Male	Female	df	Chi-square	
Feb	42	17	25	1	0.217	NS*
Mar	49	21	28	1	0.317	NS*
Apr	48	21	27	1	0.386	NS*
May	68	31	37	1	0.463	NS*
Aug	24	12	12	1	1.000	NS*
Sep	67	29	38	1	0.271	NS*
Oct	82	32	50	1	0.047	NS*
Nov	45	20	25	1	0.456	NS*
Dec	38	18	20	1	0.745	NS*
Jan	29	13	16	1	0.577	NS*
Feb	46	19	27	1	0.238	NS*
Total	**538**	**233**	**305**	--	--	--

* Not significant at 5% level
Tabulated value 3.841

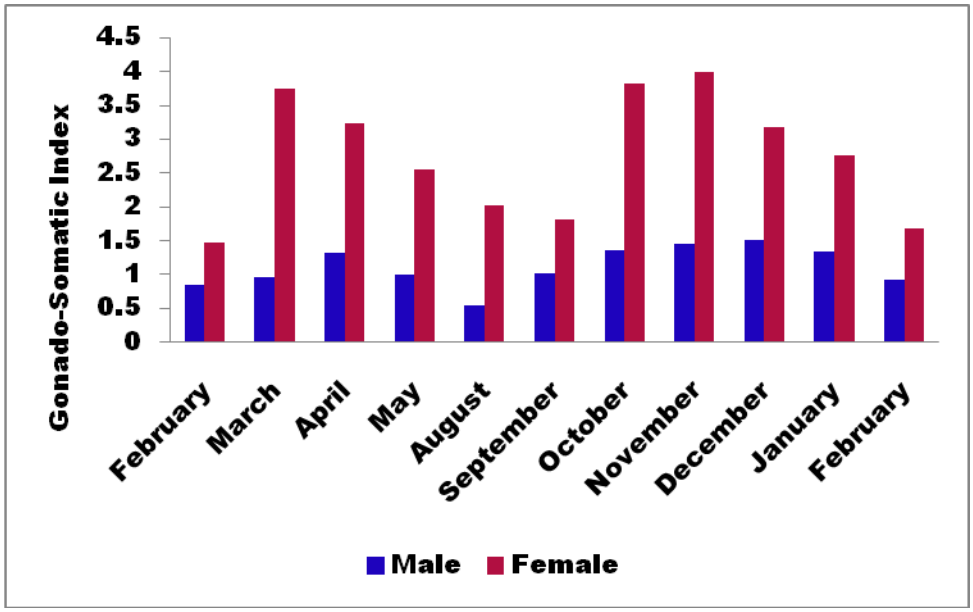

Fig. 1: Monthly variation in the GSI values of males and females of *L. savala* along Ratnagiri coast.

Table 4. The average percentage of various gonadal stages in females of *L. savala*

Stages	I	II	IIIA	IIIB	IVA	IVB	V	VIA	VIB
Feb'2012	20	5.6	2.6	--	--	--	--	20.7	51.1
Mar	10.6	27.5	21.3	11.8	6.3	--	--	--	22.5
Apr	--	--	29.3	20.1	20.5	20.9	9.2	--	--
May	--	--	15.3	16.7	27.3	30.3	10.4	--	--
Jun	--	--	--	--	--	--	--	--	--
Jul	--	--	--	--	--	--	--	--	--
Aug	30.3	52.5	11.9	5.3	--	--	--	--	--
Sep	21.6	54.3	12.6	7.5	4	--	--	--	--
Oct	--	32.1	20.6	8.3	16.2	18.8	4	--	--
Nov	--	20.6	25.6	10.3	11.5	21.9	10.1	--	--
Dec	--	--	26.7	15.6	18.7	14.1	19.6	5.3	--
Jan'2013	--	--	10.3	16.6	18.3	18.6	22.3	13.9	--
Feb	18.5	4.3	3.6	--	--	--	--	20.6	53

Table 5: The average percentage of various maturity stages in males of *L. savala*

