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BIOLOGY AND POPULATION DYNAMICS OF *SAURIDA UNDOSQUAMIS* (RICHARDSON) FROM MUMBAI WATERS, NORTHWEST COAST OF INDIA

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ABSTRACT

Biological aspects and population dynamics of *Saurida undosquamis* are presented in this paper. Feeding intensity and average volume of food per fish in relation to different years and maturity stages were studied for males and females. The principal dietary constituents based on index of preponderance were fishes, crustaceans and molluscs. This fish is a carnivore, feeding on the subsurface and bottom living organisms. Spawning period is prolonged from August to May with intensive spawning during November-December. Chi-square analysis of the sex ratio data gave a value of 20.5, which was significant at 1% level with dominance of females. The size at 50% maturity for males was 223 mm and for females 244 mm. The length-weight relationship for male was Log W = - 4.49963 + 2.71518 Log L and for females Log W = - 4.99493 + 2.93094 Log L. *L* and *K* during 1997-1999 was 392 mm and 0.57 yr^{-1} respectively. It was estimated that *S. undosquamis* reach 170 mm (CW) at the end of first year, 267 mm (CW) at second year and 321 mm (CW) at the end of third year. Longevity of the species from the present study was estimated to be 6 years. The total mortality coefficient (Z) was 1.88 and fishing mortality coefficient (F) was 1.28. The exploitation ratio (E) 0.68 was marginally above the estimated E_{max} (0.64).

Key words: *Saurida undosquamis*, biology, population dynamics, Mumbai.

INTRODUCTION

The lizardfish resource mainly supported by *Saurida tumbil* and *S. undosquamis* forms an important component of the demersal fishery along the west coast of India (Nair *et al.*, 1992). *S. undosquamis* ranks second in the lizardfish landings by the trawlers at New Ferry Wharf during 1991 - 1995 (Raje *et al.,* 2004). Rao (1981, 1983, 1983) studied biological characteristics of lizardfishes in the northwest of Bay of Bengal. Nair *et al.* (1992) and Sivakami (1999) reported the fishery and biology from Cochin. Muthiah (1994) and Rajkumar *et al.* (2003) made investigations on the fishery, biology and population dynamics of this species from Karnataka Coast and Visakhapatnam respectively. The present study deals with the biology and population dynamics of *Saurida undosquamis* (Richardson) off Mumbai.

MATERIAL AND METHODS

To study the biological details on length, weight, sex and maturity stages of *S. undosquamis*, 1,203 fresh specimens were collected from trawlers operating from New Ferry Wharf during January 1988 to December 2005. Data were not collected during 2000-2001 and 2003-2004. Food of individual specimens was analysed by volumetric occurrence method. The feeding intensity was determined based on the distension of stomachs and the amount of food content. The fishes were classified as active (gorged, full and ¾ full and ½ full), poor (¼ full), trace and empty. The index of preponderance was calculated following Natarajan and Jhingran (1961). Maturity stages of males and females were identified following Tiew *et al.* (1972) and Rao (1983). As this species occurs in the catch seasonally, the biological data of corresponding months in different years were pooled.

Data on length-frequency distribution collected for three years from January 1997 to December 1999 were used for the growth and stock assessment studies. The data were grouped into 10 mm class intervals. The growth parameters were estimated using ELEFAN I routine. Annual growth of the species was calculated using von Bertalanffy Growth Formula (VBGF). To test the growth parameters for their reliability by comparing them with the available growth studies of the same species and with related species in the same family, empirically derived growth performance index (phi prime index, Φ') which is expressed by the equation (Longhurst and Pauly, 1987), $\Phi' = \log 10\ k + 2\log 10 L_\infty$, was used. The total mortality coefficient (Z) was estimated using length-converted catch curve method of Pauly (1983) and natural mortality coefficient (M) was calculated by Pauly's (1980) empirical formula. Relative yield /recruit and Emax incorporated in the FiSAT module were used to assess the stock.

