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Feeding and Reproductive Biology of *Saurida undosquamis* (Richardson, 1848) from Parangipettai Coast, Southeast Coast of India

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Abstract: The feeding biology, spawning season, size at first maturity, sex ratio and fecundity of the commercially important lizardfish (*Saurida undosquamis*) were studied in Parangipettai waters of the southeast coast of India. Fishes formed the predominant food item. Diversity of the prey items showed maximum value (H´log 2-3.61±0.11) during the postmonsoon season and minimum during the monsoon season (2.89±0.17). The richness (1-lambda´) also showed a similar trend and varied from 0.81±0.13 (monsoon) to 0.91±0.01 (postmonsoon). The size at first maturity (50% incidence of mature fish) was 195 mm. But when the size at first maturity was calculated by adjusting the proportion of maturity percentages, the maturity size was found to be 140 mm. This method is advantageous from the point of view of fisheries management as this species can be exploited above 140 mm rather than above 195 mm. The gastrosomatic index was found maximum during postmonsoon and minimum during the monsoon season showing the inverse relationship between feeding and spawning. This species was found to spawn from August to January with a peak in November. The fecundity ranged from 19, 856 in a fish measuring from 20.1 cm in length (97 g) to 79,282 in a fish of 29 cm (290 g). The overall sex ratio (1:1.19) was found to deviate significantly from the expected 1:1 ratio. (χ^2 = 19.1, $p<0.005$). Month- wise, it conformed to the expected 1:1 ratio during most of the months except January, June, September, November and December. Higher gonado-somatic index values observed during October-December suggested spawning activity during this period. This species is found to a total spawner in the Parangipettai waters.

Key words: *Saurida undosquamis,* Parangipettai, size at first maturity, sex ratio, fecundity

INTRODUCTION

Lizard fishes belonging to the family Synodontidae contribute their mite to the demersal fishery resource of India. They range in size from 25 (*S. longimanus*) to 67 cm (*S. tumbil*). They feed chiefly on teleost fishes, cephalopods and crustaceans. Among the four species of lizard fishes belonging to genus *Saurida* occurring in the Indian waters (Jaiswar *et al*., 2002), *S. undosquamis*, the brushtooth lizardfish is the second dominant one. It is widely distributed in tropical areas between 34°N and 28° S including the Indo-West Pacific, East to Southeast Asia and Australia (Russell and Houston, 1989). The maximum body size is 36 cm (Nandha, 1980). It is found to inhabit muddy bottoms of the continental shelf down to about 100 m deep (FAO, 1974). The resource of this species is exploited by a variety of gears. However the majority comes from the bottom trawls (FAO, 1974; Nguyen, 2002) (multiday trawl net-Manojkumar and Sivakami, 2005).

Earlier research on the lizardfishes of the Indian waters includes studies by Kuthalingam (1959), Rao (1981, 1982, 1983a, b, 1984), Nair and Raghu (1990), Muthiah (1996) and Sivakami *et al.* (2003) which were mostly qualitative in nature and did not cover all the aspects of biology. Some biological aspects of lizard fishes occurring in Parangipettai waters were covered by Nandha (1980). However a detailed investigation has not been undertaken in this species and therefore presently the feeding and reproductive aspects of *S. undosquamis,* have been studied.

MATERIALS AND METHODS

The specimens for the present study were collected from the commercial trawlers operated from the Mudasalodai landing centre during January to December 2011. Specimens of *S. undosquamis* were placed in an insulated box with ice and brought to the laboratory for biological analysis. During the present study, a total of 492 fish specimens of different length groups were examined to study the feeding biology of *S. undosquamis*. The data on sex, stages of maturity in females and feeding

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conditions were collected from fresh specimens. The feeding intensity was assessed by visual estimation based on the distension of the gut and the quantity of food contained in it. The various stomach conditions based on degree of fullness are expressed as gorged, full, ¾ full, ½ full, ¼ full, trace and empty as suggested by Pillay (1952). In order to take into account both qualitative and quantitative estimations together, Index of Preponderance was employed for the quantification of the food items (Natarajan and Jhingran, 1961). This index was calculated using the equation:

$$IP = \frac{V_i O_i}{\Sigma V_i O_i} \times 100$$

where, V_i and O_i are the volume and occurrence index of food items in percentage.

