CMFRI
bulletin 44
Part One

JUNE 1989

NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP
16-18 September 1987

Papers Presented
Sessions I & II

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

Central Marine Fisheries Research Institute
40
YEARS
1947-1987

THE PRESENT STATUS AND FUTURE PROSPECTS OF ELASMOBRANCH FISHERY IN INDIA

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ABSTRACT

An increasing trend in the annual catch of elasmobranch fishery from 35.6 thousand tonnes during sixties to 53.9 thousand tonnes during seventies and 59.6 thousand tonnes during the current decade (upto 1985) was observed. This increase is mainly due to the large scale mechanisation of the fishery during the seventies. At present, though 65% of the resources is from the west coast, Tamilnadu ranks first contributing 25% of the all India catches.

The optimum levels of effort to get the MSY for sharks and rays using the Schaffer model at selected centres have been worked out and presented. The study has indicated that there is scope for increasing the trawling effort at Visakapatnam, Mandapam and Rameswaram whereas reduction of trawling effort is suggested for Madras, Kakinada, Tuticorin, Calicut and Bombay. The MSY worked out for the gill net at Cuddalore suggested the advisability of increasing the effort whereas a reduction of the effort is indicated for Calicut

Similarly MSY for sharks obtained in the trawlers at Tuticorin and Nagapatnam indicatss the need for a reduction in fishing effort at Tuticorin and increasing the effort at Nagapatnam.

INTRODUCTION

The sharks, skates and rays from one of the important groups of commercial fishes on both the coasts of India which earned a foreign exchange value of Rs. 217 9 lakhs during the year 1984. The average annual production for 10 years 1976-1985 was found to be 58,862 t. These catches are recorded along with different types of gears used mainly for catching other fishes and hence they are found unsuitable for catching larger sharks. As such it can be said that there is no gear available for these groups exclusively.

The resources of this fishery has not so far been highlighted in India, even though it contributes around 4% of the all India catch. Some literature on elasmobranchs worth while mentioning were by Setna and Sarngdhar (1946 and 1949). James (1973) summarised the available information on this group in India. Subsequently, Devadoss (1977, 1978 a and b, 1979, 1984 a and b) studied on some aspects of the biology and fishery of few species of this group.

In this paper* an attempt has also been made to throw light on the possibility of increasing or decreasing the fishing effort to achieve the maximum sustainable yied all along the coasts.

ALL INDIA ELASMOBRANCH PRODUCTION

For the 25 year peried 1961-1985 the elasmobranch catches fluctuated between 29,401 t (1967) and 69,844 t (1983) with the annual average of around 50,159 t. There is sharp increase in the average catch of this group from 35.6 throusand tonnes during sixties to 53.9 thousand tonnes during the seventies and in eighties upto 1985 it reached the peak contributing 59.6 thousand tonnes (CMFRI, 1982, 1983 and 1986). Figure 1 depicts for the period 1961-1985. The increase in the landings was very much notable from 1974 onwards. The catch during 1973 was 44, 917 and increased to 66,054 t during 1974, showing an increase of 47% over that of 1973. It is also observed that the catches were more or less steady and never

* This formed part of the thesis for the degree of Ph. D of Annamalai University by P. Devadoss

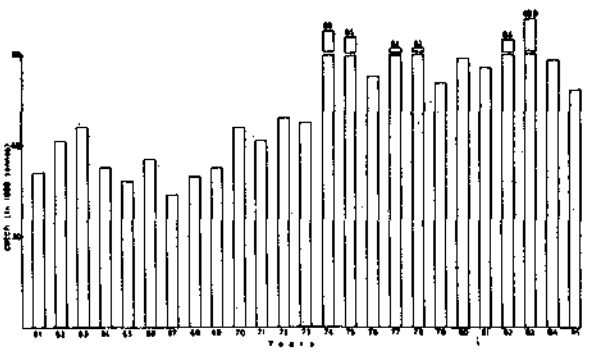

Fig. 1. Annual landings of elasmobranchs for the years 1961-1985

fell below 52 thousand tonnes. This increase in the catch is due to the significant increase in mechanised fishing effort and rapid development in the infrastructural facilities for the fishing industry as a whole.

