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SHARK FISHERY OF VERAVAL COAST WITH SPECIAL REFERENCE TO POPULATION DYNAMICS OF *SCOLIODON LATICAUDUS* (MULLER ANDHENLE) AND *RHIZOPRIONODON ACUTUS* (RUPPELL)*

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ABSTRACT

During 1979-81 on an average 823.1 t of sharks were landed in a year which constituted 2.9% of total marine fish landed. The annual average gearwise catch was 340.4 and 482.7 t by trawl and gill nets respectively. The peak period of abundance of sharks was during December-March as indicated by the catch rate of trawl net and the catch rate of gill net indicates that the abundance was good in all the months except in October and November. Among several species of sharks which supported the fishery, *Scoliodon laticaudus* (Muller and Henle) and *Rhizoprionodon acutus* (Ruppell) were dominant and constituted on average 43.3 and 31.2% in trawl and gill net catches respectively.

Sexwise growth parameters of these two species have been estimated from length frequency data, to be, L_∞ 680 mm, K 1.0822/year and t_o—0.0119 for males and L_∞ 749 mm, K 0.8818/year and t_o +0.0123 for females of *S. laticaudus*. The growth parameters of male *R. acutus* are estimated to be L_∞ 1054 mm, K 0.6457/year and t_o —0.0526 and of female L_∞ 1065 mm, K 0.6046/year and t_o—0.0556. The growth in weight of both the sexes of these two species are also given. The natural mortality coefficient for both sexes of *S. laticaudus* are 1.76 for males and 1.53 for females and for *R. acutus* are 1.12 for males and 1.01 for females. The gearwise estimates of total mortality coefficient have been given for both the sexes of these two species. The estimates of age at first capture with regards to different gears have been obtained.

The sexwise yield per recruit studies of both the species indicate that both the sexes of *S. laticaudus* is not exposed to high fishing intensity and the effort of trawl and gill net may be increased to exploit this species more effectively without further reduction in the age of first capture from the prevailing level. The males of *R. acutus* are exposed to moderately higher fishing pressure whereas the females are not. In general, there is scope for the increase in production of these two species by intensifying the effort of trawl and gill net units as the present F are lower than the F_{max} of the respective gears and species.

INTRODUCTION

AMONG elasmobranchs, though shark is considered as the most important resource, the review of literature reveals that this resource has been studied inadequately, but for a few accounts on the fishery biology by Chidambaram and Menon (1946), Sarangdhar (1944), Setna and Sarangdhar (1948), Samuel (1951), James (1973), Nair and Appukuttan (1974), Appukuttan (1978), Prabhakaran Nair (1981) and Devadoss (1983) ; on the systematics and stray occurrence of rate sharks by Thillayambalam (1928), Misra (1947, 1959), Misra and Menon (1955), Kasim and Mohammad Zafar Khan (1984) and others. Further, no information is available on the fishery and population

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dynamics of dominant species of this resource from Gujarat waters. With a view to providing required information to increase the production through proper management of the fishery, present study was initiated in Veraval, in Gujarat in 1979. This account deals with the shark fishery and growth, mortality rates, yield per recruit of dominant species *Scoliodon laticaudus* and *Rhizoprionodon acutus*.

The author is immensely thankful to Dr. P. S. B. R. James, Director, and Dr. M. D. K. Kuthalingam, CMFRI for their valuable encouragements during the period of this study.

Observations

Weekly observations were made at the landing centres on fishing days and 5-10% of the trawl and gill net units which were the only two gears commercially operated off Veraval during the period of this study, were sampled at random. Data on catch, effort, species composition and length frequency of dominant species *S. laticaudus* and *R. acutus* were collected. The data were initially raised to the sampling day and then to the month by respective raising factors. Fishing holidays and closed fishing days due to unforeseen weather conditions were excluded for the estimation. Sexwise fork length in mm and wet weight in gram were obtained for the dominant species for length weight relationship studies.

Catch Statistics

An estimated 1025.2 t of sharks were landed by trawl and gillnet units during 1979-80 which formed 3.3% of the total catch. Trawlers landed 525.3 t and gill net units 499.9 t and the percentage composition in the gearwise total catch was 1.9% and 17.6% respectively. During 1980-81 the catch declined to 620.9 t and this constituted 2.5% of total catch. The gearwise decline in the shark landings was 369.9 t in trawl net and 34.4 t in gill net units. However, during the second season the shark landings by gill net units were higher than the trawlers catch. The monthwise effort expended indicates that the trawlers effort was higher than the gill net effort in all the months except during the beginning of the season in September. There was a decline in the total effort of trawlers and conversely an increase in the total effort of gill net units during the second season (Table 1).

Abundance

The catch per unit effort of trawl net (Table 1) indicates good abundance of sharks in October, December, January and March and the catch rate of gill net shows better abundance during September, December to February, April and May in the first season. Though the catch rate of both the fishing units during the second fishing season was not as good as the first season, comparatively good abundance of sharks was recorded during November to January and in March by trawl nets and in August, September, February-June by gill nets. The annual average catch rate of these fishing units indicates that there was 2/3 and 1/3 decline in the catch rate, during the second season, of the trawl and gill net units respectively (Table 1). The decline in the total catch of sharks during the second season may be attributed to the poor abundance and reduction in the effort of trawlers.

Species Composition

Scoliodon laticaudus (Muller and Henle), *Rhizoprionodon acutus* (Ruppel), *Carcharhinus melanoptera* (Day), *Sphyrna blochii* (Muller and Henle), *Zygaena tudes* Cuvier, *Sphyrna lewini* Griffith, other *Carcharhinus* spp. *Galeocerdo* spp. and rarely *Rhincodon typus* (Smith) were observed to occur in the catch. During the first season *S. laticaudus* and *R. acutus* were dominant both in trawl (59.9% and 26.7% respectively) and gill net (34.2% and 28.1% respectively) catches. Though, the composition of other species in trawl net catch was not significant, in gill net catch *S. blochii*

TABLE 1. *Estimated month wise and gearwise fishing effort (Number of boat), catch (kg) and catch per unit effort (kg) for the fishing season 1979-80 and 1980-81*