The Gastrosomatic Index (GSI) was calculated for each specimen to estimate the feeding intensity by making use of the following equation:

$$GSI = \frac{\text{Weight of the gut}}{\text{Weight of the animal}} \times 100$$

The diversity of prey items was calculated using PRIMER v6.

Stages of gonadal maturity were classified following Rao (1983a). For determining the size at first maturity, females in stages of III-V of maturation were used by grouping them into 10 mm length groups and their frequencies scaled to percentage. Size at first sexual maturity was also calculated by adjusted proportion of maturity percentages following King (1995).

Chi square analysis was used to find out the sex ratio of the species. The formula used was:

$$\chi^2 = \frac{\Sigma(O-E)^2}{E}$$

where, O is observed value and E is expected value.

Fecundity was estimated by the gravimetric method (MacGregor, 1957), which involves counting the number of mature ova from a known weight of mature ovary. The fecundity was estimated using the formula:

$$F = nG/g$$

where, F is fecundity, n is number of eggs in subsample, G is total weight of ovary and g is weight of sub sample.

Gonadosomatic index (GSI) was calculated employing the method of June (1953) and Yuen (1955) using the following formula:

$$\text{Gonadosomatic index (GSI)} = \frac{\text{Weight of the ovary}}{\text{Weight of the animal}} \times 100$$

RESULTS

Food composition

Fishes: Fish was found to be the dominant food item during most of the months (Table 1). Among the eight species of fishes found in the gut, *Nemipterus* sp. was dominant. Size of food fishes observed in the stomachs varied from 35 to 90 mm in length. Largest fish (90 mm) encountered in the gut was *Cynoglossus* sp., in the month of March. Highest quantity of fish was recorded in the gut content during November (77.71%) followed by April (77.14%) and October (75.15%). Lowest percentage was recorded in January (27.41%). Fishes identified included *Nemipterus japonicus*, *Priacanthus harmur*, *Cynoglossus* sp., *Coilia dussummieri*, *Carangids*, *Bregmaceros mcclellandi* and *Rastrelliger kanagurta* (Table 2).

Shrimps: Shrimps formed the second dominant group in the stomach contents of *S. undosquamis*. Shrimps were found to be dominant during January (38.99%) followed by March (23.23%) and February (22.48%). Lowest percentage was observed in the month of April (13.81%).

Molluscs: Molluscs formed the third dominant group and were represented by squids and cuttlefishes. Majority of molluscs was found in the month of January (28.42%) followed by July (20.36%). Molluscs were represented minimally in the month of March (1.15%).

Digested matter: Food content which could not be identified due to the digestive process was considered as digested matter. Percentage of digested matter which was found during all the months varied from the lowest of 3.14% in April to the highest of 30.48% in June.

In the total contents, fishes ranked first (58.47%) followed by shrimps (23.68%). Molluscs were found to be the third dominant group among the food items with 6.56%. The percentage of digested matter was 11.26%.

Table 1: Monthly percentage indices of food items of *Saurida undosquamis*

Food items	Jan-11	Feb.	Mar.	Apr.	June	July	Aug.	Sep.	Oct.	Nov.	Dec-11
Fish	27.41	31.51	65.98	77.14	57.89	46.52	58.26	64.73	75.15	77.71	58.17
Shrimp	38.99	22.48	24.23	13.81	0.00	0.00	20.12	0.00	0.00	0.00	16.48
Mollusc	28.42	18.46	1.15	5.31	11.63	20.36	11.52	5.51	0.00	0.00	6.37
Digested matter	5.18	27.55	8.63	3.14	30.48	13.12	20.10	29.76	24.85	22.29	18.98

Month-wise feeding intensity in males: Male fishes showed low feeding intensity as high percentage of empty stomachs was observed during various months (69.42% in October, 40.85% in December and 34.36% in June) (Table 3). Percentage of low feeding (quarter full stomachs) varied from 8.42% in September to 27.01% in February. Percentage of high feeding (full stomach) was highest in March (46.36%) and lowest in the month of July (2.75%). Highest feeding intensity (gorged stomachs-20%) was found in January, followed by 17.25% in September, 16.55% in August and 16.29% in December.

