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Lizardfish fishery, biology and population dynamics of *Saurida undosquamis* (Richardson) off Visakhapatnam

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ABSTRACT

The average annual estimated catch of lizardfishes off Visakhapatnam is 229 t, which formed 5.3% of the total landings during the period 1990-2001. Five species of lizardfishes are landed of which, *Saurida undosquamis* and *S. tumbil* are the dominant and contributed 88% to the total lizardfish landings of small trawlers. The fishery, biology and some aspects of population dynamics of *S. undosquamis* are studied. The estimated asymptotic length ($L\infty$) and growth constant (K) in *S. undosquamis* are 395 mm and 0.31 year $^{-1}$ respectively. The fish attained maturity at 230 mm, with spawning period extending from October to March. The estimated mortality rates Z, F, and M in the species are 1.81, 1.05 and 0.76 respectively. The exploitation rate (E) of *S.undosquamis* is 0.58.

Introduction

Lizardfishes are one of the important demersal resources off Visakhapatnam, caught by small trawlers and sona boats. Detailed information is available on various aspects of fishery and biology of *S. tumbil*, and *S. undosquamis* (Rao, 1981, 1982, 1983 a &b, 1984; Kuthalingam, 1959 and Sivakami, 1999). Similar studies on *S. undosquamis*, especially on the population dynamics are limited. Since *S. undosquamis* is the dominant species accounting for 54% of the lizardfish fishery off Visakhapatnam, an attempt was made to study the fishery and some aspects of population dynamics.

Materials and methods

Data on catch and effort were collected twice a week from commercial small trawlers off Visakhapatnam during 1990-2001. The monthly and annual estimated catches were determined as per the procedure adopted by Fishery Resource Assessment Division of Central Marine Fisheries Research Institute.

Size at first maturity (L_{50}) was determined by plotting the percentage of mature specimens (stage IV and above) against length. Percentage distribution of gravid and running females (V&VI) over time was considered for determining the spawning season (Pauly, 1983a). Length-weight relationship was estimated from $W = a L^b$ by logarithmic transformation. The difference between the slopes of the regression lines of males and females were tested by ANCOVA

(Snedecor and Cochran, 1961).

The von Bertalanfy growth parameters were estimated using FiSAT (Gayanilo Jr. *et al*., 1995). The data for the period 1998-2001 were pooled and analysed for the estimation of growth parameters. The total mortality rate (Z) was estimated from the length converted catch curve method (Pauly, 1983b), while natural mortality rate (M) was estimated from Pauly's empirical formula. The t_0 was considered as 0 (Sparre *et al*., 1989).

$\text{Log}_{10} M = -0.0066 - 0.279 \log_{10} L_\infty + 0.6543 \log_{10} K + 0.4634 \log_{10} T$

Where L_∞ and K are von Bertalanfy growth parameters

T= Surface sea water temperature ($27\ ^0C$)

The fishing mortality rate F was arrived at by Z - M. The exploitation rate was estimated by the ratio of fishing mortality / total mortality.

$E = F / F + M$

Yield/recruit was estimated from the relative yield / recruit model of Beverton and Holt (1957).

Results and discussion

Fishery

Lizardfishes are one of the major demersal fishery resources caught by small trawlers and sona boats off Visakhapatnam coast. The details of the catch and effort and percentage contribution to the total landings are presented in Table 1. Though there was a reduction in the number of units, the relative effort in hours increased. The reduced number of units and increased effort in hours indicate the extended fishing voyages in the later years of the study period. The average annual estimated landings of lizardfishes is 229 t, forming 5.3% of the small trawler landings. The annual estimated catch was highest (476 t) in 1990 and below 300 t in the subsequent years. The catch was lowest (57 t) in 1999 and after that the catches showed an increasing trend from the year 2000. The catch rate also followed similar trend as that of the annual landings. The average

TABLE 1: *Catch and effort data of lizardfishes off Visakhapatnam during 1990-2001 in small trawlers*