Month	TRAWL NET			GILL NET			
	Effort	Catch	C/E	Effort	Catch	C/E	Total
August 1979	—	—	—	—	—	—	—
September	1,822	8,989	4.9	2,555	1,52,486	59.7	1,61,475
October	6,032	86,920	14.4	1,584	7,952	5.0	94,845
November	4,868	19,807	4.1	1,550	7,976	5.2	27,783
December	7,119	1,22,363	17.2	1,925	24,081	12.5	1,46,444
January 1980	8599	1,16,779	13.6	2,158	27,625	12.8	1,44,404
February	4,552	21,880	4.8	2,024	70,032	34.6	91,912
March	5,100	63,852	12.5	1,446	14,076	9.7	77,928
April	6,799	57,661	8.5	2,301	1,50,286	65.3	2,07,947
May	4,109	27,041	6.6	1,909	39,859	20.9	66,900
June	—	—	—	641	5,506	8.6	5,506
Annual Total	49,000	5,25,292	10.7	18,093	4,99,879	27.6	10,25,171

catch				TRAWL NET			
	Effort	Catch	C/E	Effort	Catch	C/E	Total Catch
August	—	—	—	600	6,675	11.1	6,675
Septemper	348	—	—	686	9,625	14.0	9,625
October	4,959	11,124	2.3	2,190	6,162	2.8	17,686
November	5,122	27,170	5.3	1,885	17,764	9.4	44,984
December	6,474	33,735	5.2	2,288	14,622	6.4	48,357
January 1980	5,057	22,074	4.3	2,047	19,065	9.3	41,139
February	5,584	12,464	2.2	3,920	51,592	13.2	64,056
March	5,742	26,928	4.7	3,348	1,54,146	46.0	1,81,074
April	5,928	13,488	2.3	2,664	1,12,752	42.3	1,26,240
May	4,256	7,980	1.9	4,046	61,404	15.2	69,384
June	—	—	—	1,012	11,698	11.6	11,698
Annual Total	43,470	1,55,363	3.6	24,686	4,65,505	18.9	6,20,868

TABLE 2. *Estimated monthwise species composition of trawl net and gill net shark landings for the fishing season* 1979-1980

TRAWL NET CATH (KG)

Month	*S. lati-caudus*	*R. acutus*	*C. mela-noptera*	*Carcharhinus*	*S. blochii*	*Z. tudes*	Other	Total
September 1979 ..	1,487	2,948	—	—	4,224	—	330	8,989
October ..	29,760	31,480	—	19,968	5,712	—	—	86,920
November ..	11,704	6,444	1,659	—	—	—	—	19,807
December ..	66,281	28,306	7,388	10,925	5,238	4,225	—	1,22,363
January 1980 ..	75,491	34,366	2,600	1,462	2,860	—	—	1,16,779
February ..	20,616	1,264	—	—	—	—	—	21,880
March ..	51,846	12,006	—	—	—	—	—	63,852
April ..	37,011	17,075	3575	—	—	—	—	57,661
May ..	20,296	6,745	—	—	—	—	—	27,041
June ..	—	—	—	—	—	—	—	—
Total ..	3,14,492	1,40,634	15,222	32,355	18,034	4,225	330	5,25,292
% ..	59.9	26.7	2.9	6.2	3.4	0.8	0.1	
CPUE (Kg) ..	6.4	2.9	0.3	0.7	0.4	0.09	0.01	10.7

GILL NET CATCH (KG)

	S. lati-caudus	*R. acutus*	*C. mela-noptera*	*carcha-rhinus spp.*	*S. blochii*	*Z. tudesdes*	Other	Total
September 1979	17,666	49,738	—	—	69,934	—	15,148	1,52,486
October	3,864	2,712	—	—	1,376	—	—	7,952
November	3,956	3,295	—	—	725	—	—	7,976
December	12,950	9,813	212	—	894	212	—	24,081
Janfiary 1980	14,788	5,174	1,059	5,102	1,502	—	—	27,625
February	6,120	2,256	40,000	19,856	—	1,200	600	70,032
March	7,536	5,790	240	510	—	—	—	14,076
April	85,368	38,454	24,030	—	—	2,444	—	1,50,286
May	18,345	21,514	—	—	—	—	—	39,859
June	516	1,837	539	1,741	873	—	—	5,506
Total	1,71,099	1,40,583	66,080	27,209	75,304	3,856	15,748	4,99,879
%	34.2	28.1	13.2	5.4	15.1	0.8	3.2	
CPUE (Kg)	9.5	7.8	3.7	1.5	4.2	0.2	0.9	27.6

TABLE 3. *Estimated monthwise species composition of trawl net and gill net shark landings for the fishing season* 1980-81

TRAWL NET CATCH (Kg.)

Month	*S. laticaudus*	*R. acutus*	*C. melanoptera*	*Carcharhinus* spp.	Others	Total
August 1980 ..						
September ..	—	—	—	—	—	—
October ..	3,237	—	—	—	8,287	11,524
November ..	5,304	416	—	—	21,450	27,170
December ..	32,798	937	—	—	—	33,735
January 1981 ..	21,508	—	566	—	—	22,074
February ..	6,856	5,608	—	—	—	12,464
March ..	26,982	—	—	—	—	26,928
April ..	12,996	—	—	492	—	13,488
May ..	5,698	2,282	—	—	—	7,980
June ..	—	—	—	—	—	—
Total ..	1,15,325	9,243	566	492	29,737	1,55,363
% ..	74.2	6.0	0.4	0.3	19.1	
CPUE (Kg) ..	2.7	0.2	0.01	0.01	0.7	3.6

GILL NET CATCH (Kg)

Month	*S. laticaudus*	*R. acutus*	*C. melanoptra*	*Carcharhinus* spp.	*S. blochii*	*S. tudes*	*S. lewini*	Others	Total
Augst 1980	—								6,675
September	—	6,594	2,205	518	308	—	—	—	9,625
October	—	4,869	1,293	—	..	—	—	—	6,162
November	1,547	3,919	292	—	416	—	—	—	17,764
December	8,320	3,128	23	—	3,151	—	—	—	14,622
January1981	2,795	5,850	85	10,049	286	—	—	—	19,065
February	3,208	8,872	6,624	25,208	3,400	—	2,000	2,280	55,592
March	4,236	7,116	27,840	80,544	15,000	—	19,410	—	1,54,146
April	3,528	9,768	15,378	60,630	10,722	—	10,374	2,352	1,12,752
May	8,841	29,414	7,539	11,291	3,150	1,169	—	—	61,404
June	242	3,168	3,239	3,394	731	924	—	—	11,698
Total	32,717	82,689	64,518	1,91,634	37,164	2,093	31,784	4,632	4,65,505
%	7.1	18.0	14.1	41.8	8.1	0.5	6.9	3.5	
CPUE (Kg)	1.3	3.4	2.6	7.8	1.5	0.09	1.3	0.7	18.6

(15.1%) and *C. melanoptera* (13.2%) also constituted a considerable proportion (Table 2). During the second season *S. laticaudus* (74.2%) was dominant only in trawl net landings whereas in gill net landings this species constituted only 7.1% since other *Carcharhinus* spp. (41.8%), *R. acutus* (18.1%) and *C. melanoptera* (14.1%) formed the major portion of the catch, owing to operation of a few gill net units exclusively for bigger sharks from February to April in 1981. A decline in the catch rate of all the species specially *S. laticaudus* and *R. acutus* except *Carcharhinus* spp. during the second season has resulted in a decrease in total shark landings (Table 3).