Month - wise feeding intensity in females: Highest percentage of empty stomachs was found in September (55.45%) and the lowest in March (8.26%) (Table 4). About 60% of females appeared to have not fed during September followed by 32.84% in October and 25.27% in April. Cessation of feeding coincided with the breeding season. Percentage of low feeding (quarter full stomachs) varied from 4.05% in the month of December to 23.26% in January. Percentage of high feeding (full stomach) varied considerably from 4.32% (September) to 31.32% during October. Similarly highest feeding (gorged stomachs) was observed in the month of December (32.86%).

Diversity of prey items: Diversity of the gut contents (Table 5) showed maximum value (Shannon-Wiener index-H´log2) during the postmonsoon season (3.6106±0.1058) and minimum during the monsoon season (2.8936±0.1753). Simpson richness (1-lambda´) also showed a similar trend and varied from 0.8071±0.1328 (monsoon) to 0.9097±0.0072 (postmonsoon).

Gastrosomatic index: The gastrosomatic index obtained for each month of *S. undosquamis* is given in Table 6. The index was found maximum during post monsoon and pres monsoon season. The index was found maximum in March-2011 (12.133±0.294), July (10.366±0.760) and the minimum value was observed in November (1±0.460).

Size at first maturity: The females in mature conditions were observed first at 127 mm in total length. The size at which 50% of the fish mature was 195 mm (Fig. 1) and this may be considered as the length at first sexual maturity of the population of *S. undosquamis* off Parangipettai waters. But when the size at first maturity was calculated by adjusting the proportion of maturity percentages, the maturity size was found to be 140 mm (Fig. 2).

Spawning season: Mature and ripe females (stages IV and V) were present more during August-November with a peak in November. Females with partly spent ovaries (Stage VI) occurred from August to January with their percentage reaching maximum in December (Table 7). From these results it was apparent that this species spawns from August to January with a peak in November. The recruitment of juveniles to the fishery was observed from February onwards (from 70 mm).

Fecundity: The number of ova of *S. undosquamis* ranged from 19, 856 in a fish measuring from 20.1 cm in length to 79,282 in a fish of 29 cm (Table 8).The weight of above fishes ranged from 97 to 290 g.

Table 2: Percentage of different items of *S. undosquamis*

Food items	Vol (V_i) mL	Occ (O_i) mL	V_i(%)	O_i(%)	$V_i O_i$	IP = $V_i O_i / \Sigma V_i O_i \times 100$
Fish	262.4	63	50.24	31.34	1575.00	58.47
Shrimp	124.0	54	23.74	26.86	637.90	23.68
Mollusc	70.8	35	13.55	17.41	176.96	6.56
Digested matter	65.0	49	12.44	24.37	303.40	11.26
Total	522.2	201			2693.00	

Table 3: Month wise feeding intensity in males of *S. undosquamis*

Fullness of stomach	Jan-11	Feb.	Mar.	Apr.	June	July	Aug.	Sep.	Oct.	Nov.	Dec-11
Empty	0.00	14.72	7.09	17.36	34.36	22.30	12.27	16.34	69.42	20.85	40.85
Trace	0.00	15.60	0.00	22.64	20.19	17.70	11.21	10.41	0.00	47.62	0.00
¼	10.00	27.01	17.28	10.27	11.09	11.24	10.16	8.40	16.29	11.25	25.57
½	30.00	0.00	18.18	19.73	25.27	26.76	27.20	24.00	0.00	8.63	0.00
¾	10.00	17.66	11.09	8.21	0.00	19.25	12.35	14.35	14.29	11.65	17.29
Full	30.00	25.01	46.36	21.79	9.09	2.75	10.26	9.25	0.00	0.00	0.00
Gorged	20.00	0.00	0.00	0.00	0.00	0.00	16.55	17.25	0.00	0.00	16.29

