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Skate fishery and some biological aspects of five species of skates off Mumbai

SADASHIV GOPAL RAJE
Mumbai Research Center of C.M.F.R.Institute, Mumbai-400 001, India

ABSTRACT

Skate landings as bycatch of trawlers at Mumbai declined from 1204.4 t in 1989 to 194.6 t in 2003, with an average annual landing of 334.8 t, at a catch rate of 248 kg/hr. The fishing pressure has reached optimum level, which is evidenced by a decline in catch and catch rate of skate population. *Rhynchobatus djiddensis* (93.2%) was the most dominant species, which landed throughout the year. Infomations on the biology of five species *Rhynchobatus djiddensis, Rhina ancylostoma, Rhinobatus granulatus, Rhinobatus obtusus* and *Rhinobatus annandalei* are presented.

Introduction

Maharashtra contributed 3.1% of the total elasmobranch catch in India in 2000. Among this, skates constituted 3% and almost the entire catch of skates was exploited by the trawl net (Raje, *et al*., 2002). Skates and rays are processed into fish meat jelly (Kamaboko) and dried skate wing (Ei-hire) in Japan (Ishihara, 1990). A study of this valuable resource was initiated at Mumbai from 1989 to 2003 since no information was available regarding its fishery and biology except for the brief account of Setna and Sarangdhar (1949).

The present paper deals with some aspects of the fishery and biology of five species of skates *Rhynchobatus djiddensis* (Forskal, 1775), *Rhina ancylostoma* (Bloch & Schneider, 1801) *Rhinobatus granulatus* (Cuvier, 1829), *R. obtusus* (Muller & Henle, 1841) and *R. annandalei* (Norman, 1926).

Materials and methods

Data on the catch, effort and species composition were collected from the commercial trawlers operating from New Ferry Wharf during 1989 to 2003. Data on total length, weight, sex, food habits and fecundity were also collected.

Results and discussion

Landings and effort

The annual average landing of skate by trawlers for the period from 1989 to 2003 at New Ferry Warf was 334.8 t with the average catch rate of 248 kg/hr. The catch indicated a general decline from 1204.4 t in 1989 to 194.6 t in 2003. The catch and catch rate appear to be declining in spite of increase in trawling effort. Devadoss (1984) reported that catch and CPUE of skates and rays fishery continued to decline even after reduction in the effort of trawlers.

The annual fishing effort showed an increase from 926.2 thousand trawling hours in 1989 to 1592.3 hrs in 2003. However, the trawler units indicated a decline from 27, 991 trawl trips in 1989 to 21,

890 trawl tips in 2003. This may be due to an increase in trawling hours as a result of multiday fishing. The annual fluctuation in number of trawling hours was mainly associated with availability of prawn, rough cyclonic weather conditions, local festivals, ban period etc.

Seasonal abundance

From Fig.1, it is to be noted that the monsoon has adversely affected the fishing activity. However, the CPH is not affected much except in June and July. It may be due to the operation of very few boats. The fact is that fishery is almost uniformly good throughout the year with some monthly fluctuations. Fisheries of skates was at its peak in February-April (38.7% at a CPH of 43.2kg) and in October-December (32.9% at a CPH of 36.7 kg).

Species composition and landings

Skate fishery in the trawl net off New Ferry Wharf was represented by 5 species (Family: Rhinobatidae). They are *Rhynchobatus djiddensis, Rhinobatus granulatus, R. annandalei, R. obtusus* and *Rhina ancylostoma. Pristis* spp. (Family: Pristidae) formed 0.30% of the skate landing. Devadoss (1984) also reported that *R.djiddensis* was the most common species in fishery off Calicut. The annual landing of *R.djiddensis* range from 1156.6 t during 1989 to 174.3 t in 2003. The 5 yearly average landings of species during 1989-1993, 1994-1998 and during 1999-2003 were 532.3 t, 231.6 t and 172 respectively, thus indicating a sharp decline over the years. This may be due to the exploitation of large number of juvenile and preadults coupled with low fecundity of the species.

