

**FISHERY AND BIOLOGY OF WHITE SARDINE, *ESCUALOSA THORACATA* (VALENCIENNES) AT VERSOVA, BOMBAY**

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**ABSTRACT**

Gill net fishery exclusively for the white sardine, *Escualosa thoracata*, which started in mid eighties at Versova, is described. During 1987-88 to 1991-92 period the annual average landing of the species was 202.2 tons with year to year fluctuations. The peak fishing season was during April-May. The size range of the species in the gill net was 41-105 mm and the von Bertalanffy growth parameters,  $L_{\infty}$  and K, estimated by the ELEFAN programme were 110 mm and 1.8 per year. The length-weight relationship was  $W = 0.000001508 L^{3.3946}$  for the males and  $W = 0.000002561 L^{3.2706}$  for the females. The food consisted of copepods, cladocerans and crustacean larvae. The size at maturity for the females was 82 mm and spawning took place during October - February period. The sex-ratio showed equal proportion except during January, July and October when females dominated in the catch.

**INTRODUCTION**

The white sardine, *Escualosa thoracata* (Valenciennes) is a shoaling clupeid, inhabiting shallow coastal waters of India. Although it is reported in small quantities from most of the coastal waters of the country, it supports economically important fishery only along the southwest coast of India (Nair, 1951).

Along the Bombay coast it was occasionally caught by means of drag nets, cast nets and dol nets operated in shallow creeks, but it did not support a regular fishery until 1984-85, when an enterprising fisherman from the South demonstrated operation of a small meshed gill net

at Versova for catching this resource. With the encouraging catch returns, the fishermen of Versova village commenced fishing operations along the shallow coastal waters of Bombay. Ever since the fishery is well established with about 65 mechanised and non-mechanised boats engaged in the fishery. The fish is locally called Bhilji or 'Motaka' due to its shining silverywhite appearance.

The fishery and biology of the species for the Indian waters were reported by Devanesan and John (1941), Chidambaram and Venkataraman (1946), Devanesan and Chidambaram (1948), Mookerjee and

Bhattacharya (1950), Nair (1951), Dutt (1971), Dutt and Rao (1981) and Shivaprakasha and Joseph (1988).

As regular fishery was established at Versova only recently, there is no report of a white sardine resource along the coast. Therefore, an investigation was carried out on the fishery and biology of *E.thoracata* along the Bombay coast.

## MATERIAL AND METHODS

The catch and effort data were collected once a week by observing 15-20 boats landed at Versova landing centre from July 1987 - June 1992. For biological study samples of fish were collected on the observation day and preserved in 5% formalin for further analysis. The data obtained on each observation day were weighted to get the estimates for that day and the pooled days' estimates were weighted to get monthly estimated catch, effort and length composition.

The length data were grouped into 5 mm class intervals and ELEFAN I computer programme of Pauly and David (1981) was used for the estimation of growth parameters.

The length-weight relationship was calculated following Le Cren (1951) and the differences between relationships of males and females were tested using Analysis of covariance (Snedecor and Cochran, 1967). Maturity stages were ascertained on the basis of micro-

scopic examination of intraovarian eggs. The feeding intensity was assessed by noting stomach 'with food' and stomach without food as empty.

## RESULTS

### Fishery

At Versova about 60-65 mechanised and non-mechanised plank built boats and dugout canoes are engaged in 'Bhiljee' fishery. These boats are also used for lobster traps, cast net and hand trawl fishing whenever lobster, pomfret and prawns are in abundance. The Bhiljee net is a drift gill net of 18-22 mm mesh of 25-30x2 m size. Each boat carries about 40-50 pieces of the net and operate in 10-12 m depth. The net is paid before the day break and about half an hour after the sun rises, it is hauled and the boats return to the landing centre. The catch consists mostly of white sardine.

During 1987-92 the average annual catch of *E. thoracata* was 202.2 tons with the catch rate of 54.5 kg/unit (Table 1). The annual landing of the species fluctuated from 327.8 tons (47.7 kg/unit) in 1987-88 to 93.9 tons (56.1 kg/unit) in 1991-92. The monthly average catch varied from 1.7 tons in September to 54.0 tons in April with catch rate of 31.52 kg/unit and 79.55 kg/unit respectively (Fig.1) The average catch and catch rate indicated that the peak period of abundance is in April and May.