The major species contributing to the fishery consists of *Carcharhinus sorrah, C. limbatus, C. dussumieri, C. melanopterus, C. marcloti, Galeocerdo cuvier, Hemipristis elongatus, Scoliodon laticaudus, Loxodon macrohinus, Rhizoprionodon acutus, R. oligolinx, Isurus oxyrhincus, Sphyrna blochii, S. lewini, S. mokarran, Rhynchobatus djeddensis, Rhinobatus granulatus, Rhina ancylostoma, Dasyatis sephen, D. uarnak, D. imbricatus, D. marginatus D alcockii, Aetobatus narinari, Aetomylus nichofii, A. maculatus, Rhinoptera javanica, Gymnura poecilura* and *Mobula diabolus*. Some oppear casually in the fishery and these include the whafe shark, cat sharks, Saw fish and electric rays.

TREND OF PRODUCTION ALONG THE EAST AND WEST COASTS

For the ten year period 1976-1985, the annual average elasmobranchs landed from the east and West coasts was 25,603t (43.5%) and 33,258t (56.5%) respectively (Table 1). It will be seen that the total catch shows considerable fluctuations in both the coasts. Unlike other fisheries which reveal a pattern of 25:75 for the east and west coasts respectively, elasmobranch fishery has showed no such marked variations between both the coasts (Fig 2).

TABLE 1.

Trend of elasmobranch production along the east and west coasts of India during 1976 - 1985

Year	*Catch in East coast* Catch (tonnes)	Increase/decrease over previous year (%age)	*Cesch in West coasf* Catch (tonnes)	Increase decrease over previovs year (%age)	Total	Increase/ decrease
1976	29,431		25,174		54,605	
1977	26,950	— 8.4	35,266	+40.1	62,216	+13.9
1978	27,624	+ 2.5	33,997	— 3.5	61,621	— 0.9
1979	24,272	—12.1	28,571	—15.9	52,843	—14.2
1980	25,661	+ 1.6	33,201	+16.2	57,862	+ 9.5
1981	22,704	— 7.9	33,305	+ 0.3	56.009	+ 3.2
1982	24,231	+ 6.7	40,085	+20.4	64,316	+14.8
1983	31,489	+30.0	38,355	— 4.3	69,844	+18.6
1984	24,845	—21.1	32,796	—14.5	57,641	—17.5
1985	19,825	—20.2	31,834	— 2.9	51,659	—10.4
Total	256,032		332,584		558,616	
Average	25,503		33,258		58,862	
Percentage	43.5		56.5		100.00	

