

## Growth and population parameters of the spade nose shark, *Scoliodon laticaudus* from Calicut coast

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### ABSTRACT

von Bertalanffy's growth equation was used to describe growth of *Scoliodon laticaudus* Muller and Henle. The  $L_{\infty}$ ,  $K$  and  $t_0$  values estimated were 715 mm, 0.3580, and 0.590 for females and 676 mm, 0.4046 and 0.590 for males respectively. Females grow larger and live longer than males. The overall sex ratio was 1 : 1.31, the females predominating, more so from 551-600 mm size group onwards. The average estimated annual catch was 14.4 tonnes at the existing  $F$  value of 0.73.

### Introduction

Elasmobranchs roughly contributed 4 % in the total fish catch at Calicut during 1977-'81. In recent years the elasmobranchs have attracted the attention of fishery scientists as well as the fishing industry because of their fins and flesh which have high utility value in both export market as well as in the country. As *Scoliodon laticaudus* is not a fast swimmer and occupies the near-shore region in shallow waters, it is mostly caught in trawl gear as a bycatch. Drift gill nets accounted for the landings of large sized sharks due to larger mesh size.

Published accounts on the taxonomy, distribution and biological aspects of *S. laticaudus* are those of Thillayambalam (1928), Setna and Sarangdhar (1948)

and Devadoss (1977, 1979, 1989). Age and growth was studied by Nair (1976). The present account deals with the differential growth in male and female sharks and other population parameters.

### Material and methods

Fish samples for the study were collected from the fish landing centre at Vellayil, Calicut where small trawlers operating in the inshore region land their catch. The total length was measured from the tip of snout to tip of upper caudal lobe to the nearest mm and weight to 0.5 g accuracy. Length measurements from a total of 7,896 sharks comprising 3,418 males and 4,478 females were taken from commercial landings during 1977-'81. Though the data pertained to earlier years, it is

expected that the information provided here would be useful for future investigations in this scarcely studied sharks. The parameters of growth were estimated using the von Bertalanffy equation based on the length data monthly modal progression. The K and L were estimated from Ford-Walford plot (Ford, 1933; Walford, 1946) of  $l_{t+1}$  against  $l_t$  on the basis of lengths attained at intervals of 3 months. The total mortality rate (Z) was estimated following the Beverton and Holt (1956) method. The length at first capture  $L' = 185$  mm and sharks below 185 mm were not considered for calculating  $\bar{L}$  values.

The empirical formula suggested by Pauly (1980) was employed for estimation of natural mortality (M):

$$\log_{10} M = -0.0066 - 0.279 \log_{10} L + 0.6543 \log_{10} K + 0.4634 \log_{10} T$$

where L and K are VBG parameters and T the annual mean temperature which is taken as 28°C.

### Results and discussion

Young sharks appeared in large numbers during June-July. Monthwise modal distribution of male and female sharks separately, grouped in 20 mm size intervals is shown in Fig.1 and 2. By connecting the maximum number of modes, it was possible with the data in hand to obtain seven curves in respect of females and six in males. The length attained at each quarterly intervals read off from the curve were used to estimate the von Bertalanffy parameters of growth (Table 1). So, on this basis the annual values of K, L and  $t_{\infty}$  were estimated as 0.3580, 715 mm and 0.590 respectively for females and 0.4046, 676 mm and 0.590 for males. Males grow faster than females in the early stages attaining sizes of 321, 439,

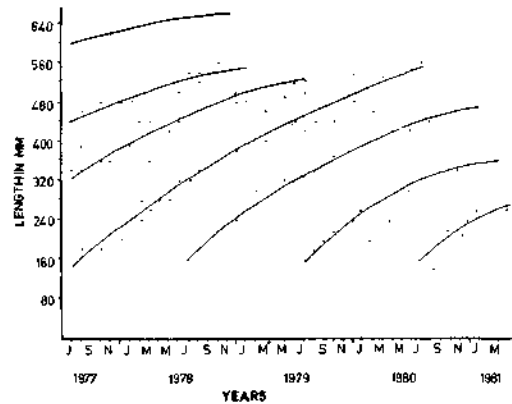


Fig. 1. Growth in length of *Scoliodon laticaudus* (female) on the basis of modal progression.