RESULTS AND DISCUSSIONS

Feeding intensity: The number of *S. undosquamis* with poorly fed stomachs was high in both the sexes (Table 1). The percentage of poorly fed stomachs in most of the years was higher in males than females. In general, the incidence of poor feeding in males increased with fish size (110-119 mm) from 66.7% to 86.4% (280-299 mm) (Table 2). Longhurst (1957) has reported that where fish is an important food item, the daily intake will be less, because of the higher caloric value of the diet and the empty stomachs will be more common. In males, the average volume of food per fish was 6.1 ml and in females 8.9 ml. The average volume of food in both the sexes increased with the size. Rao (1981) also noticed increase in the volume of food with the size of *S. undosquamis* in the northwestern Bay of Bengal. The feeding intensity and average volume of food per fish was analysed for males and females of *S. undosquamis* at different stages of sexual maturity (Table 1). The analysis indicated that the feeding intensity in stage VI of both the sexes was comparatively less than in stage V. The low feeding in stage VI of both the sexes might be due to spawning. An increased in feeding intensity and average volume of food per fish observed in females of stages VIIa and VIIb, probably indicate recovering from spawning stress. Rao (1981) found the highest feeding intensity in mature fishes of S. undosquamis. Muthiah (1994) observed better feeding in gravid stages (V & VI) individuals of *S. undosquamis,* than those in other stages. He noticed better feeding conditions in spent and spent-recovering fishes of *S. isarankurai.*

Food composition: The food items were identified as far as possible upto species level. Fishes (52.3%) formed the primary food item of *S. undosquamis* (Table 3) mainly comprised of Decapterus spp. (23.8%), Nemipterus spp. (4.8%) and Saurida spp. (2.7%) followed by molluscs (46.8% dominated by Loligo spp.) and crustaceans (0.6%) represented by

Solenocera spp., *Parapenaeopsis scuptilis* and *Metapenaeopsis stridulans*. Fishes, molluscs and crustaceans formed the regular food in almost all the months (Fig.1). Fish were the dominant food items during February-May, July-October and December; molluscs in January, June and November; and crustaceans in July.

Food in relation to size: The number of points gained (volumetric method) by one individual food item in each size group were added up and scaled down to percentage of the grand total of points gained by all the items of food. Teleosts were the dominant food items in the stomach of all the size groups (Table 2) ranging from 54% (240-259 mm) to 100% (100-139 mm and 380-399 mm). The specimens in the size ranged from 100-119 mm to 120-139 mm and from 340-359 mm to 380-399 mm were found to feed only on teleosts. Rao (1981) and Sivakami (1999) noticed fish diet in the gut of fishes in size < 160 mm and 111-200 mm respectively. Muthiah (1994) reported that the percentage of intake of cephalopods was low in fish up to 300 mm and high in larger *S. undosquamis*. The presence of bottom dwelling fishes like *Nemipterus* spp., *Saurida* spp., *Apogon* spp. sciaenids, soles, prawns, crabs *etc.* and pelagic fishes like *Decapterus* spp., *Stolephorus* spp., *Trichiurus* spp., carangids *etc.* in the gut indicates that *S. undosquamis* feed at the subsurface as well as bottom. Muthiah (1994) reported that the *S. undosquamis* is more of a pelagic feeder, based on food items such as *Leptocephalus, Fistularia* sp. *Lagocephalus* sp. and barracuda.

In the present study, it was found that *Decapterus* spp. (23.8%) was the dominant food item among teleosts and *Loligo* spp. (46.8%) among molluscs. Rao (1981) noticed *Leiognathus bindus* and *Stolephorus* spp. as the chief food items in the teleost diet of *S. undosquamis* from northwestern Bay of Bengal. Muthiah (1994) and Sivakami (1999) observed Stolephorus spp. from Karnataka coast and Cochin respectively and Rajkumar *et al.* (2003) noticed Sardinella spp. from Visakhapatnam. Thus, the most preferred item varies according to the abundance of prey in the region. Rao (1981) opined that *L. bindus* and Stolephorus spp. were dominant food items in *S. tumbil* and *S. undosquamis* and absence of these two food items indicates that this fish feed on other available fish.