(Pauly, 1980). The time of origin of a few modes was fixed by extrapolating the curves of these modes available at lower size ranges, as shown by broken lines in Fig. 1 to 4. Since, these two species are viviparous, the time of origin obtained here may be treated as to include the gestation period also. The modes thus traced were tabulated chronologically (George and Banerji, 1968) and the average sizes attained by male and female of these two species were obtained for growth estimation.

Age and Growth

The average sizes obtained by above said treatment plotted on an arithmetic graph and

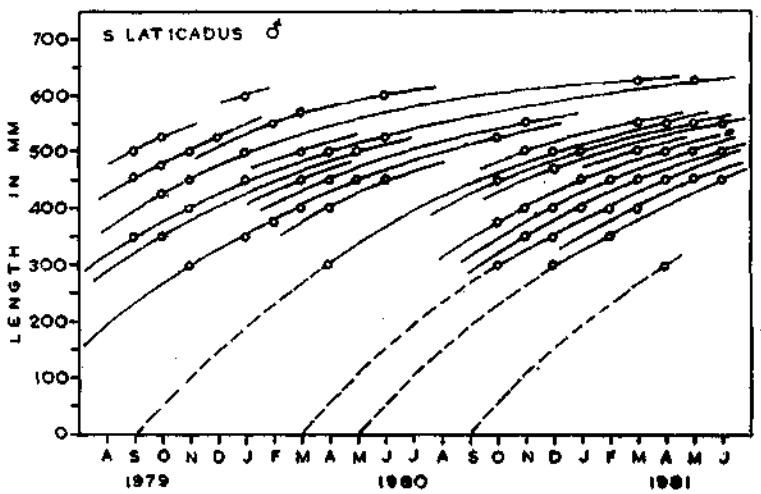

Fig. 1. Plots of modes in the length frequency against respective months and tracing of the progression of the modes in subsequent months for *Scoliodon laticaudus* males from Veraval.

Length Frequency

The sexwise and monthwise weighted size frequency obtained at interval of 25 mm for *S. laticaudus* and *R. acutus* from trawl and gill net landings was observed to be multimodal indicating the occurrence of different broods. Scatter diagrams were obtained for both the sexes of these two species on an arithmetic graph (Fig. 1 to 4) and the progress of the modes in subsequent months was traced free hand curves were fitted through the plots which may be considered as empirical growth curves of the male and female of respective species (Fig. 5 to 8). The half yearly size attained by these two species, obtained from these curves were used for further analysis to obtain growth parameters as per Bagenal (1955). The sexwise growth of these two species may be expressed as per von Bertalanffy growth equations as followed :

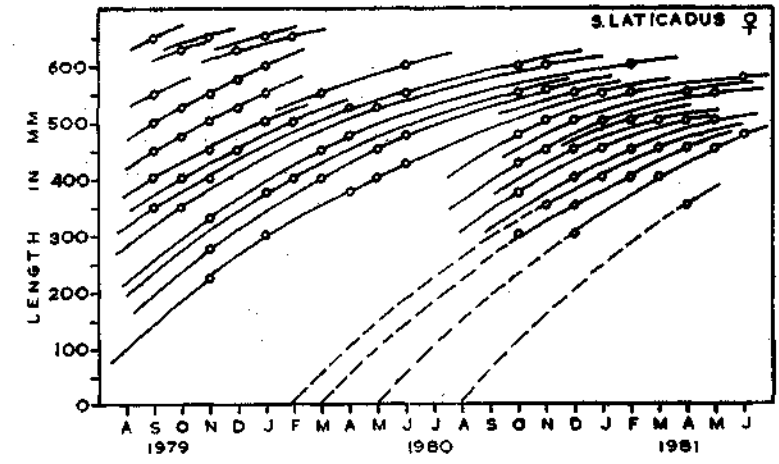

FIG. 2. Plots of modes in the length frequency against respective months and tracing of the progression of the modes in subsequent months for *Scoliodon laticaudus* females from Varaval.

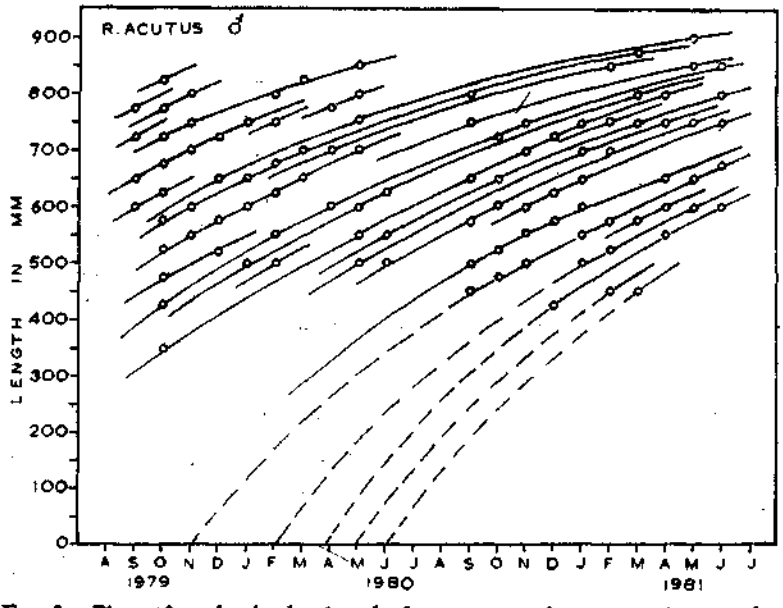

FIG. 3. Plots of modes in the length frequency against respective months and tracing of the progression of the modes in subsequent months for *Rhizoprionodon acutus* males from Varaval.