518, 570, 606, 629 and 645 mm during 1-7 years, whereas females grow to sizes of 310, 432, 517, 576, 618, 646 and 667 mm during the same period.

Fig. 3 shows the calculated growth curve of *S. laticaudus*. Krishnamoorthi and Jagadis (1986) indicated a slow growth in *Rhizoprionodon acutus*. However, the rate of growth in *S. laticaudus* is somewhat faster. Such faster growth

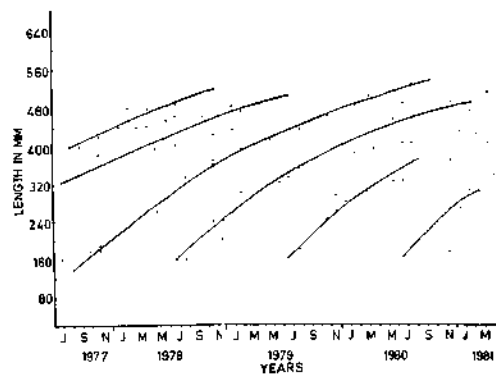


Fig. 2. Growth in length of *Scoliodon laticaudus* (male) on the basis of modal progression.

TABLE 1. The estimates of various parameters of von Bertalanffy equations and the calculated length of *Scoliodon laticaudus* at different ages. Figures in parenthesis indicate annual growth rate

Sex	K	L	$t_0$	Size at birth (mm)	Length (mm) in years						
					1	2	3	4	5	6	7
Female	0.3580	715	0.590	140	310 (170)	432 (122)	517 (85)	576 (59)	618 (42)	647 (29)	667 (20)
Male	0.4046	676	0.590	140	321 (181)	439 (118)	518 (79)	570 (52)	606 (36)	629 (23)	645 (16)

rate has been reported in *Eulamia milberti* from 600 mm at birth to 2,000 mm in two years (Springer, 1960). The K values of 0.3580 - 0.4046 obtained in the present study are higher than the expected value of 0.1 to 0.2 for selachians as suggested by Holden (1974). These expected values were obtained for species *Squalus acanthias* (Ford, 1921), *Carcharhinus milberti* (Wass, 1973) and *Galeorhinus australis* (Grant *et al.*, 1979) occurring in temperate waters. In tropical waters the growth of organisms is faster and they reach maturity earlier and so the value of K in tropical fishes is naturally expected to be higher than that obtained for temperate or cooler waters. Krishnamoorthi and Jagadis (1986) depicted a growth curve in respect of *R. acutus* based on the

predetermined K value of 0.2 for sharks as suggested by Holden (1974, 1977). However, the K value of 0.2 is very low for tropical sharks (Kasim, 1991). Hence the method suggested by Holden (1974) and Krishnamoorthi and Jagadis (1986) was not followed for the analysis of von Bertalanffy's growth parameters in the present study.

Accelerated growth is seen in the present observations during the first year in both males and females when they attain a size of 321 and 310 mm respectively and the growth slackens during the second year when they reach puberty.

#### Sex ratio

The females of *S. laticaudus* grow larger and live longer than the males. Thus the largest female measured during this study period was 658 mm and the male 510 mm. Size wise distributions of sex ratio of 1974 specimens of *S. laticaudus* (average of four years) is given in Table 2. The overall male female ratio being 1 : 1.31, females predominated in almost all size groups, chiefly from 451 mm onwards and after 501-550 mm size group the males were completely absent in the fishery. A chi-square test indicated that the differences noticed in the ratio were highly significant. Month wise data on sex

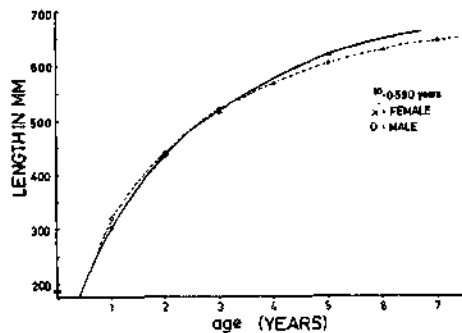


Fig. 3. von Bertalanffy growth curve for *Scoliodon laticaudus*.