The smaller sized fishes ranging from 120-149 mm preferred small teleosts followed by molluscs and crustaceans. Further, whole specimens of *Nemipterus japonicus* (maximum volume - 64 ml), Decapterus spp. (42 ml), Loligo spp. (40 ml), Upeneus spp. (45 ml) were noticed in guts content of bigger fishes. This change in the type of feeding and size of food items are attributed to swallowing habit. Moreover, presence of terminal mouth, strong dentition, absence of gill rackers, large oral opening, ability of the predator to stalk its prey and occurrence of mixed diet indicated carnivore predatory habit. Vivekanandan (2001) reported that with more teeth and large oral area, *S. tumbil* can grasp and hold large and active prey. He has also noticed that longitudinally running ridges provide elasticity to the stomach of this fish in holding large prey. Cannibalistic nature of the species was observed from 140 mm onward. Rao (1981) reported cannibalism in this species in all the size groups, but more pronounced in the size group of < 160 mm from Northwestern part of Bay of Bengal and Sivakami (1999) and Muthiah (1994) have noticed this from 110 mm size onwards. The examination of the stomach contents of *S. undosquamis* revealed that fishes and molluscs were the main constituent of the diet and crustaceans formed small portion of it. Rao (1981) reported that fish formed the major food items, squids and prawns coming next in importance from Northwest of Bay of Bengal. Muthiah (1994) also noticed fishes as major food in this fish followed by cephalopods and crustaceans from Karnataka coast. Sivakami (1999) noted that this species preferred mainly small fishes and the next preferred items were prawns and squids from Cochin. Rajkumar *et al.* (2003) observed that this species feed predominantly on fishes, crustaceans and cephalopods. This indicated that this species is mainly piscivors (Rao, 1981) and dominance of molluscs and crustaceans seem to change according to the region.

Spawning season: Maturity distribution of females indicated that the spawning in *S. undosquamis* was of prolonged nature and commenced from August and extended up to May (Fig. 2). In general, gonado-somatic index (GSI) in females gradually increased from August (1.32) to the highest in December (5.12) and declined from January (2.31) to May (1.87). However, occurrence of females with gonads in maturing, mature and spent conditions were comparatively high in November-December. The GSI values remarkably more in these months indicated intense spawning during November-December. This is further supported by occurrence of juveniles of 60-130 mm during December to May. Budnichenko and Dimitrova (1981) reported that *S. undosquamis* in the Arabian Sea spawns throughout the year with a peak during October-March. Rao (1983) noted the spawning period of the fish at northwest of Bay of Bengal from October to March with peak in November-December. Nair *et al.* (1992) reported prolonged spawning season based on continued occurrence of spawning and spent fish during the premonsoon and post monsoon months at Cochin. Muthiah (1994) observed that the species along Karnataka coast spawn during November-March and April-May, high GSI values in November-February and thereafter a decreasing trend reaching the lowest in April-May. Sivakami (1999) reported prolonged spawning period for this species with peak during October-December from Cochin. Rajkumar *et al.* (2003) have noted the spawning period of this fish extended from October-February with peak in December at Visakhapatnam. An interesting feature of the *S. undosquamis* fishery is the presence of ripe and spent males and females and very small fishes of 60-130 mm total length during December-May. It indicates that the spawning grounds for this fish are not far-off from Mumbai. Based on absence of ripe gonads in the commercial catches, Rao (1981) and Sivakami (1999) reported that *S. undosquamis* breeds away from the fishing ground.

Size at first maturity: The size at first maturity of *S. undosquamis* was determined by analysing 243 females and 220 males in stage III and above. The size at which 50% of females of *S. undosquamis* mature were 244 mm and males 223 mm (Fig. 3). Hence, these lengths may be considered as the size at which first sexual maturity was attained. Budhichenko and Dimitrova (1981) found sexual maturity in this fish at a fork-length of 15-16 cm for females and 11-12 cm for males in the Arabian Sea. Rao (1983) reported the minimum size at maturity in females at 240 mm, from Northwest of Bay of Bengal, which confirms to the present finding. Muthiah (1994) determined length at 50% maturity from Karnataka Coast as 167 mm for males and 207 mm for females. Sivakami (1999) and Rajkumar *et al.* (2003) reported length at first maturity in females of this species from Cochin and Visakhapatnam as 200 mm and 230 mm respectively. This study indicated that the males attain first maturity at a smaller length than females. Budnichenko and Dimitrova (1981) and Muthiah (1994) also found that males mature at smaller size than females.