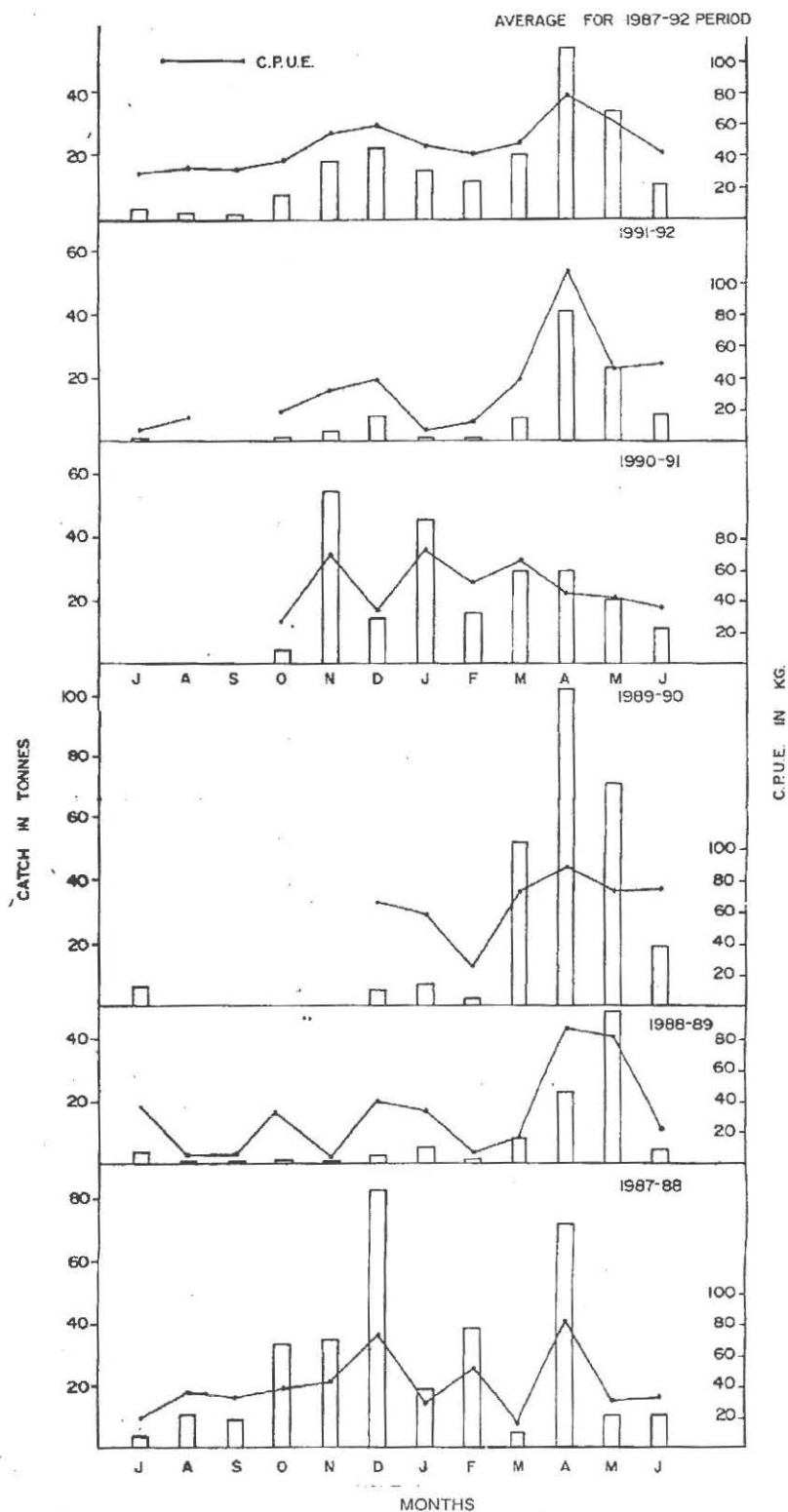


Fig. 1 : Monthwise catch and C.P.U.E. of *E. thoracata*

Table 1 : *Estimated efforts (number of units) catch (in kg) and catch rate (kg/unit) of E.thoracata during July 1987 to June 1992.*

Year	Effort	Catch	Catch rate
1987-88	6875	327.8	47.7
1988-89	2170	98.5	45.4
1989-90	3614	266.7	73.8
1990-91	4208	223.9	53.2
1991-92	1675	93.9	56.1
Average	3708	202.2	54.5

### Age and growth

For age and growth study 1,036 fishes collected from July 1987-June 1989 were measured for the total length. Samples were available in both the years excepting for September 1987, August, September and November 1988. The monthwise length frequency data raised to the monthly catch were used for the estimation of the parameters of VBGF. With the assumption that growth is similar from year to year, the monthwise data in two years were pooled together so as to represent 12 months of only one year excepting for September, when size frequency data were not available during both the years.