TABLE 2. Size wise distribution of males and females of *Scoliodon laticaudus*

Size group (mm)	Sample size (N)	% males	% females
upto 200	208	47.7	52.3
201-250	215	43.7	56.3
251-300	251	40.2	59.8
301-350	448	42.0	58.0
351-400	243	51.9	48.1
401-450	180	60.8	39.2
451-500	165	27.8	72.2
501-550	129	6.2	93.8
551-600	86	—	100.0
601-650	18	—	100.0
651-700	1	—	100.0
Total	1974	43.3	56.7

ratio also indicated the dominance of females in almost all the months (Table 3).

#### Length at maturity

Sexual maturity is determined following the methods of Springer (1960) and Devadoss (1979). Almost all males from 350 mm size and females between 351-400 mm size group with a mid point at 375 mm were found to be fully mature. Female sharks with a total length of 375 mm and above started bearing young ones. The age at maturity in female sharks is one year and seven months (corresponding to 375 mm size) as arrived at by the von Bertalanffy's growth curve and that of males one year and three months (350 mm). Holden (1974) suggested a ratio of the length at first maturity on the maximum length of the species ( $l_m/L$ ) to be 0.77 for elasmobranchs. From the work of Compagno (1984) the ratio calculated was 0.50 ( $340/690 = 0.50$ ) for

females and 0.52 ( $300/580 = 0.52$ ) for males. This ratio is in complete agreement with the result of present work where the ratio for both females ( $375/714$ ) and males ( $350/676$ ) is worked out to be 0.52 and 0.51 respectively.

#### Estimation of mortality

For estimation of total mortality ( $Z$ ), the following values were used:  $K = 0.358$ ;  $L = 715$  mm;  $L' = 185.5$  mm; and  $\bar{L}$  = annual mean length (calculated after excluding values below  $L'$ ). The annual mean length ( $= \bar{L}$  values) were 310.0, 295.6, 305.1 and 274.9 mm for the years 1977, 1978, 1979 and 1980 respectively. Total mortality rates ( $Z$ ) ranged from 1.16 to 1.76 with an average of 1.45 (Table 4). The estimated natural mortality ( $M$ ) was 0.72 and the fishing mortality rate ( $F$ ) varied from 0.44 to 1.04 with an average of 0.73.

From the yield ( $Y$ ) and exploitation rate ( $U$ ), the total stock of *S. laticaudus* off Calicut was calculated as 38.835 t and from the yield ( $Y$ ) and fishing

TABLE 3. Month wise distribution of males and females of *Scoliodon laticaudus* (Average)

Month	Samples size (N)	% males	% females
January	288	35.4	64.6
February	240	44.6	55.4
March	192	44.3	55.7
April	235	47.7	52.3
May	124	33.9	66.1
June	145	33.1	66.9
July	147	46.9	53.1
August	196	56.6	43.4
September	53	45.3	54.7
October	75	37.3	62.7
November	73	39.2	60.8
December	206	49.5	50.5
Total	1,974	43.3*	56.7*

\*  $X^2 = 35.307P < 0.001$ .

TABLE 4 Estimation of total stock and standing crop of *S. laticaudus*

Year	Yield (t)	Z	F	M	U	Total stock P=Y/U (t)	Standing crop Y/F (t)
1977	17.912	1.16	0.44	0.72	0.26	68.892	40.709
1978	6.257	1.24	0.54	0.72	0.29	21.569	12.029
1979	11.964	1.64	0.92	0.72	0.45	26.587	13.004
1980	21.343	1.76	1.04	0.72	0.49	43.557	20.522
Average	14.369	1.45	0.73	0.72	0.37	38.835	19.684

Z, M and F are the instantaneous rates of total, natural and fishing mortality coefficients.

U = Exploitation rate.

mortality (F), the standing crop was estimated as 19.684 t. As the yield (14.369) was below the standing crop, it is felt that marginally higher effort would have resulted in higher production of the species during 1977-'80.