Sex ratio: Chi-square analysis of the sex ratio data for the entire period of study gave a value 20.5, which was statistically significant at 1% level due to preponderance of females. An analysis of the occurrence of males and females in various seasons and months (Table. 4) indicated that there were more females than males. Females were more predominant in most of the years and chi-square value significantly (X 2, 20.5, P 0.01) departed from expected 1:1 ratio, which seems to suggest that a male might be spawning with more than one female at a time. Muthiah (1994) reported significant Chi-square value in sex ratio of this species, owing to the dominance of females. The sex ratio in different length groups (Table. 4) showed preponderance of males in most of the size groups up to 180-199 mm and females above 220-239 mm. This feature of the sex ratio in *S. undosquamis* may be the result of differential growth rate of sexes as shown by Qasim (1966) in some fresh water fishes of India. Krishnamoorthy (1974) also noticed differential growth rate in *Nemipterus japonicus* based on similar study. In the present study, females were found to attain maturity at higher length than males, probably due to differential growth rate in the sexes. Further, occurrence of equal proportion of males and females in the length group 200-219 mm, which is almost nearer to the size at 50% maturity of males, probably suggests the congregation of both the sexes for spawning as inferred by Kagwade (1971) in the case of *Caranx kalla.* The sex ratio in relation to length showed that females outnumbered males above the size at first maturity length of 200 mm in *S. undosqamis* (Muthiah, 1994). In the present study, males were found to be absent from 340-359 mm. Muthiah (1994) noticed females invariably above 370 mm in S. tumbil, 290 mm in *S. undosqamis* and 135 mm in *S. isarankurai.*

Length-weight relationship: To establish the length-weight relationship of S. undosquamis, 370 males ranging from 101 to 363 mm in length and 12 to 298 g in weight and 508 females ranging from 108 to 414 mm length and 8 to 463 g in weight were used. The relation was calculated separately for both the sexes by the method of least square. The logarithmic regression equation obtains as follows:

Male: Log W = - 4.49963 + 2.71518 Log L (r 2 = 0.914)

Females: Log W = - 4.99493 + 2.93094 Log L (r2 = 0.938)

The analyses of covariance (Snedecor and Cochran, 1967) revealed significant difference at 1% level for slope and 5% level for elevation (Table 4). Rao (1983) and Rajkumar *et al.* (2003) did not find any difference in length-weight relationship of this species from Visakhapatanam. Muthiah (1994) reported insignificant difference in the regression co-efficient between sexes of *S. undosquamis* but significant in *S. tumbil* and *S. isarankurai.*

Growth parameters: The estimated values for L and K during 1997-1999 periods were 392 mm and 0.57 yr-1 respectively (Fig. 4). By von Bertalanffy's growth plot (Fig. 5) it was estimated that *S. undosquamis* reach 170 mm (CW) at the end of first year, 267 mm (CW) in second year and 321 mm (CW) at the end of third year. Longevity of the species from the present study was estimated to be 6 years. Along West coast of India, Chakraborty et al. (1994) and Muthiah (1994) reported similar growth rate for the species as 0.51 and 0.60 year-1 from Maharashtra and Karnataka waters respectively whereas Rajkumar *et al.* (2003) estimated comparatively lower growth coefficient of 0.31 year-1 from Visakhapatnam, East coast of India. Similar regional difference in growth rate for the fish stocks of same species were reported by Wright *et al.* (1986). In Thailand waters, L and K estimated for the species was 406 mm and 0.6 yr-1 respectively (Boonwanich, 1991) which is comparable to the results of present study. By using Longhurst and Pauly (1987) formula, the Φ' value was 2.94 and it is within the range of 2.82-3.42, described by Boonwanich (1991) in his review paper on the species.