Table 4: Month wise feeding intensity in females of *S. undosquamis*

Fullness of stomach	Jan-11	Feb.	Mar.	Apr.	June	July	Aug.	Sep.	Oct.	Nov.	Dec-11
Empty	10.15	7.21	8.26	25.27	20.03	27.63	32.56	25.45	37.84	34.42	20.28
Trace	6.62	4.62	0.00	0.00	26.00	5.37	2.44	20.55	26.32	7.15	4.05
¼	23.26	12.57	17.74	15.64	11.28	13.39	14.26	17.70	4.26	17.42	17.22
½	9.74	21.07	34.50	22.27	10.11	12.61	16.74	11.30	6.27	15.29	21.44
¾	15.00	23.73	0.00	18.64	8.40	7.12	10.12	10.00	10.52	9.42	10.15
Full	18.18	20.35	32.50	7.09	12.15	21.88	20.88	4.32	9.27	7.15	0.00
Gorged	17.05	10.45	7.00	11.09	12.03	12.00	3.00	5.68	5.52	9.15	26.86

Table 5: Gastrosomatic index of *S. undosquamis* during January to December 2011

Months	G.S.I (%)
Jan-11	9.383±1.278
Feb.	11.2±1.234
Mar.	12.133±0.294
Apr.	8.8±0.521
June	9.1±0.346
July	10.366±0.760
Aug.	9.066±0.697
Sep.	8.416±0.741
Oct.	1.533±0.871
Nov.	1±0.460
Dec-11	2.3±0.750

Table 6: Season wise diversity indices of the food items of *S. undosquamis*

Seasons	Shannon-wiener index (H'log2)	Simpson richness (1-lambda')
Post monsoon	3.6106±0.1058	0.9097±0.0072
Summer	3.2889±0.1581	0.8071±0.1328
Pre monsoon	3.3187±0.2955	0.8861±0.0334
Monsoon	2.8936±0.1753	0.8325±0.0204

Table 7: Monthly percentage occurrence of females of *S. undosquamis* in various stages of maturity

		Percentage of maturity stages					
Months	No. of females examined	I	II	III	IV	V	VI
Jan-11	34	20.0	42.2	6.1	7.8	6.8	17.1
Feb.	90	45.2	43.0	5.3	6.5	0.0	0.0
Mar.	85	46.7	51.3	1.0	1.0	0.0	0.0
Apr.	61	37.7	62.3	0.0	0.0	0.0	0.0
June	20	56.4	43.6	0.0	0.0	0.0	0.0
July	19	36.5	63.5	0.0	0.0	0.0	0.0
Aug.	54	20.7	25.1	18.1	9.0	11.1	16.0
Sep.	72	23.0	22.0	10.0	16.8	12.9	15.3
Oct.	120	15.0	21.4	7.0	12.5	20.4	23.7
Nov.	65	10.2	12.0	22.3	20.3	16.2	19.0
Dec-11	78	14.1	33.0	5.8	12.0	4.1	31.0

Table 8: Fecundity in various size groups of *S. undosquamis*

No. of fishes examined	Total length intervals (cm)	Mean total length (cm)	Mean weight (g)	Mean weight of ovary (g)	No. of eggs
6	19.5-20.4	20.1	103	6.526	19586
4	20.5-21.4	21.2	119	4.843	25951
4	21.5-22.4	22	97	5.217	22897
5	22.5-23.4	23.2	105	4.709	30590
5	23.5-24.4	24	120	5.573	29885
4	24.5-25.4	24.9	108	5.787	32869
5	25.5-26.4	26	129	5.903	39106
6	26.5-27.4	27.1	196	6.831	39359
4	27.5-28.4	27.9	215	10.207	57190
7	28.5-29.4	29	210	12.138	79282
5	29.5-30.4	30.1	280	12.828	67988
4	30.5-31.4	30.6	242	13.269	76110
5	31.5-32.4	32	290	8.215	69305