S. laticaudus

male : $l_t = 680 \quad (1\text{-}e^{-1.0833}\ (t_{+0.0110})$
female : $l_t = 749 \quad (1\text{-}e^{-0.8818}\ (t_{-0.0128})$

R. acutus

male : $l_t = 1.054 \quad (1\text{-}e^{-0.6457}\ (t_{+0.0886})$
female : $l_t = 1.065 \quad (1\text{-}e^{-0.6046}\ (t_{+0.0456})$

Based on these equations the males of *S. laticaudus* attain 284.7, 452.5, 546.1, 602.9, 635.1 and 653.9 mm in 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 yrs respectively and females attain 267.6, 438.9, 551.6, 622.0, 667.0 and 696.4 mm during the said period respectively. Males of *R. acutus* attain 591.8, 774.0, 907.2, 977.0, 1013.6 mm in 1, 2, 3, 4 and 5 yrs respectively and females attain 502.4, 757.7, 897.1, 973.3 and 1014.9 mm in 1, 2, 3, 4 and 5 yrs respectively. Males of these two species grow faster than the females.

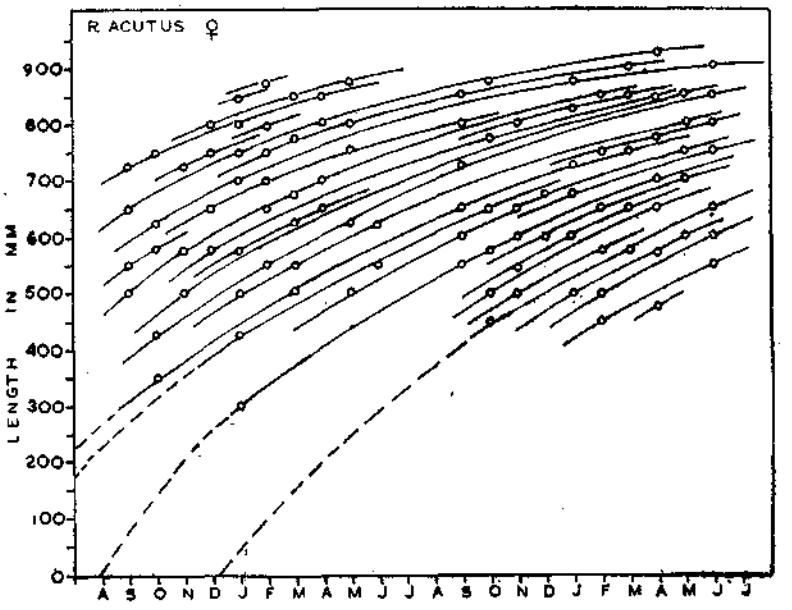

FIG. 4. Plots of modes in the length frequency against respective months and tracing of the progression of the modes in subsequent months for *Rhizoprionodon acutus* females from Veraval.

LENGTH-WEIGHT RELATIONSHIP

The log values of fork length in mm and wet weight in g were regressed as per least squares method and the length weight relationship of male and female of these two species are described as per the following equations :

S. laticaudus

male : Log W = −2.3574 +2.9349 Log L
female : Log W = −2.0661 +2.7837 Log L

R. acutus

male : Log W = −2.0159+2.8465 Log L
female : Log W = −2.6332 +3.1404 Log L

GROWTH IN WEIGHT

The cube root of the half yearly weight gained by both the sexes of these two species, obtained

from length weight relationship, were used to study the growth in weight of these two species (Bagenal, 1955) and this may be expressed as per von Bertalanffy growth equation as given below :

S. laticaudus

male : $Wt = 1042 \quad (1-e^{-1.0952}\ (t^{-0.0829})$
female : $Wt = 1386 \quad (1-e^{-0.9245}\ (t^{+0.0016})$

R. acutus

male : $Wt = 4422 \quad (1-e^{-0.6660}\ (t^{+0.0669})$
female : $Wt = 5510 \quad (1-e^{-0.5857}\ (t^{+0.0428})$

(T_{max}) of these species (Sekharan, 1975) and the estimates are 2.60 and 1.92 for males and females of *S. laticaudus* and 1.26 and 1.16 for males and females of *R. acutus* respectively.

Gearwise total mortality coefficient (Z) have been estimated by four different methods for male and female of these two species for the two fishing seasons and the average annual Z are given in Table 4. The estimates of annual average total mortality coefficient (both the gears pooled) as per Beverton and Holt (1956) are 3.39 and 3.32 for male and female of *S. laticaudus* and 2.03 and 2.44 for male and

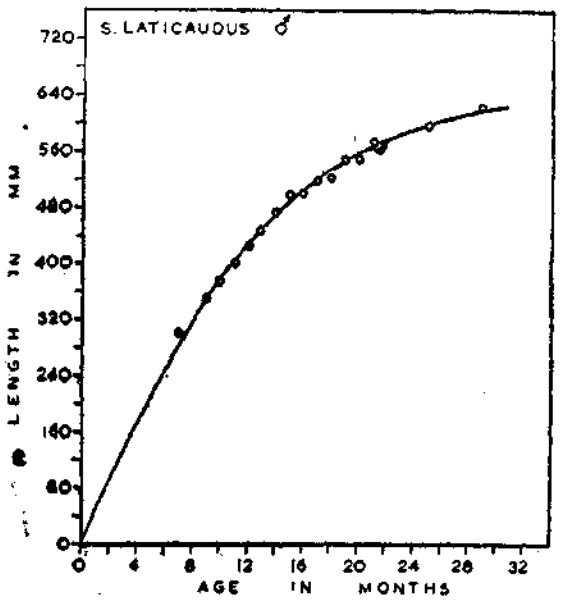

FIG. 5. Fitting a growth curve through the plots of average lengths attained by *Scoliodon laticaudus* modes in consecutive months obtained from the model progression analysis.