Monthwise pooled length-frequency data restructured by ELEFAN I programme and the optimum growth curve are shown in Fig.2. The optimum value of  $R_n = 0.368$  was obtained with the starting samples of June and starting length of 72.5 mm for  $L_\infty = 110$  mm and  $K = 1.80/\text{year}$ . The programme does not estimate the third parameter  $t_0$  of VBGF, hence it was assumed to be equal to zero. Using these

parameters the growth can be expressed as :

$$L_t = 110 [1 - e^{-1.8(t)}]$$

From the VBGF expression it is estimated that the fish reaches 65.3 mm size in 6 months and 91.8 mm in one year. The maximum size of 105 mm observed during the present investigation may be attained in 1.7 years.

The mainstay of the fishery is supported by the sizes between 75-95 mm hence it is deduced that the fishery is mostly supported by zero year class. The life span of the fish in Bombay waters is about 1.7 - 1.8 years only.

Length-weight relationship : This relationship was calculated based on the data of 472 males ranging from 43-103 mm in total length, weighing from 0.50 to 9.73g and 640 females ranging from 39-105 mm in total length and 0.45 - 11.66 g in weight. The relationships for the two sexes were :

$$\text{Males : } W = 0.000001508 L^{3.3946}$$

$$\text{Females : } W = 0.000002561 L^{3.2706}$$

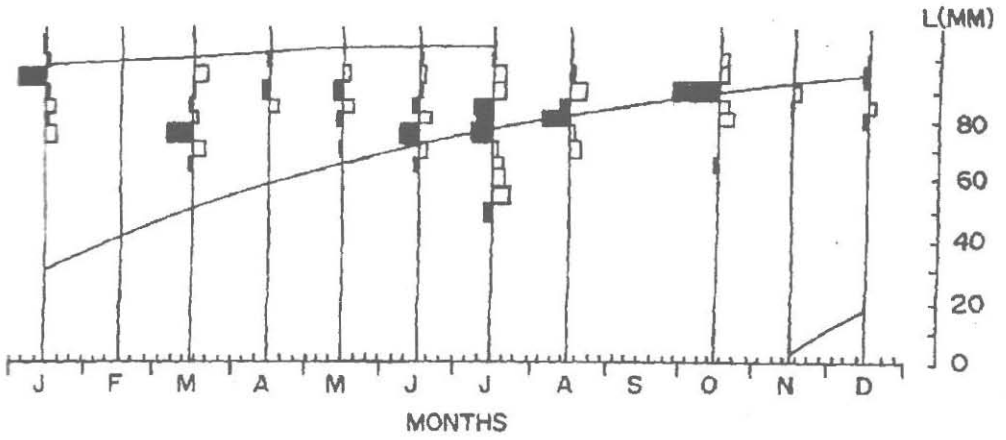


Fig. 2 : Restructured length-frequency data and growth curve for *E. thoracata*

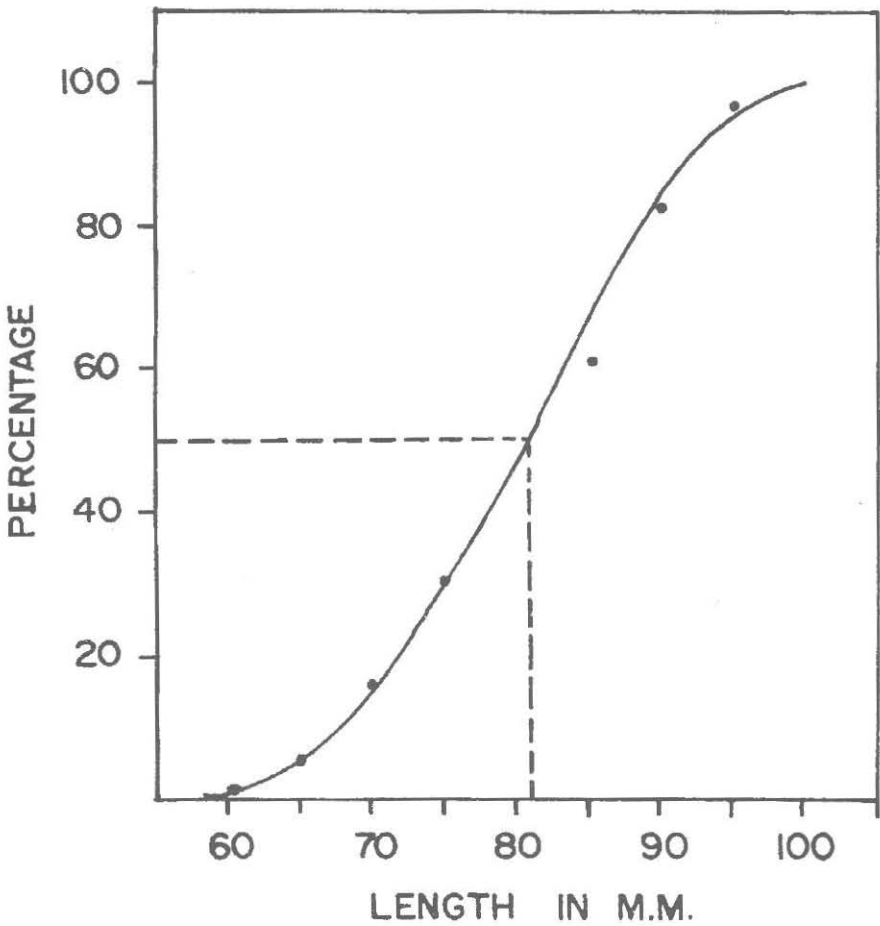


Fig. 3 : Size at first maturity in *E. thoracata*

The exponents for males and females were compared by analysis of covariance and it was found that the differences in relationships were significant at 1% level in the slope (Table 2). Hence common length weight relationship is not applicable to the two sexes.

#### Size of maturity

To determine the size at first maturity, females in stages III-VI were considered to be mature. The smallest mature female (stage III) was recorded from 64 mm length (Fig.3). The maturity curve showed that 50% of the females mature at the length of 82 mm, which is considered to be the size at first maturity in females. Chidambaram and Venkataraman (1946) have reported the size at first maturity in females of *C.koval* as 80 mm which conforms to the present investigation.