Month	I	II	IIIA	IIIB	IVA	IVB	V	VIA	VIB
Feb' 2012	20	6.3	3.8	--	--	--	--	22.3	47.6
Mar	9.5	29.6	25.3	16.3	8.6	--	--	--	10.7
Apr	--	--	28.7	20.6	22.6	24.5	3.6	--	--
May	--	--	15.8	17.9	26.1	28.5	11.7	--	--
Aug	32.5	50.2	12.6	4.7	--	--	--	--	--
Sep	20.5	56.2	12.1	6.2	5	--	--	--	--
Oct	--	34.4	22.5	7.1	16.3	15.2	4.5	--	--
Nov	--	21.5	24.7	11.5	12.6	20.9	8.8	--	--
Dec	--	--	25.6	16.3	19.5	15.6	18.5	4.5	--
Jan' 2013	--	--	8.5	18.3	16.6	20.6	25.6	10.4	--
Feb	19.3	5.6	3.8	--	--	--	--	22.8	48.5

*No sampling during June, July due to fishing ban.

Stage I - Immature
Stage II – Maturing
Stage III A- Early mature
Stage III B - Late Mature
Stage IV A- Early Ripe
Stage IV B - Late Ripe
Stage V – Spawning
Stage VI A - Partial pent
Stage VI B – Fully spent

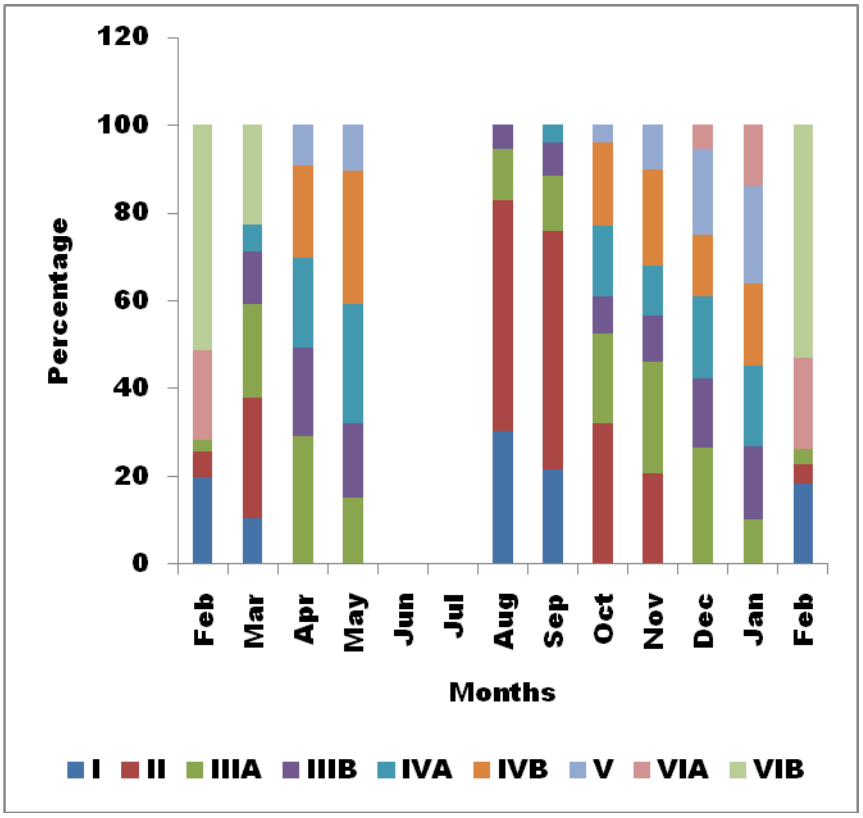

Fig. 2: Monthly variation in the maturity stages in female of *L. savala* along Ratnagiri coast.