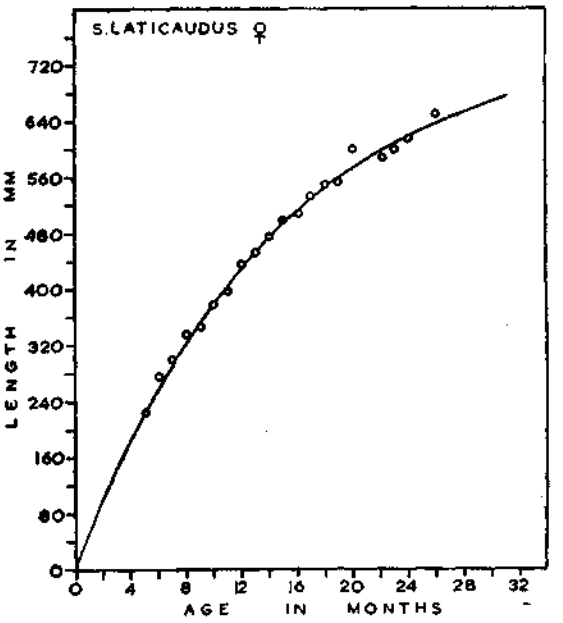

FIG. 6. Fitting a growth curve through the plots of average lengths attained by *Scoliodon laticaudus* females in consecutive months obtained from modal progression analysis.

MORTALITY RATES

The natural mortality coefficient (M) estimated as per Pauly (1980) for male and female of *S. laticaudus* are 1.76 and 1.53 and for male and female of *R. acutus* are 1.12 and 1.01 respectively. Separate estimates of M were also obtained based on the life span

female of *R. acutus* respectively which are lower than the Z obtained as per Ssentengo and Larkin (1973) *i.e.*, 4.38 (male), 4.13 (female, *S. laticaudus*), 2.62 (male), 3.0 (female, *R. acutus*) ; Alagaraja (1984) *i.e.*, 7.12 (male), 6.45 (female, *S. laticaudus*), 7.60 (male), 4.76 (female, *R. acutus*) and Pauly (1983) *i.e.*, 8.14

(male), 8.73 (female, *S. laticaudus*), 10.17 (male) (6.61 (female, *R. acutus*). The fishing mortality coefficient (F) is obtained from the relation Z-M = F.

Age at First Capture and Recruitment

The average age at first capture obtained as per Pauly (1984) are 0.6165 and 0.5653 yr for male and female of *S. laticaudus* respectively and 0.9637 and 1.0425 for male and female of *R. acutus* respectively. The average age at recruitment for male and female of *S. laticaudus* are 0.5627 and 0.5010 yr respectively and for male and female of *R. acutus* are 0.9124 and 0.9484 yr respectively.

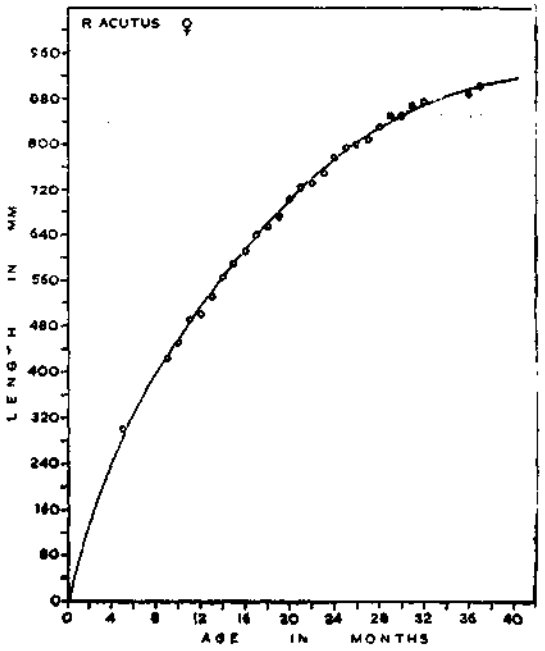

Fig. 7. Fitting a growth curve through the plots of average lengths attained by *Rhizoprionodon acutus* males in consecutive months obtained from modal progression analysis.

Yield per Recruit

The yield per recruit estimated separately for both the sexes of *S. laticaudus* and *R. acutus* as per Beverten and Holt (1957) simplified by Recker (1958) are given in Fig. 9 and 10 for these two species respectively and the F_{max} and Y_{max} are indicated by broken lines. The yield isopleth diagrams drawn from the estimates obtained from different combinations of varying age at first capture and F for male and female of *S. laticaudus* are given in Fig. 11 and 12 and for male and female of *R. acutus* in Fig. 13 and 14 respectively. The yield generated by the prevailing F obtained by four different methods (open circle) and the F_{max} for present age at first capture (closed circle) already mentioned are indicated in the isopleth diagrams.

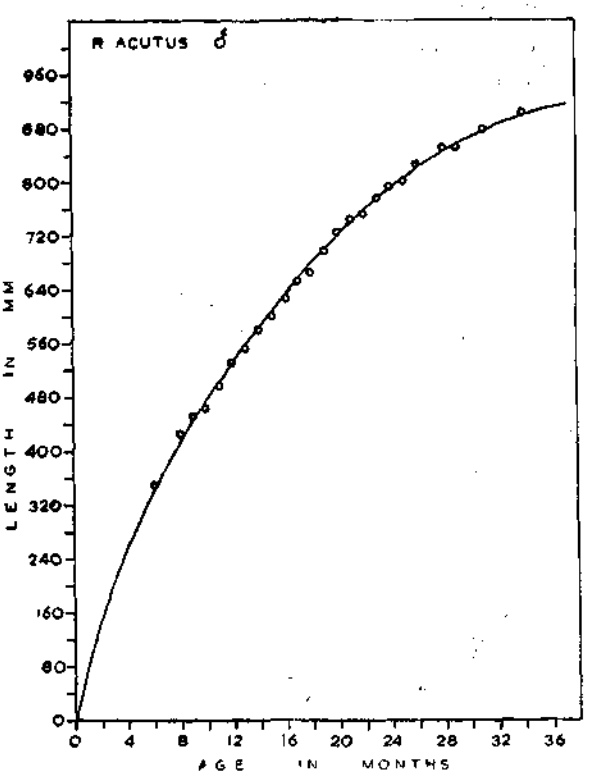

Fig. 8. Fitting a growth curveth rough the plots of average lengths attained by *Rhizoprionodon acutus* females in consecutive months obtained from modal progression analysis.

Optimum Age of Exploitation and Potential Yield per Recruit

The optimum age of exploitation and potential yield per recruit estimated as per Krishnankutty and Qasim (1968) for male and female of *S. laticaudus* are 0.9369 yr and 1.0732 yr ; 148.0 g and 153.0 g respectively and for male and female of *R. acutus* 1.4363 yr and 1.6939 yr ; 660.0 g and 668 g respectively. The potential yield per recruit in g are indicated in the respective yield isopleth diagrams.