#### Spawning

To determine the spawning period only females were taken into account. The percentage composition of females in various maturity stages in different months was analysed (Table 3). The occurrence of specimens in stage III and IV in the highest percentage from October-January and specimens in V and VI during January and February suggests that the population of *E.thoracata* spawns from October to February in Bombay waters. Devanesan and John (1941) also reported that spawning season roughly ranges between the months of November and February along the West coast of India.

#### Sex ratio

The study of sex-ratio in the population of *E.thoracata* in relation to different months is shown in Table 4. The sex-ratio for the entire period

Table 2 : Comparison of regression lines of length-weight relationship of males and females of *E.thoracata*.

Source of variation	DF	Regression co-efficient	Deviation from regression		
			DF	SS	MS
Within Males	471	3.39446	470	5.64005	0.01200
Within Females	639	3.27064	638	7.81516	0.01225
			1108	13.45521	0.01214
Pooled (within)	1110	3.32045	1109	13.54903	0.01222
Difference between slopes			1	0.09382	0.09382
Total	1111	3.32052	1110	13.56651	0.01222
Between adjusted means			1	0.01748	0.01748

Comparison of slopes : 7.72817 ( $df = 1,1108$ ) significant at 1% level

Comparison of elevations :  $F = 1.43044$  ( $df = 1,1109$ ) not significant

Table 3 : *Monthly percentage frequency distribution of females of E.thoracata at different stages of maturation from May 1987 to February 1992 (pooled).*

Months	No. of specimens	% of maturation stages		
		I & II	III & IV	V & VI
January	82	--	91.46	8.54
February	72	52.78	43.05	4.17
March	69	49.28	50.72	--
April	112	64.28	35.72	--
May	88	94.31	5.69	--
June	50	90.00	10.00	--
July	90	97.77	2.23	--
August	9	55.56	44.44	--
September		No data		
October	40	--	100.00	--
November	14	--	100.00	--
December	57	--	100.00	--