#### Acknowledgment

The author is thankful to Dr. E. Vivekanandan, Senior Scientist and Shri Hameed Batcha, Technical Assistant, Madras Research Centre of C. M. F. R. Institute for the help rendered in the statistical work.

#### References

- Compagno, L.J.V. 1984. FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2. Carcharhiniformes. *FAO Fish. Synop.*, (125) Vol. 4 (2) : 534-535.
- Beverton, R.J.H. and S.J. Holt 1956. A review of method for estimating mortality rates in fish populations, with special reference to sources of bias in catch sampling. *Rapp. P.V. Reun. CIEM*, 140 : 67-83.
- Devadoss, P. 1977. Studies on the elasmobranchs of Porto Novo coast (South India). *Ph.D. Thesis*, Annamalai Univ., 210 pp.
- Devadoss, P. 1979. Observations on the maturity, breeding and development of *Scoliodon laticaudus* Muller and Henle off Calicut coast. *J. mar. biol. Ass. India*, 21 : 103-110.
- Devadoss, P. 1989. Observations on the length-weight relationship and food and feeding habits of spade nose shark *Scoliodon laticaudus* Muller and Henle. *Indian J. Fish.*, 36 (2) : 167-174.
- Ford, E. 1921. A contribution to our knowledge of the life histories of dogfishes landed at Plymouth. *J. mar. biol. Ass. U.K.*, 12(B) : 486-505.
- Ford, E. 1933. An account of herring investigations conducted at Plymouth during the years 1924-1933. *J. mar. biol. Ass. U.K.*, 19 : 305-384.
- Grant, C.J., R.L. Sanland and A.M. Olsen 1979. Estimation of growth, mortality and yield per recruit of the Australian school shark, *Galeorhinus australis* (Macleay), from tag recoveries. *Aust. J. Mar. Freshw. Res.*, 30 : 625-637.
- Holden, M.J. 1974. Problems in the rational exploitation of elasmobranch populations and suggested solutions. In : *Sea Fisheries Research*, F. R. Harden Jones (Ed.), Logos Press, London, 510 pp.
- Holden, M. J. 1977. Elasmobranchs. In : *Fish Population Dynamics*, J. A. Gulland (Ed.) p. 187-214. p. 187-214. p. 187-214., J. Wiley & Sons Ltd., London, 373 pp.
- Kasim, H. M. 1991. Shark fishery of Veraval coast with special reference to popu-

- lation dynamics of *Scoliodon laticaudus* (Muller and Henle) and *Rhizoprionodon acutus* (Ruppell). *J. mar. biol. Ass. India*, **33** ( 1 & 2) : 213-228.
- Krishnamoorthi, B. And I. Jagadis 1986. Biology and population dynamics of the grey dogshark, *Rhizoprionodon (Rhizoprionodon) acutus* (Ruppell), in Madras waters. *Indian J. Fish.*, **33** : 371-385.
- Nair, K. P. 1976. Age and growth of the yellow dog shark, *Scoliodon laticaudus* Muller and Henle, from Bombay waters. *J. mar. biol. Ass. India*, **18** : 531-539.
- Pauly, D. 1980. A selection of simple methods for the assessment of tropical fish stocks. *FAO Fisheries Circular*, No. 729, 54 pp.
- Setna, S. B. And P.N. Sarangdhar 1948. Description, bionomics and development of *Scoliodon sorrakowah* (Cuvier). *Rec. Indian Mus.*, **46** (1) : 25-53.
- Springer, S. 1960. Natural history of the sandbar shark *Eulamia milberti*. *U. S. Fish and Wildlife Service, Fish. Bull.*, **178**(58) : 1-38.
- Thillayambalam, E.M. 1928. *Scoliodon* (The shark of the Indian seas). *Indian Zool. Mem.*, **2** : 1-116.
- Walford, L. A. 1946. A new graphic method of describing the growth of animals. *Biol. Bull Woods Hole*, **90** : 141-147.
- Wass, R. C. 1973. Size, growth and reproduction of the sand bar shark, *Caracharhinus milberti*, in Hawaii. *Pacif. Sci.*, **27** : 305-318.