Table 4. *Estimates of gearwise average annual total mortality coefficient (Z) by four different methods for male and female of* Scoliodon laticaudus *and* Rhizoprinodon acutus *from veraval during* 1979-81

Methods	*S. laticaudus*				*R. acutus*			
	Male		Female		Male		Female	
	Trawlnet	Gill net	Trawlnet	Gill net	Trawlnet	Gill net	Trawlnet	Gillnet
Beverton and Holt (1956)	2.14	1.25	2.48	0.84	1.05	0.98	1.20	1.24
Ssentengo and Larking (1973)	2.64	1.74	2.90	1.23	1.34	1.28	1.48	1.52
Alagaraja (1984)	3.68	3.44	3.64	2.81	3.27	4.33	2.09	2.67
Pauly (1983)	5.11	4.79	4.03	4.70	4.75	5.42	2.71	3.90

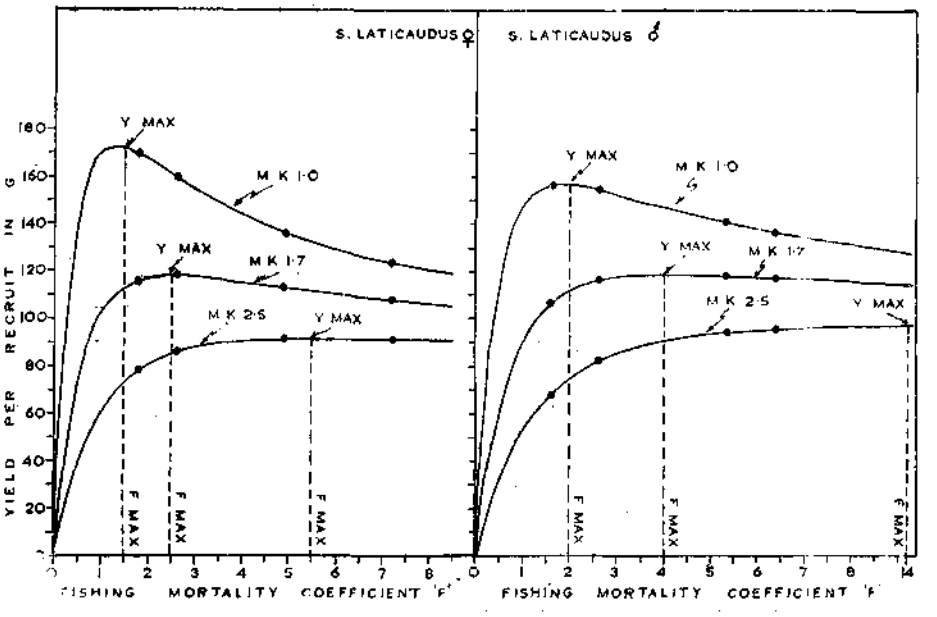

Fig. 9. Yield per recruitment of male and female *Scoliodon laticaudus* from Veraval for the prevailing age at first capture at different M/K ratios and various fishing mortality coefficient. The yield max and F max are indicated for each M/K ratio.

Discussion

The growth rate of both the sexes of *S. laticaudus* recorded in this study are higher than that obtained by Prabhakaran Nair (1981) for this species from Bombay waters. Krishnamoorthi and Jagdis (1986) have assumed the L ∞ of *R. acutus* as 100 cm and K as 0.2 which are lower than the estimates obtained for both the sexes of this species in this study. Slow growth rate for sharks have been recorded by different workers mostly from temperate waters (Olsen. 1954; Holden and Meadows. 1962; Hensen. 1963; Kato and Cavallo. 1967; Holden. 1973. 1974. 1977). However. Springer (1960) has reported faster growth rate *i.e.*, 700 mm per annum for *Eulamia milberti*. The tropical species including sharks. being poikilotherms. their growth rate is directly correlated to the environmental temperature and it is. naturally higher than their counterpart in temperate waters. The higher K values obtained in this study indicate that the life span of these two species are shorter and further. the males of these two species have comparatively shorter life span than the females. Generally. low L∞ and high K value are attributed to higher environmental temperature (Pauly. 1980). Naturally. the low fecundity should have been augmented by factors like faster growth rate and parental care so as to act as a buffer against the intensive fishing pressure in the tropics and sustain the fishery.

The yield per recruit studies reveal the *S. laticaudus* is not exposed to higher fishing pressure as the gearwise F are lower than the F_{max} of this species and it appears that there is scope for increasing the effort of trawl and gill net units further to match the F_{max}. The males of *R. acutus* seems to have been exposed to moderately higher fishing pressure whereas the females are not. In general. there seems to be scope for increasing the effort of trawl and gill net units as the F generated by these gears are lower than the F_{max} of these two gears. However. the commercial exploitation of sharks off Veraval is by trawl and gill nets only during the period of this study and if the total fishing mortality rate is taken as

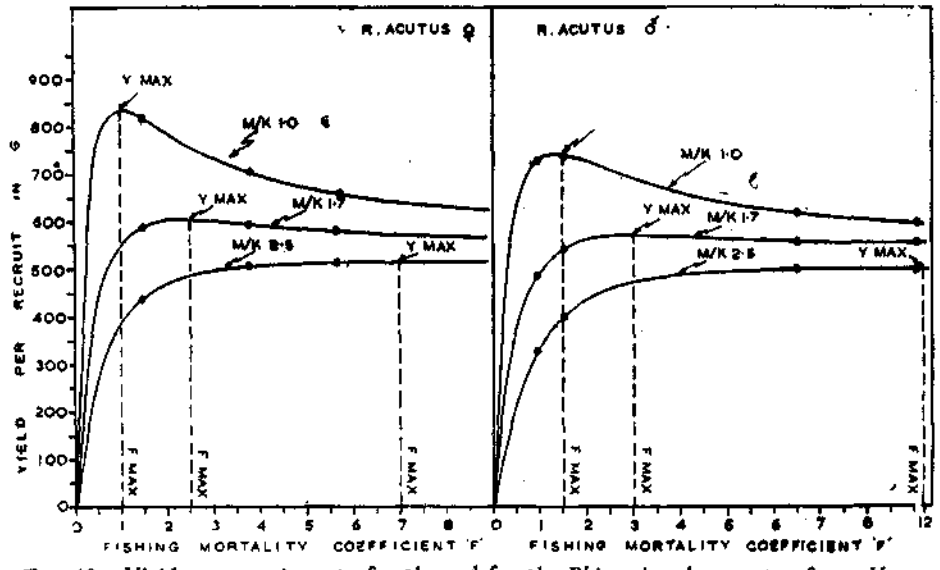

FIG. 10. Yield per recruitment of male and female *Rhizoprionodon acutus* from Veraval for the prevailing age at first capture at different M/K ratios and various fishing mortality co-efficient. The yield max and F max are indicated for each M/K ratio.