R.granulatus accounted for 2.6% with annual average catch of 8.8 t. The average landing of this species during 1989-1993 was 9.3 t, which decreased to 5.2 t during 1994-1998, increasing thereafter to 11.9 t in 1999-2003. The catch of this species ranged from a 1.5 t in 1993 to 19.2 t in 2001. Seasonally, good catch was realised during January-March and November-December with a high in March. The average catch of *R.obtusus* declined drastically from 9.5 t (1989-1993) to 1.7 t (1999-2003). The lowest catch was recorded in 1998 (0.2t) and the highest in 1989 (21.3 t). The peak occurrence was during April and September-October with maximum landing during September (15.1 t). This species appears to have been over fished, as indicated by the decline in catch probably caused by the exploitation of mature stock than juveniles and pre-adults. The average catch of *R. annandalei* increased from 0.3 t (1994-1998) to 7.6 t (1999-2003). The landing showed increasing trend from 1.7 t in 2000 to 6.0 t in 2003. The

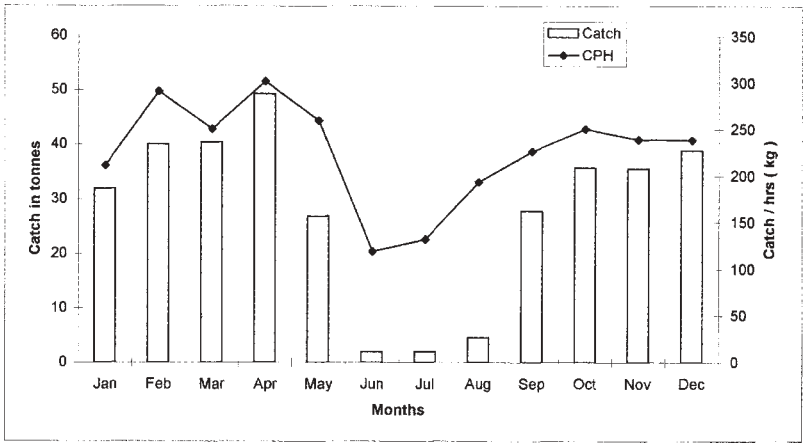

Fig.1. Monthly average catch (tonnes) and Catch rate (kg/hrs) of skates landed by trawlers at N.F. Wharf during 1989-2003

TABLE 1: *Annual species wise catch (t) and percentage (parenthesis) in total skates landed by trawlers at N.F. Wharf during 1989-2003.*