Relationship between fecundity and total length: The relationship between fecundity and total length was determined by plotting the observed values in a scatter diagram (Fig. 3a, b). The relationship between fecundity and total length was found linear indicating that the fecundity increases with increase in total length. The regression equations derived are as follows:

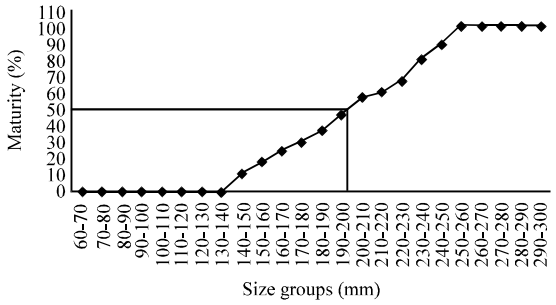

Fig. 1: Size at first maturity in *S. undosquamis*

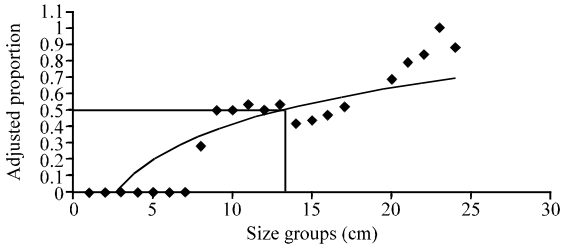

Fig. 2: Size at first maturity in *S. undosquamis* by adjusted proportion method

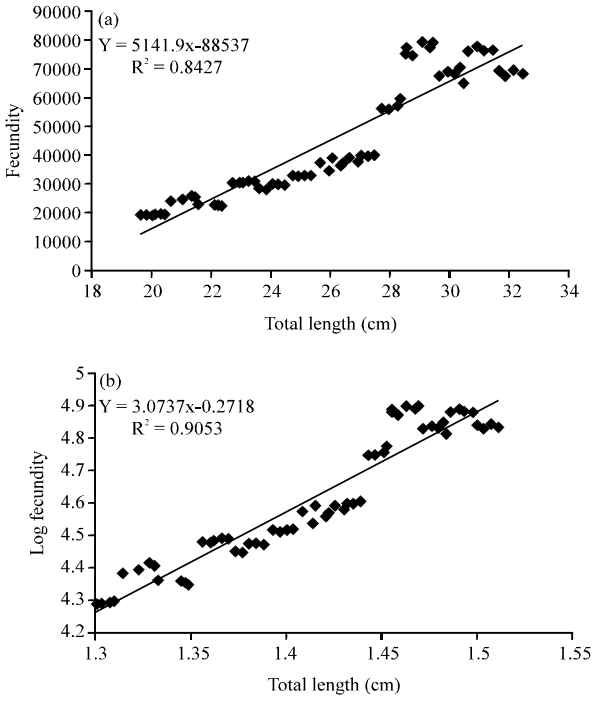

Fig. 3(a-b): Linear relationship between fecundity and total length in *S. undosquamis*, (b) Logarithmic relationship between fecundity and total length

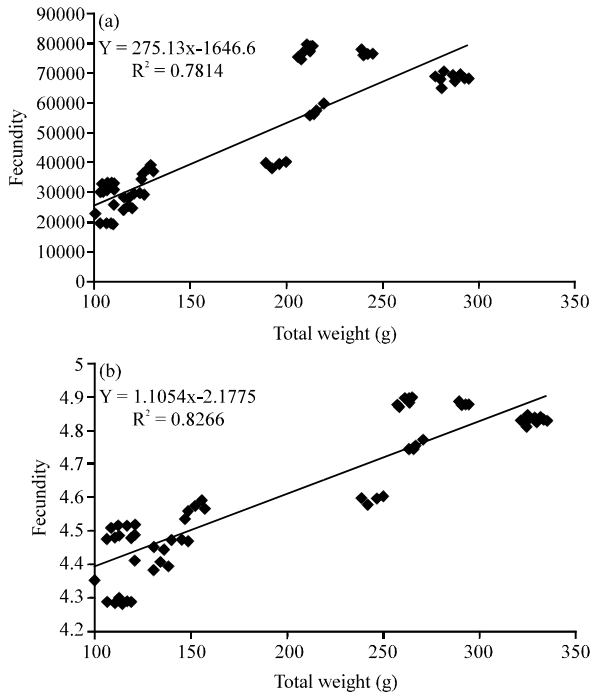

Fig. 4(a-b): Linear relationship between fecundity and total weight in *S. undosquamis*, (b) Logarithmic relationship between fecundity and total length