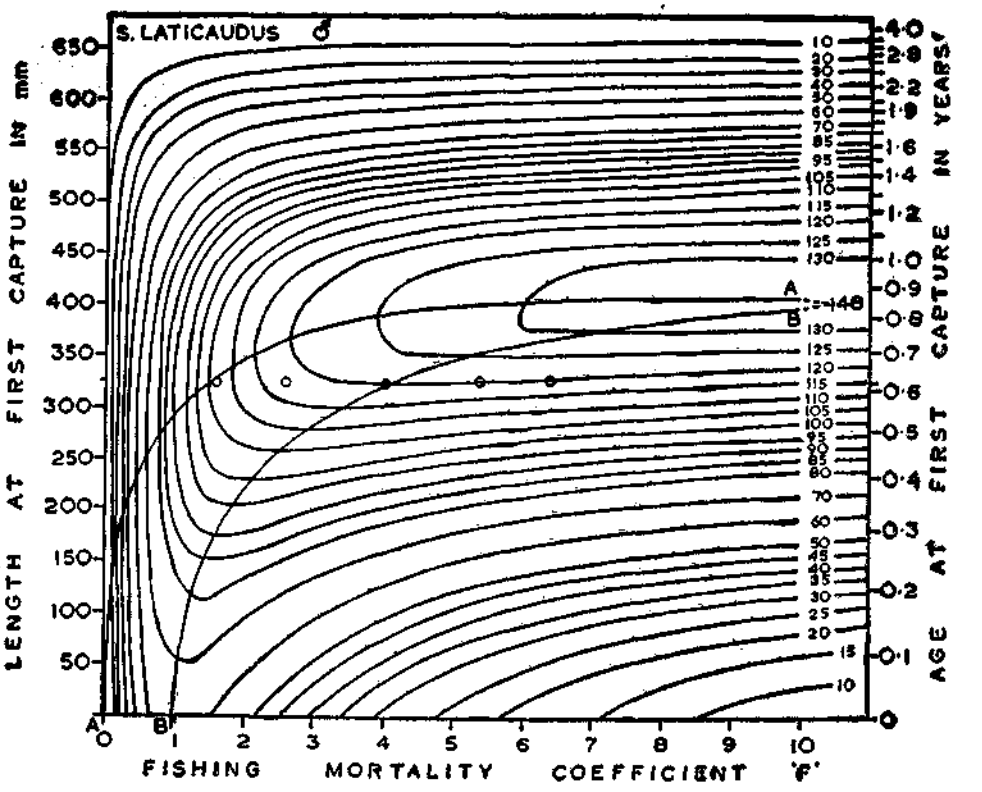

FIG. 11. Isopleth diagram for yield per recruit in gram of *Scoliodon laticaudus* males from Veraval. The eumetric fishing curve (line A-A), maximum sustainable yield curve (line B-B) and potential yield per recruit of 148g are also shown.

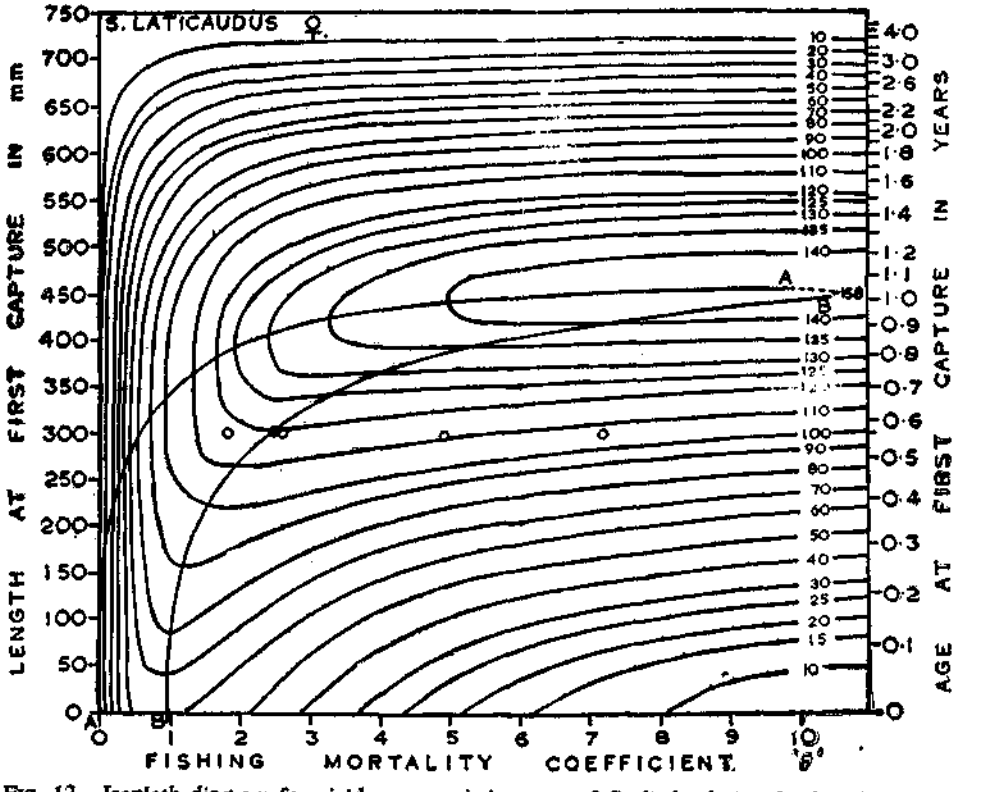

FIG. 12. Isopleth diagram for yield per recruit in gram of *Scoliodon laticaudus* females from Veraval. The eumetric fishing curve (line A-A), maximum sustainable yield curve (line B-B) and potential yield per recruit of 158g are also shown.