Years	Species composition					
	Pristis spp.	*R.djiddensis*	*R.granulatus*	*R.obtusus*	*R.annandalei*	*R. ancylostoma*
1989	2.5	1156.6	16.2	21.3	--	7.8
	(0.21)	(96.03)	(1.35)	(1.77)	--	(0.65)
1990	--	474.3	2.4	7.5	--	2.8
	--	(97.37)	(0.49)	(1.54)	--	(0.57)
1991	3.2	123.3	3.6	1.8	--	0.2
	(2.42)	(93.34)	(2.73)	(1.36)	--	(0.15)
1992	2.7	381.5	9.7	9.1	--	5.1
	(0.66)	(93.50)	(2.38)	(2.23)	--	(1.25)
1993	--	525.9	14.7	7.9	--	25.2
	--	(91.68)	(2.56)	(1.38)	--	(4.39)
Average						
1989-1993	1.68	532.32	9.32	9.52	--	8.22
%	(0.30)	(94.9)	(1.66)	(1.77)	--	(1.47)
1994	1.7	234.5	6.5	0.7	--	4.9
	(0.68)	(94.48)	(2.62)	(0.28)	--	(1.97)
1995	0.3	420.1	6.1	5.9	--	12.9
	(0.07)	(94.38)	(1.37)	(1.32)	--	(2.90)
1996	1.7	190.9	5.9	4.6	--	3.3
	(0.82)	(92.45)	(2.86)	(2.23)	--	(1.60)
1997	--	193.5	5.3	2.0	--	5.0
	--	(94.02)	(2.58)	(0.97)	--	(2.43)
1998	--	119.1	2.1	0.2	1.3	0.6
	--	(96.59	(1.70)	(0.16)	(1.05)	(0.49)
Average						
1994-1998	0.74	231.62	5.18	2.68	0.26	5.34
%	(0.30)	(94.23)	(2.11)	(1.09)	(0.11)	(2.17)
1999	--	160.8	6.8	6.9	21	0.8
	--	(81.92)	(3.46)	(3.52)	(10.70)	(0.41)
2000	--	244.4	6.8		1.7	4.5
	--	(94.95)	(2.64)	0.00	(0.66)	(1.75)
2001	2.8	169.8	19.2	1.6	3.7	4.0
	(1.39)	(84.39)	(9.54)	(0.80)	(1.84)	(1.99)
2002	--	111	15.1	--	5.4	7.1
	--	(80.03)	(10.89)	--	(3.89)	(5.12)
2003	--	174.3	11.6	--	6.0	2.5
	--	(89.57)	(5.96)	--	(3.08)	(1.28)
Average						
1999-2003	0.56	172.06	11.9	1.7	7.56	3.78
%	(0.28)	(87.1)	(6.02)	(0.86)	(3.83)	(1.91)
Average						
1989-2003	0.99	312	8.8	4.6	2.6	5.8
%	(0.30)	(93.2)	(2.63)	(1.37)	(0.78)	(1.73)

TABLE 2: *Monthly sex ratio of* R. djiddensis, R. granulatus, R. obtusus *and* R. annandale.

Species	*R.djiddensis*			*R.granulatus*			*R.obtusus*			*R.annandalei*		
Months	No. of specimens examined	Sex ratio M:F	Chi-square	No. of specimens examined	Sex ratio M:F	Chi-square	No. of specimens examined	Sex ratio M:F	Chi-square	No. of specimens examined	Sex ratio M:F	Chi-square
January	55	01:01.5	2.2	13	01:00.9	0.08	--	--	--	--	--	--
February	63	01:01.9	5.73**	13	01:02.2	1.92	4	01:00.3	1	--	--	--
March	51	01.01.3	0.96	20	01:01.2	0.2	3	01:00.5	0.33	--	--	--
April	34	01:00.6	1.88	6	1:01	0	13	01:01.2	0.07	1	01:00.0	0
May	5	01:00.3	1.86	1	0:01	0	--	--	--	7	01:00.2	3.57
June	21	01:02.5	3.86	1	0:01	0	--	--	--	4	1:01	0
July	--	--	--	--	--	--	13	01:02.2	1.92	--		
August	29	01:00.7	0.86	4	1:03	1	32	01:02.5	6.12**	64	01:02.4	10.56*
September	81	01:01.0	0.01	7	01:02.5	1.28	67	01:01.7	4.31**	284	01:02.5	50.70*
October	128	01:01.4	3.78	35	01:01.1	0.03	168	01:01.2	1.92	95	01:01.5	3.8
November	101	01:01.1	0.25	25	01:00.9	0.04	1	01:00.0	0	1	1:00	0
December	38	01:00.7	0.95	14	1:01	0	--	--	--	--	--	--
Pooled	606	01:01.2	4.12	139	01:01.2	1.21	301	01:01.4	8.64*	456	01:02.1	54.74*

*=Significant at 1% level **=Significant at 5% level

peak production period of this species appears to be September. *R. ancylostoma* constituted 1.7% of the skate with an average catch of 5.8 t (Table 1). The average catch of 8.2 t in 1989-1993 dropped to 1.9 t in 1999-2003. Maximum catch was recorded in 1993 (25.2 t) and minimum in 1991 (0.2 t). The catch of the species was better during January, August and December. *Pristis* spp. constituted only 0.3% with an average catch of 0.99 t. Its landing was sporadic and the maximum occurrence was during March-April. The decline in catch of these species may be due to low litter size and late maturation. Setna and Sarangdher (1949) reported the length of pregnant female of *P. cuspidatus* to be 243 cm. Taniuchi (1990) observed the decrease in annual batoid landing from 9,000 t (1985) to 6,000 t (1991) over the last five years in the Japanese fishery.