Table 4 : *Sex ratio of E.thoracata in different months for the period 1987 to 1992*

Months	No. of specimens examined	Males	Females	Male:Female	Chi-square
January	137	55	82	0.67:1	5.3 **
February	139	67	72	0.93:1	0.18
March	126	57	69	0.82:1	1.14
April	221	109	112	0.97:1	0.04
May	163	75	88	0.85:1	1.04
June	102	52	50	1.04:1	0.04
July	155	65	90	0.72:1	4.03 **
August	15	6	9	0.67:1	0.60
September	--	--	--	--	--
October	64	24	40	0.60:1	4.00 **
November	24	10	14	0.71:1	0.67
December	104	47	57	0.82:1	0.96
Pooled	1250	567	683	0.83:1	10.76 **

\* *Significant at 1% level*\*\* *Significant at 5% level*

of observation was statistically significant with 0.83:1 showing significant departure due to preponderance of females. Monthwise sex-ratio showed significant differences in January, July and October with preponderance of females

#### Food and feeding

The food and feeding studies of *E.thoracata* is based on 1250 specimens. Since the size of stomach of the fish is extremely small, quantitative estimation of feeding intensity was not possible. In the occurrence method followed in the present study, the number of guts containing a particular item of food were expressed as a percentage of total number of guts examined (Hynes, 1950).

It is seen that empty stomachs occurred in high percentage (89.92%) of the total stomachs examined. (Table 5). It may also be seen that the incidence of empty stomachs was always higher in all the months and found to range from 73.3 in August to 97.74% in April.

Copepods, cladocerans, crustacean remains and crab larvae formed the main food items of *E.thoracata* (Table 6). The occurrence of copepod was higher in January-February and April-June while cladocerans were maximum in June and December. The crustacean remains formed an important constituent of food in most of the months and crab larvae were observed in January and May.

Table 5 : Percentage occurrence of stomachs of *E.thoracata* with food and empty stomachs from May 1987 to February 1992 (pooled).

Months	No. of fish examined	Fish with food	Fish with empty stomach
January	137	34.31	65.69
February	139	6.48	93.52
March	126	2.38	97.62
April	221	2.26	97.62
May	163	6.13	93.87
June	102	6.86	93.14
July	155	7.74	92.26
August	15	26.67	73.33
September	--	--	--
October	64	6.25	93.75
November	24	4.17	95.83
December	104	23.08	76.92
Total	1250	10.08	89.92



Table 6 : *Percentage occurrence of different food items in E.thoracata during 1987-92.*

Food items	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Copepods	32.05	45.46	--	20.00	33.34	25.00	14.29	--	--	14.29	--	20.51
Cladocerans	21.79	18.18	--	--	20.00	37.50	23.81	--	--	14.29	--	28.21
Crustacean remains	17.95	9.09	25.00	--	13.33	--	14.29	--	--	14.29	--	20.51
Crab larvae	3.85	--	--	--	13.33	--	--	--	--	--	--	--
Digested matter	24.36	27.27	75.00	80.00	20.00	37.50	47.61	100.00	--	57.13	100.00	30.77

## DISCUSSION

Despite various gears used along the coast of Bombay for pelagic resources such as Bombay duck, pomfret, *Coilia* and non-penaeid prawns, the white sardine resource remained nearly untapped in the region. The drift gill nets operated in the region for pomfret, seer fish etc. have larger mesh size of 50 - 140 mm and therefore the net is unable to catch this small sized fish. Raje and Deshmukh (1989) noticed that the dol nets used in the region are generally operated beyond 10-15 m depth zone, therefore, this highly shallow water resource (Nair, 1972) is not available in the dol nets whereas those operated in creeks are able to exploit it to some extent. The demonstration of a small meshed gill net (Bhilji net) for *E.thoracata* thus proved useful.

The operation of this net is in the early morning hours at sunrise to harvest maximum may be attributed to the feeding behaviour of the fish. The gut analysis of the fish showed that it feeds mainly on planktonic crustacean such as copepods, cladocerans and crab larvae. These organisms undergo diurnal migrations and their density increases in early hours (Gajabhiye *et al.*, 1984). In order to feed on these organisms the shoals of white sardine come to the surface in the morning hours and are easily caught by the drift gill nets. Occurrence of large percentage of fish with empty stomachs observed in the present

investigations also lends support to this view.