Years	Units	Hours	Catch (t)	CPUE (kg/unit)	Cph (kg/hr)	percent in total catch
1990	19699	314519	476.2	24.2	1.5	9.8
1991	21188	306836	270.4	12.8	0.9	5.1
1992	14180	220867	160.4	11.3	0.7	4.2
1993	14088	191701	200.6	14.2	1.0	5.3
1994	14232	205933	271.5	19.1	1.3	6.5
1995	10170	176454	163.0	16.0	0.9	4.9
1996	8998	146893	194.7	21.6	1.3	7.0
1997	10746	159491	258.5	24.1	1.6	9.0
1998	11602	240786	156.7	13.5	0.7	3.6
1999*	8215	225977	57.3	7.0	0.3	2.2
2000*	13874	507579	234.9	16.9	0.5	3.5
2001*	10702	292569	297.2	27.8	1.0	4.4
Average	13141	249134	228.4	17.4	0.9	5.3

* The data for the year is for 11 months since May is declared as closed season from 1999 onwards

catch rate was 0.9 kg/hr. The catch rate (Cph) and percentage contribution to the fishery ranged from 0.3 (1999) to 1.6 kg/hr (1997) and 2.2 (1999) to 9.8 percent (1990) respectively (Table 1). The fishery in the later parts of the period was poor as indicated by the decreased landings, Cph and percentage contribution to the total landings. The annual landings decreased during the study period compared to that of eighties (Luther *et al.*, 1988) when it was 625 t per year.

Seasonal abundance

The Cph of lizardfishes in different months during the period 1990-2001 (monthly average) is presented in Table 2. The Cph ranged from 0.6 in March to 2.2 kg in May. During May fishing ban was imposed by local authorities from 1999 onwards as a measure of conservation. During May the average number of units operated were more but, the effort put in (trawling hours) was less and hence the sharp rise in Cph. Constant catch rate was observed from September (1.2) to January (0.9) and this period may be considered as the peak period of abundance for lizardfishes.

Species composition

Five species of lizardfishes were landed during 1990-01. *S. undosquamis* (54%) was the dominant followed by *S. tumbil* (34%), *S. micropectaralis* (8%), *Trachynocephalus myops* (3%) and *S. longimanus* (1%). *S. tumbil* and *S. undosquamis* contributed to the fishery throughout the year. The dominance of these two species along Indian coast was reported by Rao (1983) and Nair *et al.* (1992). Luther *et al.* (1988) reported the dominance of *S. tumbil* (65%) and *S. undosquamis* (35%) in trawl landings off Visakhapatnam during 1980s. Rao (1984) reported the dominance of *S. tumbil* in northwestern Bay of Bengal and *S. tumbil* and *S. undosquamis* together contributed up to 90% of the catch from that region.

Biology of S.undosquamis

Food and feeding : A total of 502 specimens collected from January 2000 to December 2001 were examined for gut contents. The stomach contents were divided into empty/little, half full, full and gorged based on the fullness of the stom-

TABLE 2: *Average monthwise catch during 1990-01 in small trawlers*

Months	Units	Hours	Catch (t)	CPUE (kg/unit)	Cph (kg/hr)	percent in total catch
Jan.	842	19691	17.3	20.5	0.9	5.8
Feb.	957	18998	14.9	15.5	0.8	4.3
Mar.	1083	17843	10.2	9.5	0.6	3.3
Apr.	1345	11332	8.3	6.2	0.7	3.0
May*	1906	11173	24.0	12.6	2.2	6.9
Jun.	1007	20701	14.6	14.5	0.7	4.8
Jul.	1363	34479	32.1	23.6	0.9	6.5
Aug.	1227	25338	21.0	17.1	0.8	5.7
Sep.	1162	28151	32.4	27.9	1.2	6.6
Oct.	900	19983	19.7	21.9	1.0	5.1
Nov.	781	16867	15.2	19.5	0.9	4.6
Dec.	1046	27373	24.8	23.7	0.9	5.7
Pooled	13618	251927	234.5	17.4	0.9	5.3

* The data for May is for 9 years only since May is declared as closed season from 1999 onwards

ach. *S. undosquamis* is a carnivore, feeding predominantly on fishes, crustaceans and cephalopods. Fishes formed the major food item forming about 70% of the stomach contents. The major fish species observed in descending order of occurrence were *Sardinella* spp, *Stolephorus* sp., *Pentaprion* sp., *Rastrelliger kanagurta*, *Upeneus* spp., *Leiognathus* spp., *Nemipterus japonicus*, *Apogon* sp. etc. The crustaceans were prawns such as *Acetes*, *Metapenaeus* sp., *Solenocera* sp., and juvenile crabs. The squid, *Loligo duvacelli* was the common cephalopod. Similar observations on the gut contents of *S.undosquamis* were made by Rao (1981) and Sivakami (1999).