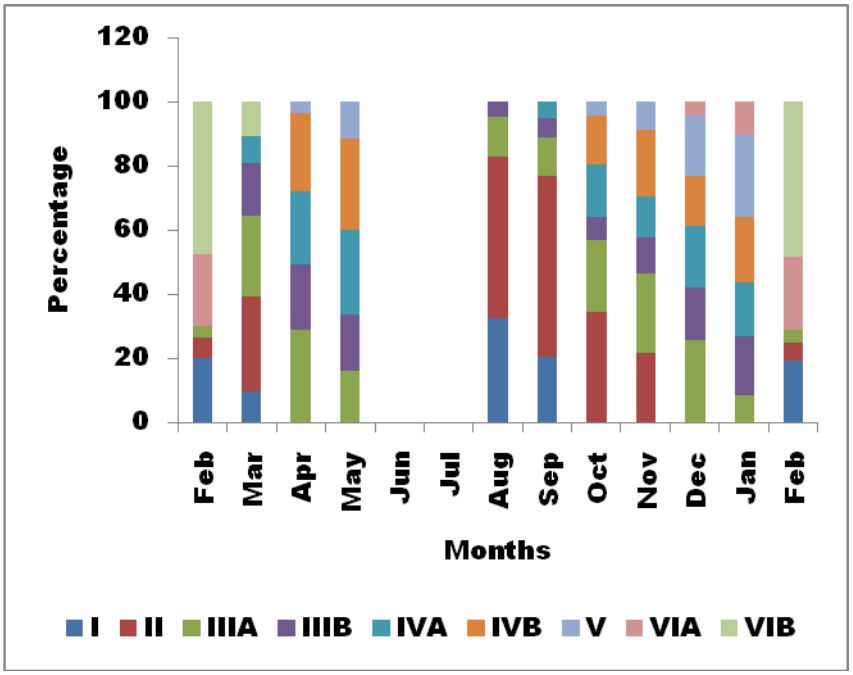

Fig. 3: Monthly variation in the maturity stages in male of *L. savala* along Ratnagiri coast.