Mortality and selection parameters: The total mortality coefficient (Z) estimated by 'linearized length-converted catch curve' was 1.88 (Fig. 6). The natural mortality coefficient (M) estimated by Pauly's (1980) formula was 0.6 and the fishing mortality coefficient (F) estimated was 1.28. The exploitation ratio (E) was 0.68. Along West coast of India, in early nineties the species was reported to be exploited optimally (Chakraborty *et al.,* 1994 and Muthiah, 1994) but during the present study, the species is found to be overexploited. The selection parameters L50, L75 obtained for the species by the probability of capture method were 186.3 mm and 215.6 mm respectively. Emax was estimated as 0.64 (Fig. 7) which is marginally lower than existing exploitation ratio (0.68). The present study showed that the exploitation during 1997-1999 was crossing the maximum Y/R level and addition of further fishing pressure will lead to lesser Y/R value.

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Table 1: Feeding intensity (%) and average volume of food per fish in relation to various years, months and maturity stages of males and females of *S. undosquamis* (Pooled 1988-2005)

	No of stomach	Male		No of stomach	Female		Average volume of food	
	analysed	Active (%)	Poor (%)	analysed	Active (%)	Poor (%)	(in ml) per fish	
							Male	Female
Year								
1988	45	33.3	66.7	52	20.8	79.2	2.43	3.41
1989	82	23.6	76.4	63	13.8	86.2	4.5	5.8
1990	33	16.2	83.8	62	115.6	54.4	7.68	14.7
1991	42	23.1	76.9	78	25.7	74.3	6.6	12.2
1992	57	12.8	87.2	78	15.7	84.3	5.4	11.7
1993	27	25.9	74.1	53	11.5	88.5	8.4	10.4
1994	32	13.9	86.1	47	17.0	83.0	6.4	11.7
1995	76	15.5	84.5	78	26.4	73.6	9.9	8.4
1996	36	8.8	91.2	10	22.2	77.8	5.4	7.0
1997	52	12.2	87.8	50	17.3	82.7	5.6	6.0
1998	13	8.3	91.7	34	21.9	78.1	4.7	12.7
1999	19	4.8	95.2	13	-	100.0	7.7	12.2
2002	12	18.2	81.8	37	22.4	77.6	3.5	8.6
2005	5	17.7	82.8	17	20.4	79.6	8.0	4.9
Pooled	531	17.6	82.4	672	22.2	77.8	6.1	8.9
Month								
January	58	10.3	89.7	82	22.0	78.0	5.3	9.3
February	70	8.5	91.5	75	28.0	72.0	6.5	8.6
March	100	23.0	77.0	151	22.2	78.8	5.1	7.3
April	77	23.4	76.6	104	9.6	90.4	5.8	8.3
May	52	5.8	94.2	67	16.4	83.6	5.6	5.4
June	17	27.4	70.6	8	12.5	87.5	3.0	3.6
July	16	18.8	81.2	4	0.0	100.0	5.2	2.3

August	19	26.3	73.7	26	42.3	57.7	7.4	8.0
September	40	22.5	77.5	57	36.9	63.1	8.0	13.1
October	29	17.2	82.8	53	24.6	75.4	4.2	12.8
November	24	20.5	78.5	31	25.8	74.2	6.7	11.7
December	21	19.0	81.0	22	22.7	77.3	6.0	16.0
Maturity stage								
I	102	17.7	82.3	87	13.8	86.2	2.6	3.6
II	134	23.9	76.1	203	17.7	82.3	5.5	7.1
III	107	25.9	84.1	71	21.2	78.8	8.2	11.3
IV	58	13.8	86.2	100	27.0	73.0	9.7	9.2
V	72	8.3	91.7	56	21.4	78.6	6.5	16.0
VI	13	0.0	100.0	14	14.3	85.7	5.7	7.1
VIIa	4	0.0	100.0	51	23.6	76.4	0.0	11.3
VIIb	3	0.0	100.0	35	28.6	71.4	0.0	16.6

Table 2: Feeding intensity, average volume of food per fish and relative importence of food item in *S.undosquamis* in relation to various size groups