Biology

Food

Stomach content of *R.annandalei*, *R. djiddensis*, and *R.ancylostoma* was determined by volume of each category of food organisms. Among fishes, *Harpodon nehereus* (19.33%) constituted an important diet of *R. annandalei* followed by *Cynoglossus* spp., *Priacanthus hamrur* and *Trichiurus* spp. Crustacean food was composed of prawns and squilla. Fishes formed the main bulk of the diet of *R.djiddensis*. Among the fish, *H.nehereus* (73.24%) formed major item of diet followed by *Coilia dussumieri*, *Tripauchen vagina*, sciaenids and *Bregmaceros macclellandi*. Crabs (6.27%) was dominant food item

among the crustaceans followed by *Panulirus polyphagus, Nematopalaemon tenuipes*, squilla, prawns, *Acetes* spp. and *Parapeneopsis stylifera*. The food items observed in gut content of *R.ancylostoma* in order of abundance were sciaenids (38.1%), crabs, prawns, bivalves and cephalopods. The occurrence of demersal fishes, crustaceans and mollusc in the gut indicated that these species are benthic carnivores. Devadass (1984) reported that *R. djiddensis* feed on the bottom fishes, squids, prawns, crabs, squilla and polychaetes off Calicut. Venkateswaran (1967) noted appendages of *Squilla* spp., crabs and semi-digested organic matter in the diet of *R. ancylostoma* from Port Novo.

Sex ratio and population structure

R.djiddensis

The observed sex ratio of males to females was tested against 1:1 ratio by Chi-square. The ratio in this species for entire period of investigation was 1:1.18, showing no significant difference from the expected 1:1 ratio (Table 2). Significant Chi-square value was found in February only due to the predominance of females. The length range of brood was 210-422mm and sex ratio was 1:1. The length frequency distribution for the entire period showed that females attain larger size than males. Females were present in all the size class. The modal class for females were at 55,80,115,140 and 230 cm and for males the modal length were at 55,80,130 and 145 cm. The smallest mature male measured 132 cm, while the smallest female was 182cm in total length. The smallest pregnant female had a total length of 210cm. Presence of large number of juveniles and preadults in the fishery indicates migration into inshore waters and their exploitation by trawlers will have disastrous effect on this species. Similar concern was expressed by Bonfil *et al.* (1990) on the shark *Carcharhinus falciformis* in the commercial landing at Yucatan.

R. granulatus

The ratio of M: F in *R. granulatus* during the study period and in different months (Table 2) were not significant from the normal expected value. Males were smaller than females. There are two modes for females at 90, 130cm, and one for males at 85cm. Mature males were recorded from 75 cm onward.

R. obtusus

The 1:1.41 ratios of males to females for the entire period of observation were statistically significant at 1% level (Table 2) due to preponderance of females. Monthwise sex ratio showed significant difference during August and September with a predominance of females. There were two modes for females at 50 and 75cm, while males had a single mode at 50cm. Mature male and females respectively were encountered from 51 cm and 58 cm onward.

R.annandalei

The overall male : female ratio was statistically significant with 1:2.1 showing significant departure due to predominance of females. The analysis of sex ratio in months (Table 2) showed Chi-square value was significant in August-September with dominance of females which were larger than males. Adults of both the sexes dominated the catch. Mature males were observed at 50 cm and females at 59cm; pregnant females were noted at 60 cm. Maximum mature, pregnant and parturient females were observed during September-October. The size range of embryo was 115-223mm with a male to female ratio of 1:2.2. The sex ratio of captured specimens and that of embryo was more or less equal.