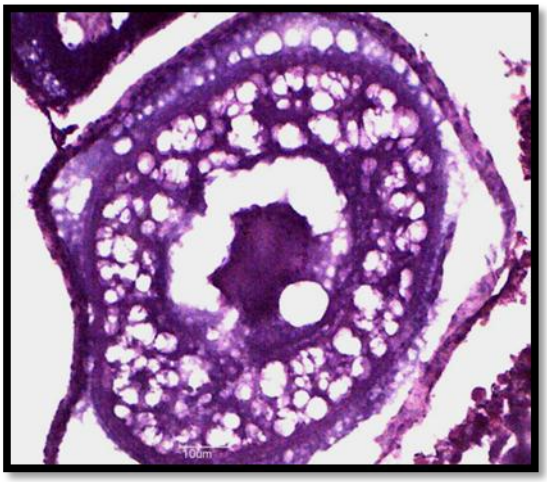

Plate1. Immature (Female) – I

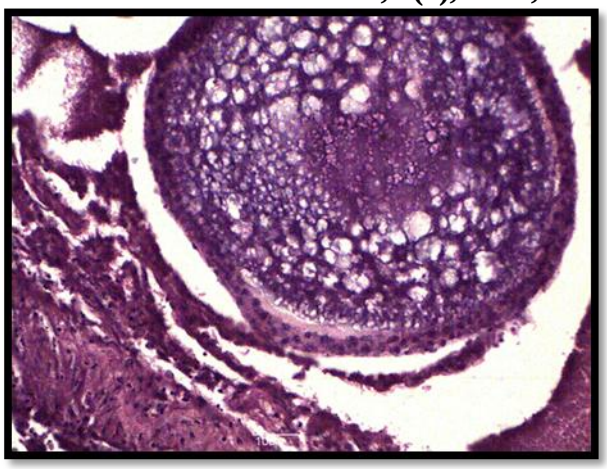

Plate 2. Maturing (Female) - II

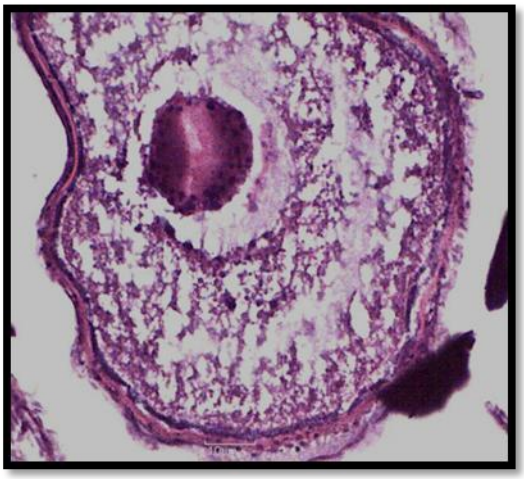

Plate 3. Early mature (Female) – IIIA

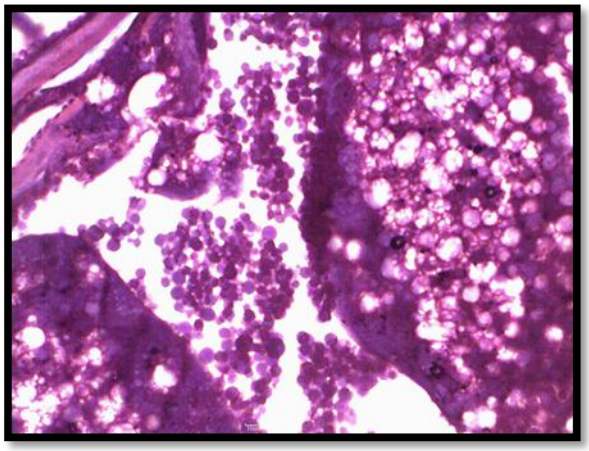

Plate 4. late mature (Female) - IIIB

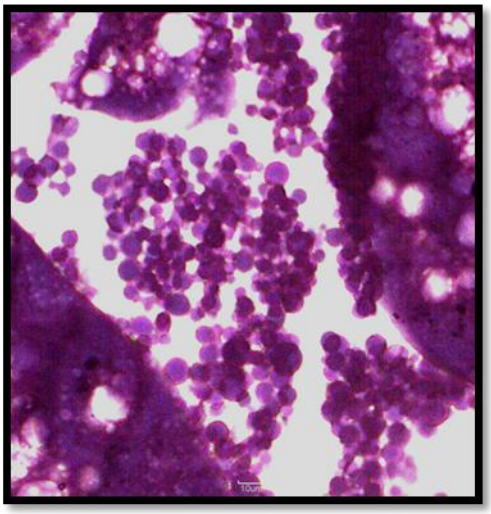

Plate 5. Early ripe (Female) - IVA

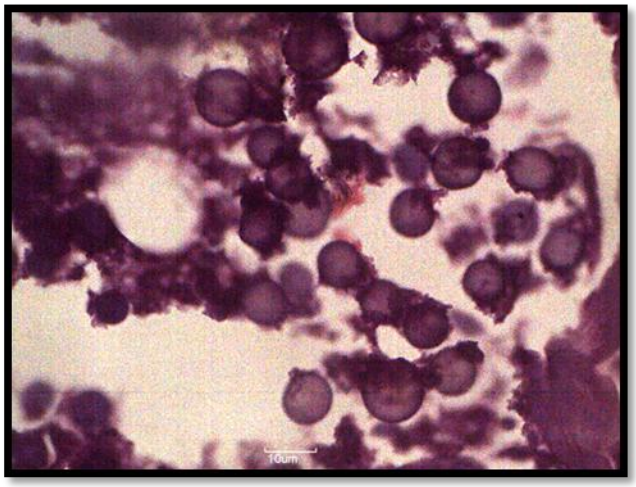

Plate 6. Late ripe (Female) - IVB

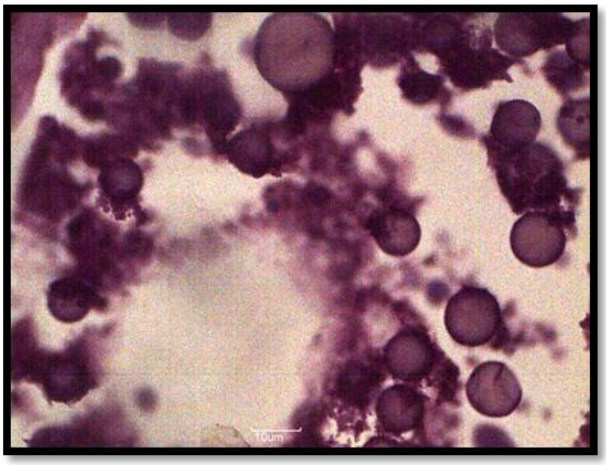

Plate 7. Spawning (Female) - V

Plate 8. Partially spent (Female) - VIA

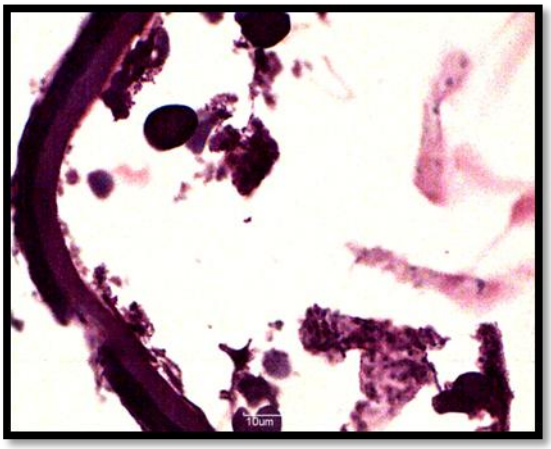

Plate 9. Fully spent (Female) - VIB

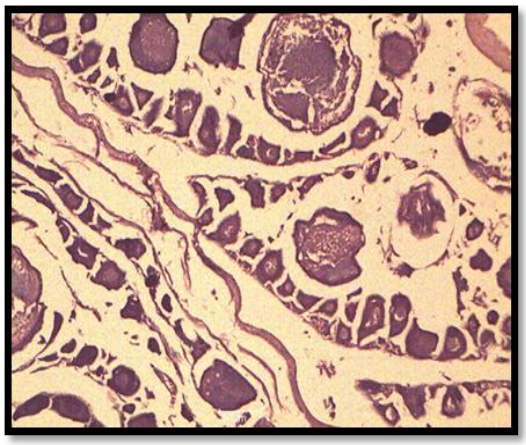

Plate 10. Immature (Male) - I

Plate 11. Maturing (Male) - II

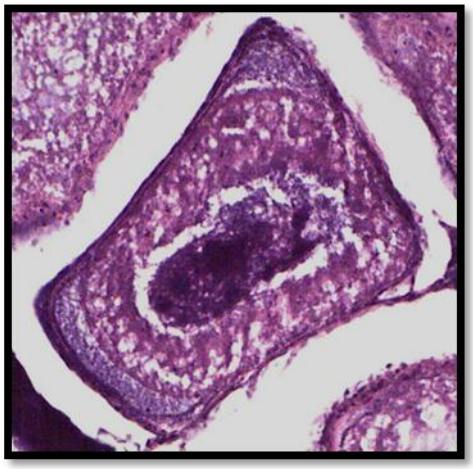

Plate 12. Early mature (Male) - IIIA

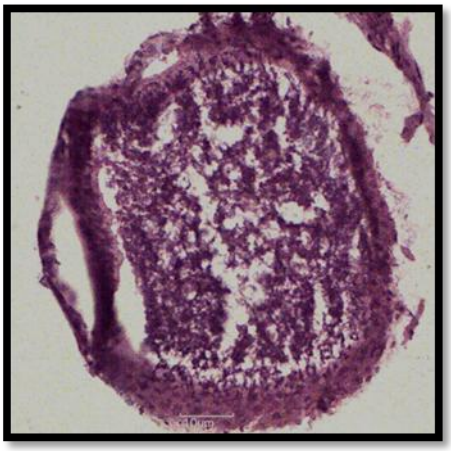

Plate 13. Late mature (Male) - IIIB

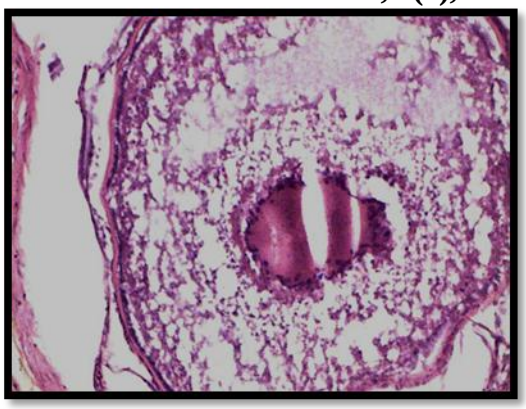

Plate 14. Early ripe (Male) - IVA

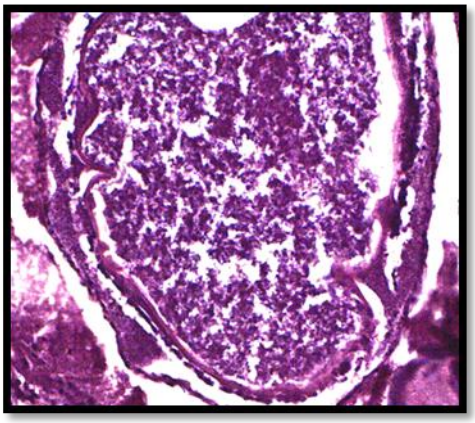

Plate 15. Late ripe (Male) - IVB

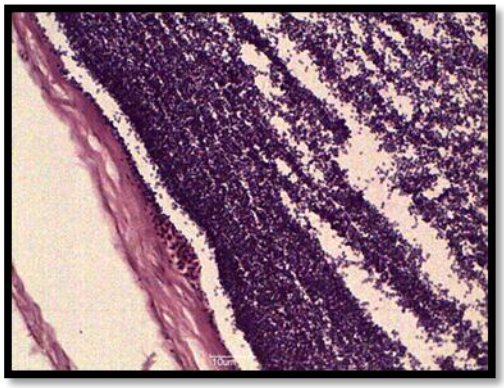

Plate 16. Spawning (Male) - V

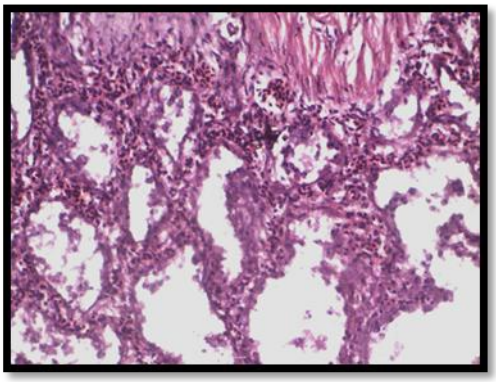

Plate 17. Partially spent (Male) - VIA

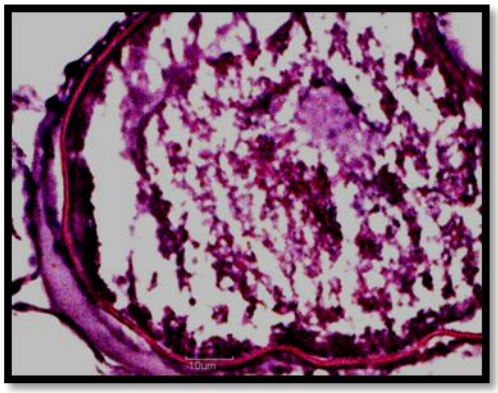

Plate 18. Fully spent (Male) - VIB