Size group (mm)	No.of stomach	Male		Female		Average volume of food per fish (ml)		*Saurida* spp.	*Nemiptetus* spp.	*Decopterus* spp.	Other fishes	Crustaceans	Molluscus
		Active	Poor	Active	Poor								
	analysed	%	%	%	%	Male	Female						
100-119	6	33.3	66.7	-	100.0	1.5	1.6	-	-	-	100.0	-	-
120-139	4	42.9	57.1	-	100.0	2.7	-	-	-	-	100.0	-	-
140-159	36	25.0	75.0	-	100.0	2.2	0.6	28.6	14.2	-	28.6	28.6	-
160-179	68	15.5	84.5	13.0	87.0	2.7	2.9	16.0	4.0	-	40.0	24.0	16.0
180-199	144	19.1	80.9	15.0	85.0	4.3	4.4	8.3	3.2	3.2	41.0	24.6	19.7
200-219	229	13.1	86.9	22.6	77.4	4.3	7.0	2.6	6.2	21.2	42.5	8.8	18.7
220-239	254	17.1	82.9	21.0	79.0	6.8	7.9	9.5	4.2	13.5	36.4	5.2	31.2
240-259	186	22.2	77.8	21.1	78.9	7.5	9.8	9.5	9.5	7.9	27.0	9.6	36.5
260-279	88	16.7	83.3	26.6	73.4	9.3	12.6	7.9	10.5	18.4	26.4	2.6	34.2
280-299	74	13.6	86.4	30.8	69.2	10.4	14.4	12.9	12.9	12.9	29.0	12.9	19.4
300-319	22	-	-	53.3	46.7	3.5	20.1	-	23.1	23.1	15.4	-	38.4
320-339	13	-	-	9.0	91.0	-	12.2	-	-	50.0	25.0	25.0	-
340-359	6	-	-	33.3	66.7	-	12.7	16.7	16.7	50.0	16.6	-	-
360-379	4	-	-	0.0	0.0	-	2.5	-	100.0	-	-	-	-
380-399	3	-	-	6.7	83.3	-	12.0	-		-	100.0	-	-

Table 3: Index of preponderance of food items of *S.undosquamis* during 1988 - 2005

Food item	% Volume	% Occurrence	Index of preponderance
Fish:			
Decapterus spp.	23.71	13.6	23.8
Nemipterus mesoprion	8.54	7.57	4.77
Nemipterus japonicus	2.35	0.53	0.1
Saurida undosquamis	4.74	5.71	2.0
Saurida tumbil	3.21	2.88	0.68
Apgon spp.	1.72	2.15	0.27
Eels	1.34	1.41	0.14
Stolephorus spp.	0.95	1.19	0.08
Soles	0.52	0.95	0.03
Platycephalus spp.	0.42	0.95	0.03
Sciaenids	0.52	0.72	0.03
Carangids	0.32	0.95	0.02

Upenus spp.	1.45	0.23	0.02
Leiognathus spp.	0.48	0.71	0.02
Trichiurus spp.	0.45	0.47	0.01
Priacanthus hamrur	0.9	0.24	0.01
Puffer fish	0.81	0.24	0.01
Lactarius lactarius	0.19	0.23	0.01
Bregmaceros macclellandi	0.08	0.47	0.01
Fish eggs	0.07	0.47	0.01
Fish digested	12.83	21.33	20.2
Crustaceans:			
Solenocera spp.	0.63	2.14	0.1
Parpenaeopsis sculptilis	0.63	1.19	0.05
P. stylifera	0.26	0.24	0.01
Metapenaeopsis stridulans	0.52	0.95	0.03
Acetes spp.	0.16	0.95	0.01
Nemotopalaemon tenipes	0.1	0.24	0.01
Crabs	0.05	0.27	0.01
Prawn remain	1.24	4.06	0.37
Molluscs:			
Loligo spp.	29.18	21.72	46.77
Sepia spp.	0.58	0.95	0.04
Digested matter	1.04	4.29	0.33

Table 4: Sex ratio in *S. undorsqumis* in relation to various years months and size (pooled 1988-2005)