Length at first maturity : A total of 278 female specimens collected during 2000-01 were used to determine the length at first maturity (L_{50}). The length at first maturity of *S. undosquamis* was 230 mm (Fig. 1). Rao (1983) observed the size at first maturity of *S. undosquamis* as 240 mm, which was almost similar to

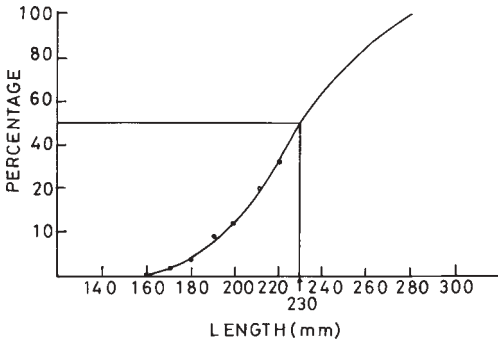

Fig. 1. Length at first maturity of *S. undosquamis*

the present study. Rao *et al.* (1988) also reported similar findings (240 mm) off Mangalore coast, whereas Sivakami (1999) reported lower length (200 mm) at first maturity. The fish attains maturity in the middle of the third year of life.

Spawning : A total of 276 females were studied for determining the spawning season. The spawning season extended from October - February with a peak in December. Rao (1983) reported similar spawning season for *S. undosquamis* (October-March) with peak in November – December in the north-western part of Bay of Bengal. Sivakami (1999) observed the spawning period from September to December from Cochin waters.

Length -Weight Relationship : A total of 466 (170 male and 296 female) specimens in the range of 90-240 mm of total length and 26-174 g weight were used for determining the length-weight relationship. The relationship for male and female are:

Male: log W= log - 5.4255 + 3.1155 x log L or

$W= 0.000003754 \times L^{3.1155}$. (r = 0.94)

Female: log W= log - 5.311 + 3.0689 x log L or

$W= 0.000004887 \times L^{3.0689}$. (r = 0.96)

The two regression lines were tested by ANCOVA for difference in slopes. Since there is no significant difference between the slopes, a combined relationship was considered for male and female (Table 3).

log W= log - 5.1025 + 3.1025 x log L or

$W= 0.000003754 \times L^{3.1025}$. (r = 0.96)

Rao (1983) reported the length weight relationship in *S. undosquamis* as $W= 0.005811 \times L^{3.038}$.

Population dynamics

Age and growth : A total of 1650 fishes in the range of 110-310 mm in total length were used for estimation of growth parameters. The estimated VBGF

TABLE 3: *Comparison of regression lines of length-weight relationship of males and females of* S. undosquamis *off Visakhapatnam*

Source	df	ΣX^2	ΣXY	ΣY^2	b	Deviation from Regression			F
						df	SS	MSS	
Within									
Males	169	1.7753	5.5309	19.5156	3.115	168	2.284	0.01360	
Females	295	5.6901	17.4613	57.7465	3.069	294	4.163	0.01416	
						462	6.447	0.01393	
Pooled	464	7.4654	22.9922	77.2621	3.080	463	6.450	0.01393	0.21
Between slopes						1	0.003	0.00297	
Between	1	1.1668	3.7894	12.3073					
Total	465	8.6322	26.7816	89.5694	3.103	464	6.479	0.01396	2.04
Between adjusted means						1	0.028	0.02848	

* F value is not significant at 1% level.

parameters of *S. undosquamis* were asymptotic length ($L\infty$) 395 mm and growth constant K= 0.31 year $^{-1}$ (Fig. 2).