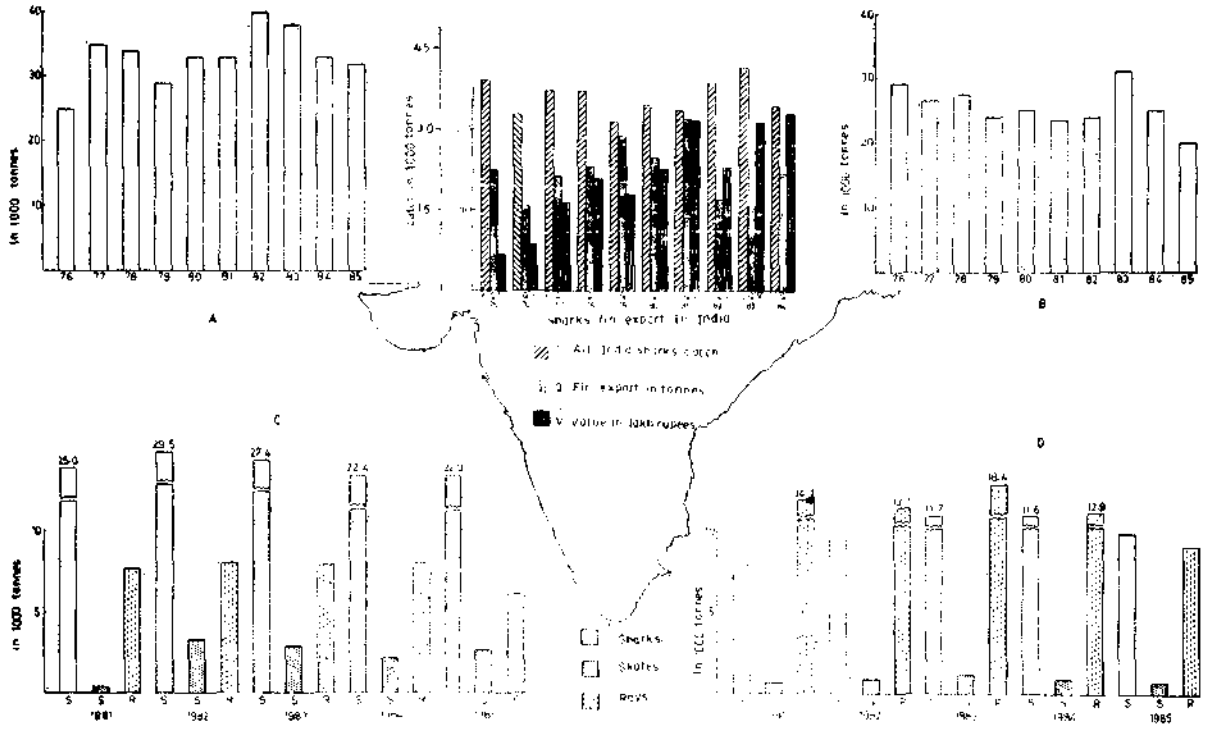

Fig. 2. Elasmobranch production along the east and west coasts of India and export figures for shark fins. A. Elasmobranch catch during 1976-1985 on the west cost B. Elasmobranch catch during 1976-1985 on the east coast C. Trends in catch of sharks, skates and rays in 1985 on the west coast. D. Trends in catch of sharks, skates and rays in 1984-1985 on the east coast.

DETAILS OF STATE-WISE PRODUCTION

The state-wise average production of elasmobranches is shown in figure 3. The estimated catch for the ten year period, 1976-1985 revealed that Tamilnadu ranked first with an average landings of 14,783 t which constitutes 25% of the total elasmobranch landings of

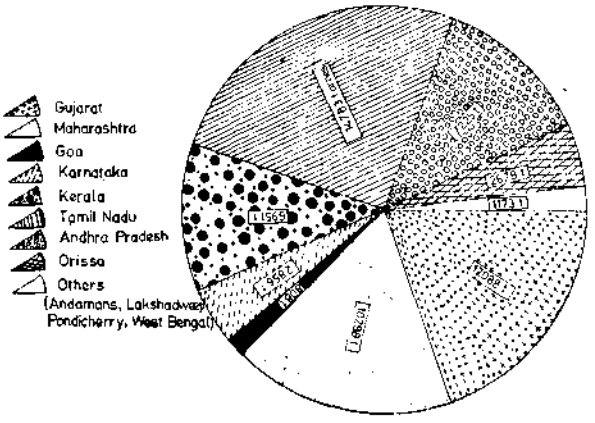

Fig. 3. Contribution of elasmobranchs from the maritime states and union territories.

India. Gujarat with 12,088 t ranked second forming 20.5%. West Bengal contributed a dismal 0.7% of the catch. The Union Territories of Pondicherry, Andamans and Lakshadweep together contributed 1.2%. While fishes almost all round the year as incidental catch, in Tamilnadu and in certain parts of southern Andhra Pradesh a specialised bottom fixed net for rays and skates is operated during September, October and January to March period when large quantities of rays and skates are landed.

It is noted from the data furnished that the increased production in the year 1983 may be attributed mainly to the increased landings from Tamilnadu, Kerala and Maharashtra. While the fishery showed fluctuating trends in almost all the states like Andhra Pradesh, Maharashtra and Gujarat produced a definite pattern of catch. Andhra Pradesh recorded an increasing trend in recent years—1983, 1984 and 1985 as Gujarat reached maximum catch during 1980-1982 and Maharashtra during 1982 and 1983.

GROUP-WISE LANDINGS

Analysis of data for the period 1981-85, presented in table 2 in respect of three major groups, sharks, skates and rays, revealed the

TABLE 2.

All India landings o sharks, skates and rays (In tonnes)

Year	Sharks		Skates		Rays		Total
	West coast	East coast	West cost	East cost	West cost	East cost	
1981	25,184	7,927	397	661	7,063	14,777	56,009
1982	29,568	10,196	2,422	923	7,142	14,065	64,316
1983	27,455	11,772	2,916	1,288	7,981	18,429	69,844
1984	22,455	11,064	2,254	861	8,087	12,920	57,641
1985	22,910	9,825	2,716	799	6,208	9,201	51,659
Total	127,527	50,786	10,708	4,532	36,481	69,392	299,469
Average	25,552	10,157	2,142	906	7,296	13,878	59,894
Percentage	71.5	28 5	70.3	29.7	34.4	65.6	—

dominance of sharks in all years (fig 2). Sharks contribution during the five years, works out on an average to 59.6%, followed by rays 35.3% and sharks 5.1%. West coast emerged as centre for sharks fishing (71.5%) as east coast for rays (65.6%) as shown in table 2 Even though the contribution by sharks was not impressive, 70% of them were landed from west coast. The peak landing was noticed during 1982 and 1983 for sharks and 183 for rays and sharks. The following years, 1984 and 1985 recorded a declining trend. Species of gray sharks *carcharhinus* dominated the sharks catch with 70-75%, while *Dasyatis* formed 68% of the rays and skates fishery at Calicut (Devadoss, 1984).