Gupta (1967 a and b) and Narasimham (1972) have attributed the fluctuations in the condition factor of ribbonfishes during different months to many reasons. In male and female of *L. savala,* the higher values of condition factor, during April-May and in December-January might be due to higher feeding intensities as shown by gastrosomatic index (Rizvi, 2001). The peak breeding of the species was found during December and May (Rizvi and Nautiyal, 2002). The size at maturity of *L. savala* was 517 mm (Rizvi et al., 2003) and therefore, most of the fishes after this size showed remarkable change in the condition factor. The sharp rise in k, of females larger than 541-580 mm appeared to be due to gonadal maturation, as the ovaries attain larger size and weight.

Azadi and Ullah (2008) worked on the relative condition factor of *L. savala* from Bangladesh. They reported that highest Kn value 1.1155 was found at 25 to 30 cm length group and lowest 0.9695 at 40 to 45 cm length group with a mean of 1.001± 0.033. Monthly highest Kn value was found in January 2004 (1.005 ± 0.028) and lowest in May 2003 (0.998 ± 0.014). Kn values generally fluctuated with changing seasons, amount of food supply, and maturity of gonads. In the present study no such effect was observed on Kn values due to the ribbon shaped long body and gonads; no major effect was also resulted due to the maturity of the gonads.

Rizvi et al., (2012) studies the condition factor k in *L. Savala*. They found that the k value of *L. savala* of males was the highest during April but declined in August to rise again in December and February. For females of *L. savala*, the estimated k values obtained in different months followed a similar pattern as males, with maximum in May, December and January.