The VBGF for *S. undosquamis* is

$L_t = 395\ (1\text{-}e^{-0.31(t)})$

The fish attained a size of 105 and 182 mm at the end of 1st and 2nd years respectively. Chakraborty *et al.* (1994) and Muthaiah (1996) reported faster growth rates, viz., 0.51 and 0.64 year^{-1} respectively for *S.undosquamis* from Maharashtra and Karnataka coasts (Table 4). Ingles and Pauly (1984) observed $L_?$ and K for the species to be 305 mm and 0.80 year^{-1} from Philippine waters. Tsi-Shiang *et al.* (1987) reported slower growth rate 0.13 and 0.12 yr^{-1} for male and female respectively from Australian waters. The varied growth rates may be due to the environmental conditions, availability and competition for food and exploitation. The regional differences in growth rate for the fish stocks were reported by Wright *et al.* (1989).

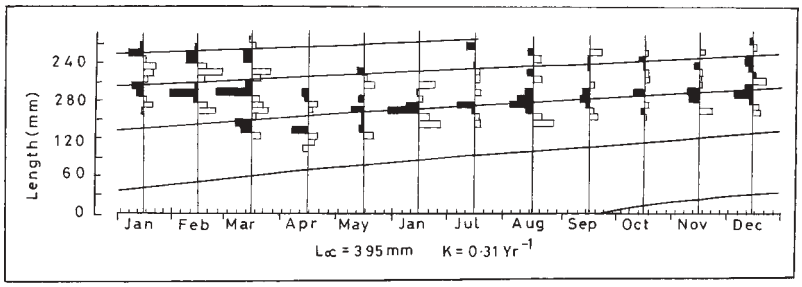

Fig. 2. Restructured growth curve of *S. undosquamis* off Visakhapatnam

Recruitment : The recruitment pattern obtained from FiSAT indicates an unimodal, protracted period from April to August with a peak in July (Fig. 3). Peak spawning was observed in December and recruitment to the fishery occurs at the end of the first year. Varying recruitment strengths result from year -to-year variations in reproductive effort or success, as well as variations in the survival or settlement of larvae and juveniles. Recruitment patterns obtained by the FiSAT programme give only approximate results as it is based on several assumptions. The results however suggest that recruitment pattern contain useful information from which legitimate inferences on the dynamics of fish stock can be drawn.

Mortality : Estimation of mortality

TABLE 4: *Population parameters of* S. undosquamis

Sr. No.	Area	L∞(mm)	K/yr	Z	M	F	E	Author
1	Maharashtra	420	0.51	2.52	1.10	1.42	0.56	Chakraborty *et al.* 1994
2	Karnataka	360	0.64	2.62	1.31	1.31	0.5	Muthaiah, 1996
3	Philippines	305	0.80	4.07	1.54	2.53	0.62	Ingles and Pauly, 1984
4	Australia	599 (male)	0.123	-	-	-	-	Tsi-Shiang *et al.* 1987.
		589 (female)	0.121	-	-	-	-	
5	Visakhapatnam	395	0.31	1.81	1.05	0.76	0.58	Present study