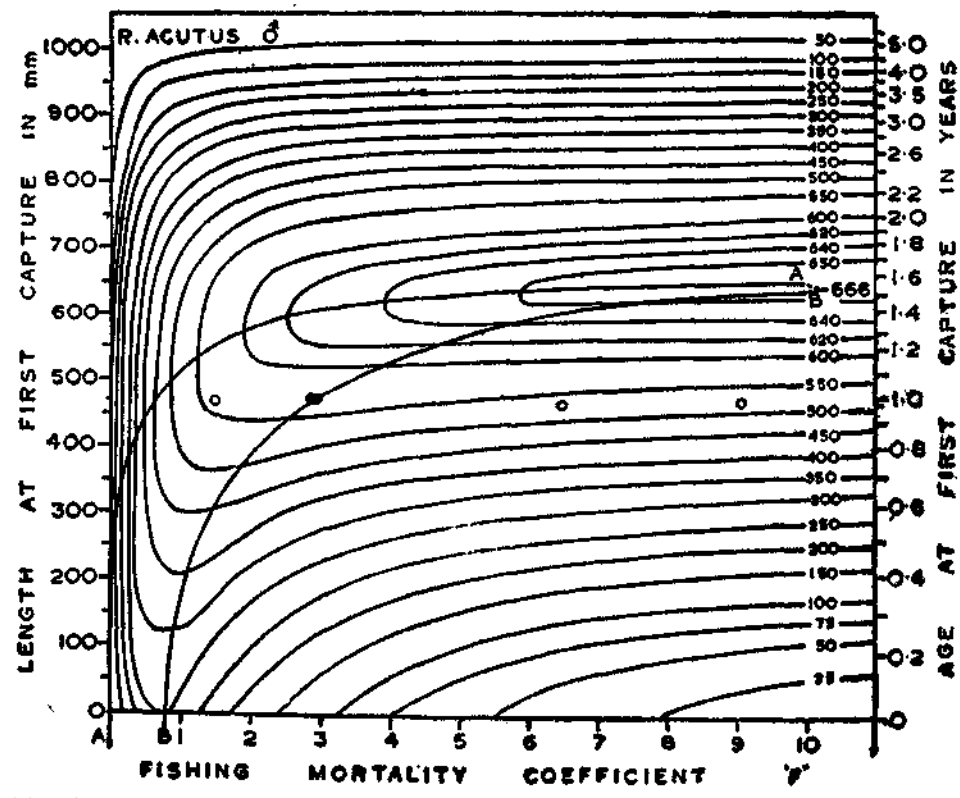

Fig. 13. Isopleth diagram for yield per recruit in gram of *Rhizoprionodon acutus* males from Veraval. The eumetric fishing curve (line A-A), maximum sustainable yield curve (line B-B) and potential yield per recruit of 666g are also shown.

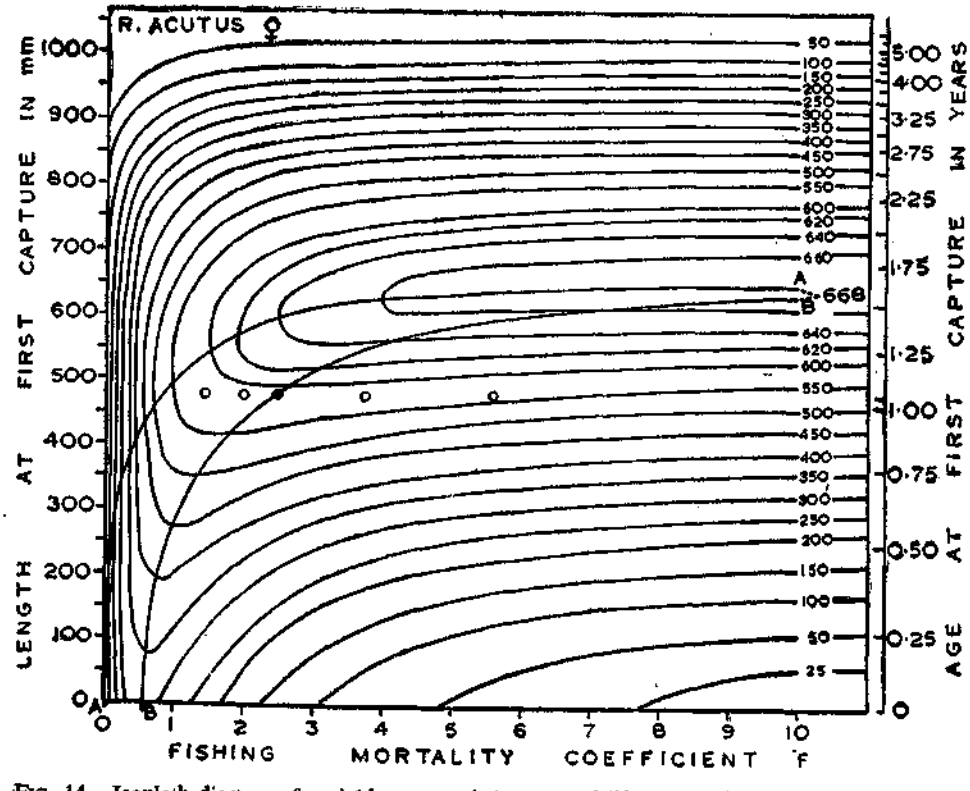

FIG. 14. Isopleth diagram for yield per recruit in gram of *Rhizoprionodon acutus* females from Veraval. The eumetric fishing curve (line A-A), maximum sustainable yield curve (line B-B) and potential yield per recruit of 668 g are also shown.

the total average of these two gears together, except the values obtained through Beverton and Holt (1956) method all other values obtained through other three methods are higher than the F_{max}.

As seen from the yield isopleth diagrams and considering the optimum age of exploitation, there is scope to increase the shark production further by increasing the age at first capture as close to the optimum age of exploitation as possible by manipulating the selection property of trawl and gill nets operated of Veraval. However, increasing the age at first capture means enlarging the mesh size which is not possible under the prevailing circumstances as the main aim of these two gears is to exploit some other resources and sharks form only by a catch in these gears. Nevertheless, as mentioned already a few gill net units operated large mesh sized drift gill nets during February-April, 1981 with the aim to exploit bigger sharks and increasing the operation of such gears may also be explored to increase the shark production.

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