	No.of specimens Examined	Male : Female ratio	Chi - square
Year			
1988	97	1 : 1.13	0.37
1989	145	1 : 0.76	2.49
1990	95	1 : 1.87	8.85 *
1991	120	1 : 1.85	10.8 *
1992	135	1 : 1.36	3.27
1993	80	1 : 1.96	8.45 *
1994	79	1 : 1.47	2.85
1995	154	1 : 1.02	0.02

1996	46	1 : 0.27	14.69 *
1997	102	1 : 0.96	0.04
1998	47	1 : 2.61	9.38 *
1999	32	1 : 0.68	1.2
2002	49	1 : 3.08	12.75 *
2005	22	1 : 3.4	12.75 *
Total	1203	1 : 1.13	20.5 *
Month			
January	140	1 : 1.4	4.1
February	145	1 : 1.1	0.2
March	251	1 : 1.5	10.4 *
April	181	1 : 1.3	4.0
May	119	1 : 1.3	2.4
June	25	1 : 0.5	3.3
July	20	1 : 0.2	7.2 **
August	45	1 : 1.4	1.1
September	97	1 : 1.4	2.9
October	82	1 : 1.8	7.0 **
November	55	1 : 1.3	0.9
December	43	1 : 1.1	0.02
Size group (mm)			
100-119	6	1 : 1.1	0.2
120-139	9	1 : 0.3	2.8
140-159	35	1 : 0.5	3.4
160-179	75	1 : 0.5	7.1**
180-199	159	1 : 0.8	2.8
200-219	240	1 : 1	
220-239	258	1 : 1.4	6.2 **
240-259	175	1 : 1.8	14.9 *

260-279	100	1 : 2.6	19.4*
280-299	78	1 : 2.1	10.1*
300-319	27	1 : 2	3
320-339	12	1 : 5	5.3**
340-359	7	0 : 7	7.0 **
350-379	4	0 : 4	4
380-399	6	0 : 6	6.0**
400-419	1	0 : 1	1
* = Significant at 1% level		** = Significant at 5% level	

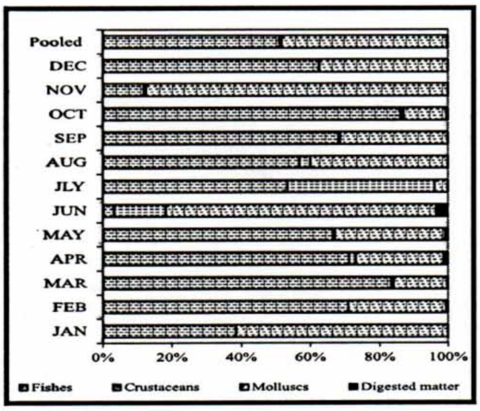

Fig. 1: Index of preponderance of main food items in *S.undosquamis* during 1988-2005

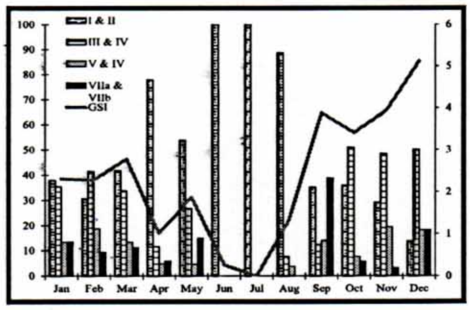

Fig. 2: Monthly percentage occurrence of females in different maturity stages and gonado-somatic index for *S. undosquamis*