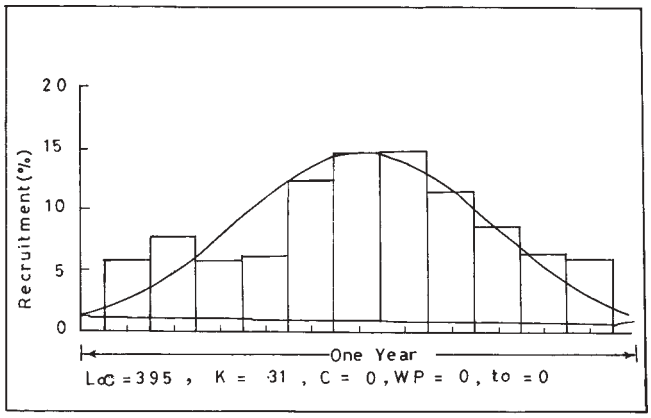

Fig. 3. Recruitment pattern of *S. undosquamis* off Visakhapatnam

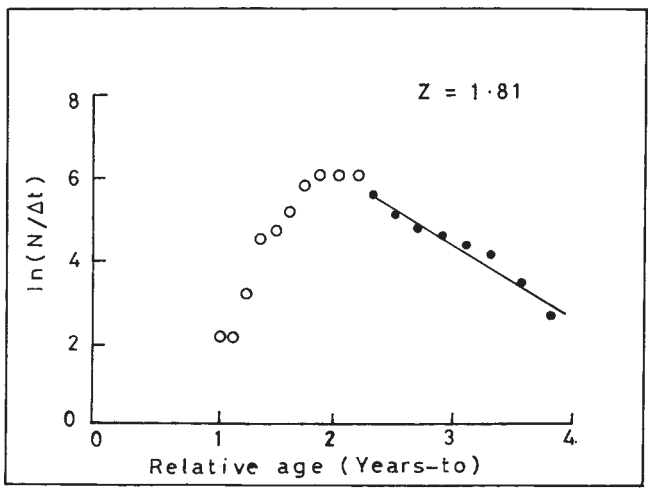

Fig. 4. Length converted catch curve of *S. undosquamis* off Visakhapatnam (1998-2001)

rates is an important criterion for fisheries management. The estimated values of total mortality (Z), fishing mortality (F) and natural mortality for *S.undosquamis* are 1.81, 1.05 and 0.76, respectively. Fig. 4 shows the length converted catch curve for *S.undosquamis*. Chakraborty *et al.* (1994), Muthiah (1996) and Ingles and Pauly (1984) reported higher mortality rates for the species (Table 4).

Yield/Recruit : The exploitation of the resource is measured in terms of exploitation rate (E=F/ F+M). The exploitation rate (E) in the present study is 0.58. The present exploitation rate of the resource is more than the E_{max} 0.48. The optimum yield per recruit is 1.7 gm and biomass per recruit is 0.27 g (Fig. 5). The optimum yield & biomass per recruit can be maintained by reducing the exploitation rate up to 0.3. Chakraborty *et al.* (1994) and Muthaiah (1996) reported lower exploitation rates for

S.undosquamis, while Ingles and Pauly (1984) reported higher E (Table 4) than the present study. The exploitation rate is on higher side, which may be detrimental to the resource. The reduction in the number of units and decrease in effort will improve the status of the resource.

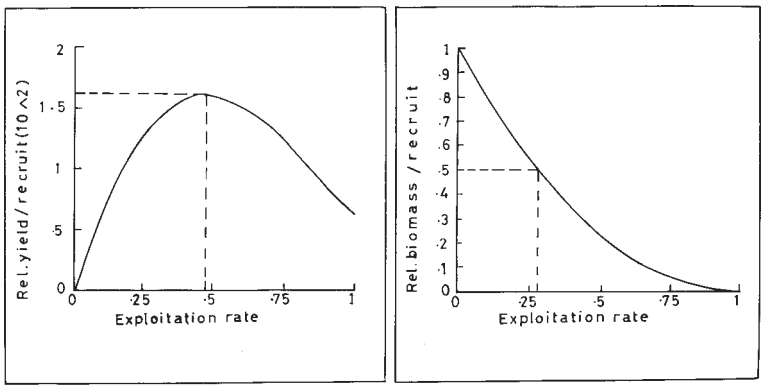

Fig. 5. Yield/recruit and biomass/recruit of *S. undosquamis* off Visakhapatnam (1998-2001)

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References

Beverton, R. J. H and S. J. Holt 1957. On the dynamics of exploited fish populations. *Fish. Invest. Ser. London*, **19**: 553 pp.

Chakraborty, S. K, V. D. Desmukh, M. Zaffarkhan, K. Vidyasagar and S. G. Raje 1994. Estimtes of growth, mortality, recruitment pattern and MSY of important resources from the Maharashtra coast. *Proc. Nat. Symp. Aquacrops*, 1-39.

Gayanilo, F. C. Jr., P. Sparre and D. Pauly 1995. FAO-ICLARM Stock Assessment Tools (FiSAT) User's Manual. *FAO Comp. Info. Ser. (Fisheries)*, **8**: 126 pp

Ingles, J. and D. Pauly 1984. An atlas of the growth, mortality and recruitment of Philiphine fishes. *ICLARM / Tech. Rep.*, **13**: 127pp.