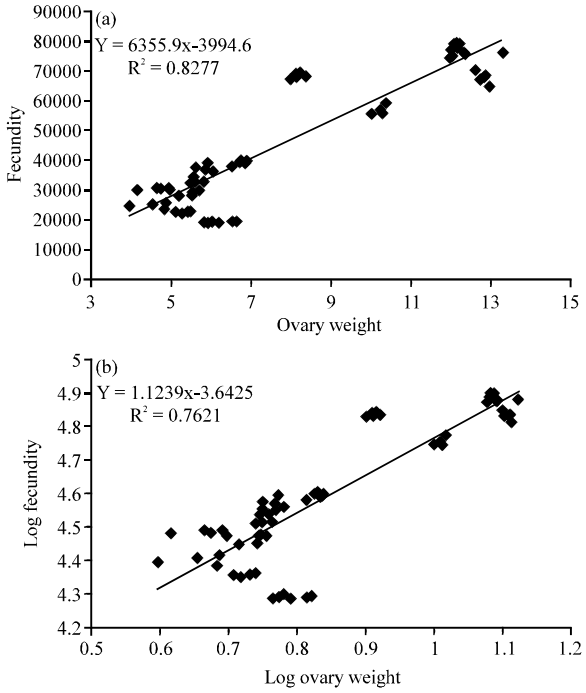

Fig. 5(a-b): Linear relationship between fecundity and ovary weight in *S. undosquamis*, (b) Logarithmic relationship between fecundity and total length

- Based on observed values:

$$F = -88537 + 4012.5\ TL\ (R^2 = 0.8427)\ (n = 64)$$

- Logarithmic equation:

$$\text{Log } F = 0.2718 + 3.0737\ \text{Log } TL\ (R^2 = 0.9053)\ (n = 64)$$

Relationship between fecundity and total weight: The relationship between fecundity and body weight was determined by plotting the observed values in a scatter diagram (Fig. 4a, b). The linear relationship between fecundity and body weight showed the fecundity to increase in direct proportion to total weight. The regression equations derived are as follows:

- Based on observed values:

$$F = 1646.6 + 275.13\ TW\ (R^2 = 0.7814)\ (n = 64)$$

- Logarithmic equation:

$$\text{Log } F = 2.1775 + 1.1054\ \text{Log } TW\ (R^2 = 0.8266)\ (n = 64)$$

Relationship between fecundity and ovary weight: The relationship between fecundity and ovary weight was determined by plotting the observed values in a scatter diagram (Fig. 5a, b). The relationship between fecundity and ovary weight was found linear. It was found that fecundity generally increased with increase in ovary weight. But significant differences were also observed in the fecundity of ovaries having the same weight. The regression equations derived are as follows:

- Based on observed values:

$$F = 3994.6 + 6355.9\ OW\ (R^2 = 0.8277)\ (n = 64)$$

- Logarithmic equation:

$$\text{Log } F = 3.6425 + 1.1239\ \text{Log } OW\ (R^2 = 0.7621)\ (n = 64)$$

The fish being a total spawner, the correlation co-effecients values obtained were positive and highly significant.