Chakravarty *et. al*., (2013) reported that in *L. savala*, high GSI values in males and females were observed in July 2006 (1.94 ± 0.07) and March 2007 (2.73 ± 0.17) respectively, and low in September 2006 (0.03 ± 0.02 in males and 0.07 ± 0.05 in females).

Sex ratio

Sex ratio of fish population may be due to differential fishing or due to difference in growth rate of two sexes (Qasim, 1966). In the present study, data on sex-ratio of *L. savala* showed that in most of the month, females dominated over male and the overall male: female ratio was 1:1.3. Chi-square test applied for monthly sample indicated that no significant difference was noticed at 5 % probability level in all months of study periods.

James (1967a) reported in case of *L. savala* the ratio of males to females was found to be 1: 1.7 in the first year and 1: 1.2 in the second year of observation. Radhakrishna *et al.,* (1981) reported that the ratio between males and females of *L. savala* was 1: 4.6 in shore-seine samples, 1:3 in boat seine samples and 1:1 in trawler samples. According to Bal and Rao (1984) the *L. savala* the male: female ratio is about 1:1.4 practically throughout the year. Kwok and Ni (1999) studied the sex ratio of *Trichiurus lepturus* and *T. nanhajensis* from South China Sea. For both species, a chi-square analysis indicated significant deviation from a 1:1 sex ratio among different months (*T. lepturus*: $\chi^2 = 263.37$, n = 595, p <0.001; *T. nanhajensis*: $\chi^2 = 21.07$, n = 525, P < 0.05). For *T. lepturus*, however, females outnumbered males for most size and age classes.

Maturity and spawning

In the present study, nine stages of gonad development were identified, It was seen that in females, immature stages I occurred from February to March and again from August to September, maturing stage II occurred from February to March and again from August to September, stage III from March to May and again from August to January, stage IV occurred from April to

May and again from October to January. Stages V occurred in April to May and again from October to January, spent stage VI was observed in January to February. Thus peak spawning season generally appeared to be from March to May and October to December.

In males, immature stages I occurred from February to March and again from August to September, maturing stage II occurred from February to March and again from August to September, mature(Stage III) was reported during March to May and August to January. The percentage of males in ripe stage IV was observed to be increasing from April to May and October to January. Majority of males in spent stage (VI) were recorded from January to February. Recovering males were observed from March to February during the study period. After the first spawning, the spent ovaries containing oocytes at less advanced maturity stages were observed, which would develop and contribute to next spawning.