Kuthalingam, M. D. K. 1959. *Saurida tumbil* (Bloch): development and feeding habits. *J. Zool. Soc. India*, **1**(2): 115-129.

Luther, G, T., S. Appa Rao, Y. Rueben, M.V. Appanna Sastry, Somaraju and K. Radhakrishna 1988. Marine Fish Calendar. 20. Visakhapatnam. *Mar. Fish. Infor. Serv., T. & E. Ser.*, **80**: 1-21.

Muthaiah, C. 1996. *Studies on the fishery and biology of lizardfishes Saurida spp., from the Karnataka coast*. P.hd thesis, Karnataka University, Karwar. 185pp.

Muthaiah C. and B. Neelakantan 1997. The lizardfish fishery along the Karnataka coast. *J. Mar. Biol. Ass. India*, **39** (1&2) : 97-107.

Nair, K. V. and R. Reghu 1990. Studies on the threadfinbreams and lizardfish resources in the Exclusive Economic Zone of India based on the demersal trawling operation of FORV Sagar Sampada. *Proc. First Workshop Scient. Resul. FORV Sagar Sampada, 5-7 June*, 1989, p. 239-255.

Nair, K. V., D. Vinay, D. Deshmukh and S. G. Raje 1992. Present status of exploitation of fish and shell fish resources; lizardfish. *Bull. Cent. Mar. Fish. Res. Inst.*, **45**: 169-181.

Pauly, D. 1983a. Some simple methods for the assessment of tropical fish stocks. *FAO Fish. Tech. Paper*, No. 243, 52pp.

Pauly, D. 1983b. Length converted catch curves. A powerful tool for fisheries research in tropics (Part -I). *ICLARM Fishbyte,* **1**(2): 9-13.

Rao, K.V., C. Muthaiah and Madan Mohan 1988. Marine fish calendar, Mangalore. *Mar. Fish. Infor. Serv., T. & E. Ser.,* 79.

Rao, K.V.S. 1981. Food and feeding of lizardfishes (*Saurida* spp.) from north western part of Bay of Bengal. *Indian J. Fish*., **28**(1&2): 47-64.

Rao, K.V.S. 1982. Studies on the population of *Saurida tumbil* (Bloch) from Indian waters. *Indian J. Fish*., **29**(1&2): 8-19.

Rao, K.V.S. 1983 a. Maturation and spawning of lizardfishes (*Saurida* spp.) from northwestern part of Bay of Bengal. *Indian J. Fish*., **30**(1): 27-54.

Rao, K.V.S. 1983 b. Length weight in *Saurida tumbil* and *S. undosquamis* and relative condition in *S. tumbil*. *Indian J. Fish*., **30**(2): 296-305.

Rao, K.V.S. 1984. Age and growth of lizardfishes (*Saurida* spp.) from the north western Bay of Bengal. *Indian J. Fish*., **31**(1): 19-30.

Showers, P. A. T. 1996. Comparative growth performance for species of the family clupeidae, of sierra Leone. *NAGA, The ICLARM quarterly*, **19** (4): 42-45.

Sivakami, S. 1999. Fishery of lizardfishes off Cochin with a note on the biology of *S. undosquamis* (Richardson). *The fourth Indian fisheries Forum Proceedings, 24-28 November*, 1996. Kochi. P. 245-248.

Sparre, P.,E.Ursine and S.C.Venema 1989. Introduction to tropical fish stock assessement. *FAO Fisheries Technical Paper*, 337pp.

Snedecor, G. W. and W.G. Cochran 1967. *Statistical Methods.* 593pp.

Tai-Shiang Wen, His – Chiang Liu, and Sheanya-yeh 1987. Age and growth of lizardfish *Saurida undosquamis* (Richardson) in the north-west shelf off Australia. *Acta Oceanographica taiwanica,* **18**: 1-15

Wright, P. J, N. G. Willouby and A. J. Edwards 1989. Growth, size and age composition of *Stolephorus heterolobys* in north central Java. *Tuna bait fish in the Indopacefic region. ACIAR proceedings,* **30**: 142-146.