Sex ratio: A total of 1,121 fishes were examined of which 510 were males and 611 females. The overall sex ratio

Table 9: Month-wise sex ratio of *S. undosquamis*

Months	Male	Female	Total	Sex ratio (M:F)	Chi-square
Jan-11	44	26	70	1:1.591	6.612[2]
Feb	57	89	146	1:1.569	0.404
Mar	48	51	99	1:1.062	1.924
Apr	50	52	102	1:1.040	2.647
Jun	55	78	133	1:1.054	3.977[1]
Jul	48	58	106	1:1.418	0.943
Aug	54	76	130	1:1.037	3.723
Sep	40	62	102	1:1.550	4.745[1]
Oct	42	59	101	1:1.404	2.861
Nov	38	60	98	1:1.578	4.937[1]
Dec-11	34	54	88	1:1.588	5.165[2]
Overall	510	611	1121	1:1.198	19.100[3]

1: $p<0.05$, 2: $p<0.025$, 3: $p<0.005$

Table 10: Gonadosomatic index of S. undosquamis during January to December 2011

Months	G.S.I (%)
Jan-11	3.28±0.22
Feb	3.09±1.81
Mar	4.15±2.94
Apr	4.71±1.06
Jun	5.12±2.37
Jul	5.94±1.53
Aug	6.07±2.49
Sep	6.10±1.93
Oct	8.27±2.07
Nov	10.46±1.64
Dec-11	9.30±1.14

(1:1.19) was found to deviate significantly from the expected 1:1 ratio. ($\chi^2 = 19.1$, $p<0.005$). Month-wise, it conformed to the expected 1:1 ratio sex ratio during most of the months except January, June, September, November and December (Table 9).

Gonadosomatic index (GSI): Values of gonadosomatic index (Table 10) showed an increasing trend from March 2011 onwards. However the values were more during October - to December 2011(8.27±2.07- 10.46±1.64) with the peak during November. The higher GSI values obtained during November (10.46±1.64) showed high spawning activity during this month.

DISCUSSION

In the present study *S. undosquamis* was found to be a carnivore feeding on fishes, shrimps and molluscs (squids and cuttlefish). The overall percentage of fish was found to be high as compared to shrimps, indicating fish to be the preferred food item. The digested matter was also found to have fish scales, fish bones and eyeballs. Euzen (1987) who studied the food content of two species of lizard fishes belonging to the genus *Saurida* in Kuwait waters found that they eat fishes of the family Theraponidae (*Helotes sexlineatus*), Cynoglossidae (*Cynoglossus macrolepidotus*), Nemipteridae (*Nemipterus japonicus* and *N. tolu*), Leiognathidae (*Leiognathus* sp.,), Clupeidae (*Ilisha indica*) and Carangidae (*Caranx leptolepis*). Bakhsh (1994) noted most of prey items in the stomach of *S. undosquamis* occurring in waters of Jizan region of the Red Sea to be *Nemipterus japonicus*, *Caranx* sp, *Rastrelliger kanagurta*, juveniles of *Saurida tumbil*, squid and shrimps (*Metapenaeus monoceros*). He further found the principal food item to be fishes particularly lizard fishes and sardines which constituted respectively 70 and 22%, of the gut contents. Raje *et al.* (2004) noticed teleost fishes to be the dominant food item in Mumbai waters during almost all the months. The highest percentage was observed during the months of November (77.71%) followed by April (77.14%) and October (75.15%) and the lowest percentage in January (27.41%). They reported that *Decapterus* sp., was the predominant food item followed by *Nemipterus* sp., *Saurida tumbil* and *Apogon* sp.

Rajkumar *et al.* (2003) also found *S. undosquamis* occurring in Vishakhapatnam waters to be a carnivore, feeding predominantly on fishes (*Sardinella* sp., *Stolephorus* sp., *Leiognathus* sp., *Nemipterus japonicus*, *Pentaprion* sp., *Rastrelliger kanagurta, Upeneus* sp. and *Apogon* sp.), besides crustaceans (*Acetes*, *Metapenaeus*, *Solenocera* and *Crabs*) and squid (*Loligo* sp.). The food items observed in the present study were mainly fishes (*Nemipterus japonicus*, *Priacanthus harmur*, *Cynoglossus* sp., *Stolephorus indicus*, *Bregmaceros mcclellandi* and *Rastrelliger kanagurta*) besides shrimps (*Acetes* sp., *Metapenaeus* sp. and *Solenocera* sp.) and molluscs (*Loligo* and *Sepia* sp.). Similar observations were made by Fofandii (2011) in the Veraval coast.