Gupta (1967b) reported that the spawning season of *L. savala* appeared to be prolonged from about May to September and the fish attained maturity at about 407 mm. James (1967) reported that the specimens of *L. savala,* both males and females were observed during January in Stage II. In February, Stage III and IV were recorded. In March and April, Stages II and III were common. Again in May, Stage IV was frequently noticed. In November and December Stages I, II and III were recorded. Fluctuations in the condition factor of ribbonfishes during different months have been attributed to many reasons by Gupta (1967a) and Narasimham (1972). Bal and Rao (1984) reported that the peak spawning season of *L. savala* was during April-May and November. Gupta (1967b) found mature specimens of *T. savala* in III and IV stages of gonadal maturity in the size groups 250 to about 320 mm (TL.) during the months of March and April. Rizvi (2001) observed that *L. savala* attained 50% maturity was 517 mm. In male and female of *L. savala* the higher values of condition factor k, during April-May and in December-January may be due to higher feeding intensities as shown by gastrosomatic index.

The peak breeding of the species was found to be during December and May (Rizvi and Nautiyal, 2002). The size at maturity of *L. savala* is 517 mm (Rizvi *et al*., 2003) and therefore, most of the fishes after this size showed remarkable change in the condition factor.

Two spawning peaks were reported during the current study, from March to May and October to December**.** The results were on par with the work done by Rizvi (2001) and Rizvi and Nautiyal (2002). The present observations are also similar to those of earlier reports.

Fecundity

Knowledge of the total number of eggs produced by a fish during a year is important in determining the spawning potential of fish. Fecundity of the fish is usually determined from the number of ova of the mature group in the ovary (just prior to spawning stage). Hence, in the present study, matured ovaries were taken in consideration for fecundity estimation. The fecundity of *L. savala* ranged from 1,421 to 25,535 eggs with an average of 12757.68 eggs per female.

According to James (1967) *L. savala* ranging in size between 37.0-54.0 cm. S.L. (17.9-19.5 cm. snout-vent length), the fecundity ranged between 9178 to 17347 eggs. The numbers of mature ova in the two specimens were 10,899 (156 mm. S-V. length) and 11,369 (150 mm. S-V. length), respectively. The ovaries of quite same size of fishes contained different numbers of eggs. This variation may occur due to the variations in environmental conditions and food intake by the individual. Doha and Hye (1970) reported that the variation of fecundity is very common and observed in fishes and the number of eggs produced by

an individual female is dependent on several factors like size, age, environmental conditions. Reproductive potential of the fishes is also influenced by availability of space and food. Gupta (1967b) reported that numerous factors like different stock of fish, nutritional status, racial characteristics (Das, 1977) and time of sampling, maturation stage and changes in environmental parameters have so far been reported to affect the fecundity both within the species and between fish populations. According to Bal and Rao (1984) the fecundity of *L. savala* varied from 9178 (37.0 cm) to 17347 (54.0 cm). According to Rizvi (2001) the fecundity of *L. savala* varied between 3,113 and 23,188 eggs in the size range of 465-655 mm total length. The variation in fecundity is very common in fish and has been reported by many researchers (Reddy and Rao, 1991; Bhuiyan and Zaman, 2006).

Conclusion

Studies on reproductive biology showed that *L. savala* exhibited two spawning peaks annually along the Ratnagiri coast from March to May and October to December. GSI showed wide variations between sex and it was higher for female throughout the sampling period. GSI was highest for females during March (3.7448) and November (3.9850), showing occurrence of more ripe individuals. For males GSI is highest during April (1.3277) and November (1.4590).

The overall male: female ratio in the Ratnagiri catches was found to be 1:1.3. There was an overall predominance of females in the population of all months during the present study. The fecundity of *L. savala* ranged from 1,421 to 25,535 eggs with an average of 12757.68 eggs. It has been seen that the fecundity increased with increasing length.

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