Mookerjee and Bhattacharya (1950) studied the age and growth of the young sardine, *Clupea lile* (*E.thoraceta*) from Canning river, West Bengal and stated that the fish with a mean length of 25 mm in April reached an average length of 72 mm in October thereby showing growth rate of 7.83 mm per month. Nair (1951) reported from the length frequency analysis of the same at West Hill, Calicut on the west coast that in the commercial fishery there is mostly one mode at 105 mm and this unimodal nature of size frequency represents only one age group. He remarked that this size class which dominates the fishery every successive year is the stock recruited during the previous spawning season and inferred that the average life span of the white sardine is about one year and only a relatively small number survive for a longer period. He further remarked that the new stock recruited during the intensive spawning period extending from November-January apparently grows to a size of about 100-110 mm and dominates the best part of white sardine season from September to November every year. The present investigation also indicates that in Bombay waters *E.thoracata* has spawning period extending from October-February and the new recruits grow to a size of 91.8 mm in one year but the sizes between 75-95 mm dominate the

fishery throughout the year. The fish exhibits an average monthly growth rate of 7.65 mm which is close to that of Mookerjee and Bhattacharya (1950) as well as Nair (1951).

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#### REFERENCES

- Chidambaram, K. and Venkataraman, R.S.** 1946. Tabular statements on the natural history of certain marine food fishes of the Madras presidency. *West Coast Govt. Press, Madras*, 1-26.
- Devanesan, D. W. and Chidambaram, K.** 1948. The Common Food fishes of the Madras Presidency. Government Press, Madras : 79 p.
- Devanesan, D.W. and John, V.** 1941. On the natural history of *Kowala thoracata* (Cuv. and Val.) with special reference to its gonads and eggs. *Rec. Indian Mus.* **43** : 215-216.
- Dutt, S.** 1971. On 'Kowala thoracata' Cuvier and Valenciennes of Cantor (1950) *J.mar. biol. Ass. India.* **13** (1&2) : 145-146.
- Dutt, S. and Rao, B.V.S.** 1981. Biometric comparison of samples of the Clupeoid fish, *Esculosa thoracata* (vol.1847) from two localities. *Matsya*, **7** : 50-63.
- Gajbhiye, S. N., Nair, V. R. and Desai, B.N.** 1984. Diurnal variation of zooplankton off Versova (Bombay). *Mahasagar-Bull. Natn. Inst. Oceanogrph.* **17** (4) : 203-210.
- Hynes, H.B.N.,** 1950. The food of the freshwater sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fish *J. Anim. Ecol.* **19** : 36-58.
- Ingles, J. and Pauly, D.** 1984. An atlas of the growth, mortality and recruitment of philippine fishes. *ICLARAM Tech. Rep.* **13**. ICLARM, Manila. 127 p.
- Le Cren, E.D.** 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (*Perch fluviatilis*). *J. Anim. Ecol.* **20** : 201-210.
- Mookerjee, H.K. and Bhattacharya, R.** 1950. Some aspects of the natural history of Clupealife. Proc.37th Indian Sci. Congr.Pt III, 250-251.
- Nair, R.V.** 1972. Studies on the life-history, bionomics and fishery of the white sardine, *Kowala covala* (Cuv.). *Proc. Indo-Pacif. Fish. Coun.* 3rd Meeting, Madras.

- Nair, R.V.** 1972. Indian Sardines. CSIR Zoological Monograph No.2.
- Pauly, D. and David, N.** 1981. ELEFAN - I A Basic Program for the objective extraction of growth parameters from length-frequency data. *Meraestorsch.* **28** (1981) : 205-211.
- Raje, S.G. and Deshmukh, V.D.** 1989. On the 'dol' net operation at Versova, Bombay. *Indian J. Fish.* **36** (3) : 239-248.
- Shivaprakasha, S.M. and Joseph, S. P.** 1988. Reproductive biology of the white sardin *Kowala coval* (cuvier) from the Mangalore coast. *The First - Indian Fisheries forum Proceedings.* Dec. 4-8 1947: 221.
- Snedecor, G.W. Cochran, W.G.** 1967. Statistical Methods. Oxford and IBH Publishing Co. New Delhi Sixth Edition. 593 p.