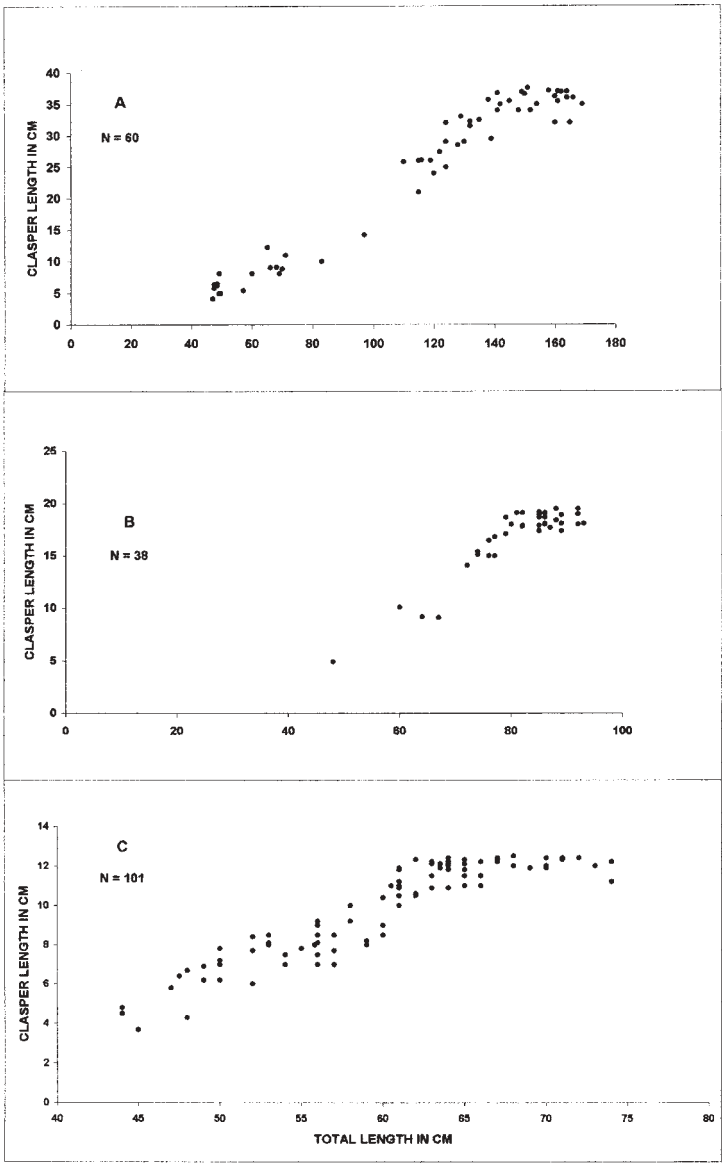

Fig.2. Relation between total length and clasper length of males of *R. djiddensis* (A), *R. granulatus* (B) and *R. annandalei* (C)

R.ancylostoma

The maximum size observed at Mumbai water was 210 cm. The proportion of male to female was 1:3. Pregnant females were noticed at 180 cm. The present study showed that females were larger than males, indicating differential growth rate as observed in other selachians by Schwartz (1983) and Devadoss (1998).

Maturation in males

Only external characteristics were used for the determination of sexual maturity in males. Maturity of males was determined by comparing total length of fish with clasper length. (Devadoss, 1978).

The smallest mature males of *R. djiddensis* with completely calcified clasper measured 132 cm. The growth of clasper slackens at a size of 140 cm (Fig.2 A) and after this, the growth rate is not appreciable and this size appeared to be the size at maturity. Similarly, males of *R. granulatus* mature at 80cm (Fig. 2B) and *R.annandalei* at 80 cm (Fig.2C).