In the present investigation, the highest percentage of empty stomachs was observed in October (37.84%) and the lowest in January (5.15%). It is a common fact that in most of the fishes, feeding is found to be very low during the breeding season. Thomas (1969) observed that the feeding in mature fishes declines during the breeding season, as the ovaries are enlarged and densely packed with ova, spreading out and occupying a lion share of the abdominal cavity, exerting quite a lot of pressure on the stomach.

The peak spawning season was found to be October and November. This agrees with the findings of Annigeri (1963) who reported that the peak spawning period of this fish occurring in Mangalore coast commences from October and ends in December. Rao (1983b) observed the spawning season of this species to extend from October to March, with a peak in November and December in the north western part of Bay of Bengal. Thus the results obtained in this study agree with the finding of the above studies. Raje *et al.* (2004) obtained similar results on some biological aspects of *S. tumbil* collected from Mumbai

waters. Bauchot (1987) stated that lizardfish spawn from April to May off Japan. Sanders and Morgan (1989) reported that in the Suez Canal, lizardfish reproduce partly in April, May and June and fully during the other months. The spawning season has been reported to vary from one geographical area to another. The differences have been attributed to seasonal, geographical and ecological variations (Latife and Shenouda, 1973).

The length at first maturity of *S. undosquamis* in the present study was 195 mm and this agrees with the previous work of Nandha (1980). However Rao (1983a) and Rajkumar *et al.* (2003) reported the values of 230 and 240 mm, respectively from the North-western Bay of Bengal and Visakhapatnam waters. Amin *et al.* (2007) found the size to be 174 mm in the Egyptian waters. King (1995) pointed out the drawback in the calculation of size at maturity based on the incidence of (percentage) advanced stages of ovary as it overestimates the size at first maturity. Instead he suggested the use of adjusted proportion of maturity percentages. In the present study this was followed and the size at first maturity was found to be lower (140 mm) than 195 mm. As this has an important bearing on the fisheries management (more than 140 mm can be caught-that way it is beneficial to fishermen with more catch) this method is found to be advantageous.

The sex ratio was (M:F-1:1.6) of the present study agrees with the studies of Redding and Patino (1993) and El-Greisy (2005). Nikolsky (1963) pointed out that availability of food is an important factor determining the sex ratio. It was further mentioned that when food is abundant, females predominate, with the situation inverting in regions where food is limited. Feeding activity, in this case, would be influencing metabolism through hormonal activity, resulting in production of individuals of a given sex. Females require better environmental conditions than males, for the development of ovary (Taghavi Motlagh *et al*., 2012).

Overall females were found to predominant over males. Young males were less in number than females. However in higher age groups females were more dominant. Both males and females were similar in the median age groups. The predomination of females over the males was uniform throughout the year. Bakhsh (1994) pointed that, this may be due to movement of the females towards the shore in search of food and for spawning.

The fecundity in the present study ranged from 19,856 to 79,282 eggs. Torcu (1995) in Mersin Bay found it to be lower in the range of 14,226-65,833 eggs. The results of Zienab Abdel and Greisy (2005) from the Mediterranean coast of Egypt agree with the present study. Bagenal (1963) concluded that the variation in fecundity was not related to changes in hydrographic conditions, but this may be due to the variations in food availability.

Information regarding the spawning season could be gathered using the gonadosomatic index (Abdel and Greisy, 2005). In the present study, maximum values of Gonadosomatic Index (GSI) were observed in the months of October and November. Then it decreased gradually due to the cessation of spawning activity. This indicates that this species spawns once in a year. However it is in variance with the observations of Ismen (2003) and Torcu (1995) who reported that the it spawns more than once in the Eastern Mediterranean sea and South Aegean sea coasts.

In the present study no plant material was found in the stomachs of *S. undosquamis*. This suggests that this fish is strictly a carnivore, predominantly a piscivore. However, this fish is not a ravenous feeder and most of them sustain themselves to low feeding intensities particularly during the spawning season (September to December).

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