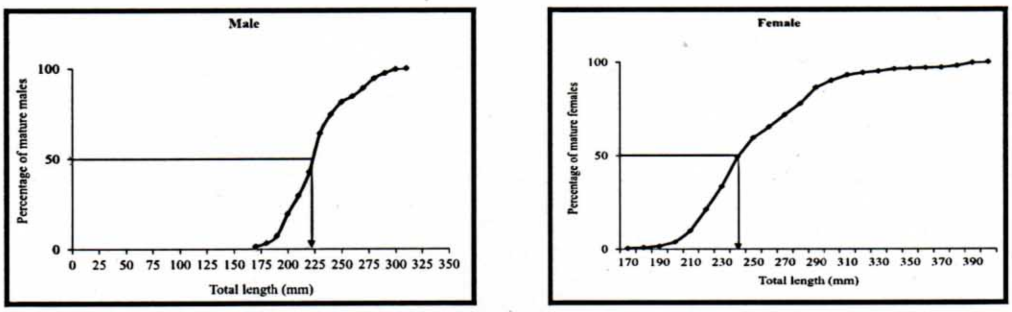

Fig. 3: Length at first maturity in male and female of *S. undosquamis*

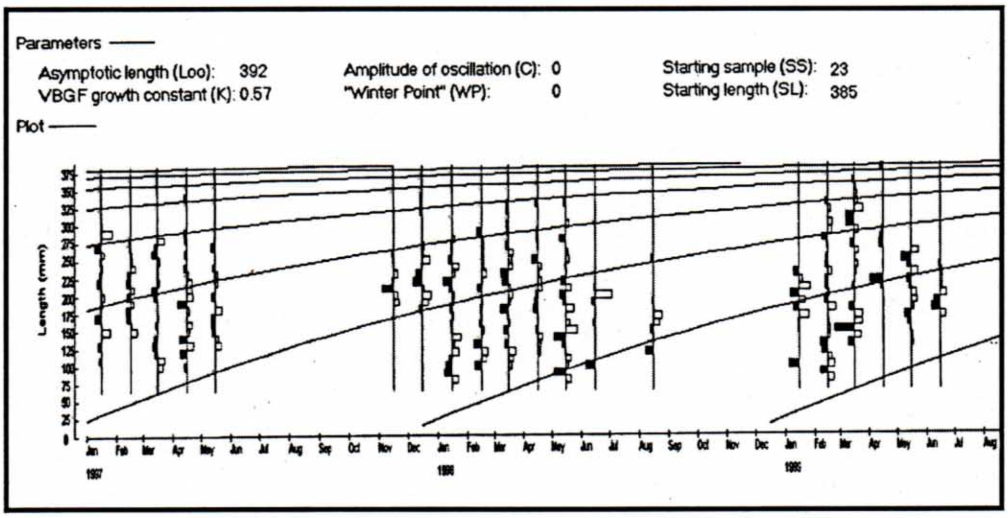

Fig . 4: Estimation of L_∞ and *K* of *S. undosquamis* using ELEFAN I method

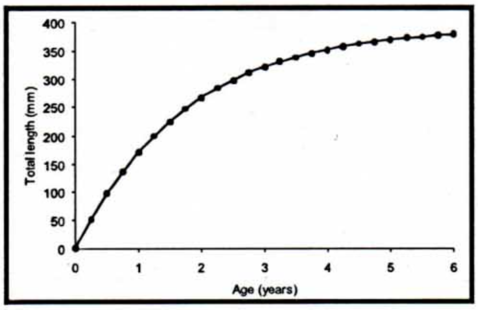

Fig. 5: Growth curve (VBG) of *S. undosquamis*

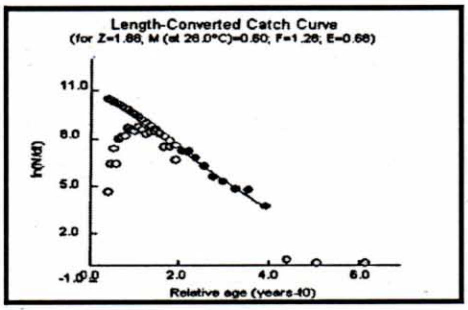

Fig. 6: Length converted catch curve of *S. undosquamis*

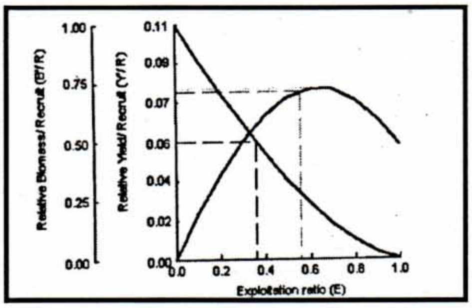

Fig.7: Yield per recruit analysis of *S. undosquamis*

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