Fecundity

Females of *R.djiddensis* (Table 3) produce 3-12 brood (Average-7); *R.annandalei* 3-20 (8.5), *R.obtusus* 1-6 (5.5), *R.granulatus*, 1-0(1), and *R.ancylostoma* 2-11 (6.5). Setna and Sarangdher (1949) reported 5-10 embryos in *R.djiddensis* in Bombay waters. Devadoss (1977) reported the range of embryos in *R.granulatus* to be 3-14 while in *R.obtusus*, the litter size range be-

TABLE 3: *Litter size of skates from Mumbai water*

Species	Range	Average	Maximum	Females examined	Study
R.djiddensis	3-12	8.0	12	7	Present
R.annandalei	3-20	8.5	20	9	"
R.obtusus	1-6	3.5	6	2	"
R.ancylostoma	2-11	6.5	11	2	"
R.grannulatus	1	1	1	1	"
R.djiddensis	5-10	7.8	10	11	Setna and Sarangdhar (1949)
Anoxipristis cuspic	3-8	5.7	8	4	"

tween 4-8 from Porto Novo. The same author has noticed up to 12 embryos in a single specimen of *R.granulatus* at Cuddalore. Devadoss and Hameed Batcha (1995) recorded nine brood in *R.ancylostoma* from Madras.

Length-weight relationship

R.djiddensis: A total of 210 numbers of males (TL: 41.7-191.0 cm) and 208 females (TL: 42.2-170.0 cm) was studied. Analysis of covariance revealed no significant difference in the regression coefficient between the sexes. Therefore, a pooled equation was arrived at as:

Log W=-12.1451+2.9794 LogL(r=0.97)

R.granulatus : A total of 42 males (47.1-193 cm) and 49 females (36-153 cm) were used. In this species also, there was no significant difference found between the sexes and hence a common equation was derived as:

Log W= -10.3213+2.6342 Log L(r=0.89)

R.obtusus: In a total of 123 males (26-76 cm) and 174 females (36.9-80 cm) were analysed for length-weight relationship, the difference in the regression between the sexes was significant at 1% level in slope and elevation. Therefore, seperate regression equation are given as:

Males : Log W=-6.6566+2.0559 LogL(r=0.87)

Females :Log W=-11.3859+2.8179 LogL(r=0.95)

R.annandalei:In this species also, male (85 numbers:30+74 cm) and females (179 females:27.5-98 cm) studied had their regression difference at 1% level in slope. Hence, separate formulae are given as:

Males:Log W=-3.6020+2.3234LogL (r=0.08)

Females:

Log W = -4.3293+2.9568LogL(r=0.91)

Abdurahiman *et al.* (2004). estimated 'a' and 'b' value for male as 0.004 and 2.910(r=0.94) and for females as 0.005 and 2.889 (r=0.97) respectively for *R. granulatus* from the southern coast of Karnataka.

The apparent reduction in stock of skates over the last fifteen years might be associated with limited brood number, late maturity in both the sexes, capture of large number of juveniles, preadults, mature stock of certain species, long gestation period and increasing fishing hours. Holden (1973, 1974) has observed relatively few offspring, late maturity and slow growth in some elasmobranchs and stated that these characteristics generally make the group vulnerable to overfishing.

It appears that the, stock of the

skates cannot be sustained, with increasing fishing pressure. Hence, conservation and management measures are necessary. The adult females had to be given considerable protection for sustainable fisheries (Holden, 1968, 1974). The size of population and regulatory size limits would have to be established, thus providing the non-reproductive individuals an opportunity to mature and reproduce (Martin and Cailiet, 1998). Reduction in effort is highly essential to maintain the MSY of elasmobranchs at most of the centres along the Indian coast (Devadoss, *et al.*, 1998). Given the limited ability of many shark species to increase their population size, this multi-species stock will take many years to recover, even after stringent management measure are implemented (Hoff, 1990).

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