GEAR-WISE CATCH

Elasmobranchs are landed mainly by gill nets and trawls. Hooks and line also is used some times, but the catch is negligible. Gearwise landing estimated for the period 1981-85 are presented in table 3. Since particulars of catch are not available for all the centres, details are projected only from all centres. Trawlers landed 80% of the elasmobranchs, while gill nets' contribution was 19%, the remaining by other units.

At Visakapatnam and Kakinada rays and skates formed 90% and 87% respectively of the elasmobranchs landed by trawl (fig.4) Rays and skates also dominated the elasmobranchs landed by trawlers at Madras, Nagapatnam, Mandapam, Rameswaram and Tuticorin with 65-100% and sharks formed 70-90% among the elasmobranchs from gill net catches of these centres. The Major centres of Kerala, Sakthikulangara, Cochin and Calicut accounted for more than 90% sharks in the elasmobranchs landed by gill nets, while rays and skates shared 85% of elasmobranchs landed by the trawls. The same trend is noticed at Veraval and New ferry wharf af Bombay, but the catches at Bombay's sasoon dock and Mangalore revealed the dominance of sharks from both the gears, whereas at Tuticorin the gill net catches of elasmobranchs showed 50% by skates and rays.

The catch trend appeared to show Sakthikulankara, Cochin, Calicut and Mangalore as centres of shark fishing (drift gill net), and other centres for rays and skates (trawl).

ESTIMATION OF SUSTAINABLE YIELD (MSY)

Based on the recent years catch and effort for sharks and rays from the mechanised trawls and gill nets the surplus production model i.e, Schaffer model (Ricker, 1975), the maximum sustainable yield (MSY) and the optimum level of effort to get the MSY was estimated in major centres of India. The percentage contribution of sharks, skates and rays, cpue and total catch of

TABLE 3.

Percentage contribution of sharks, skates and rays; catch per unit effort and total catch of elasmobranchs in trawls and gill nets (in parenthesis)

Centres	Sharks %	Skates %	rays %	CPUE (kg)	Total catch (t)
Visakapatnam	10	28	62	4 3	126
Kakinada	13	16	71	8.9	384
Madras	35	12	53	8.7	259
Cuddalore	71	5	24	39.4	68
Cuddalore	(90)	(0)	(10)	(179.1)	(252)
Nagapatnam	7	2	91	13.2	344
Mandapam	0	0	100	5.4	242
Pamban Palk Bay	(54)	(0)	(46)	(6.7)	(70)
Pamban Gulf of Mannar	(90)	(0)	(10)	(17.0)	(118)
Rameswaram	0	0	100	31.8	2,930
Tuticorin	34	0	66	17.2	601
	(50)	(0)	(50)	(8.5)	(4)
Sakthikulangara	11	0	89	2.3	349
Cochin	(94)	(1)	(5)	(52.1)	(645)
Cochin	12	11	87	1.2	58
	(95)	(1)	(4)	(23.2)	(434)
Calicut	15	0	85	7.1	33
	(97)	(0)	(3)	(35.3)	(107)
Mangalore	70	0	30	1.3	49
	(100)	(0)	(0)	(16.7)	(47)
Bombay Sasson Docks	64	10	26	67.8	1589
	(72)	(7)	(21)	(79.8)	(309)
Bombay New Ferry Warf	33	29	38	182.1	3,496
	(90)	(0)	(10)	(68.0)	(10)
Veraval	23	25	52	—	965
	(78)	(0)	(22)	(—)	(425)

elamobranchs in trawl net and gill net are given in table 3 for different centres. In general rays dominates trawl catch except in centres of Bombay and Mangalore where sharks contributed 64% and 70% respectively in the elasmobranchs catch. But in gill netters shark formed the major portion. The present (1980-85) annual average catch, effort and cpue and estimated MSY, sharks and rays in different centres are given in tables 4 and 5. The salient features are discussed centre-wise.

Visakapatnam : At the Visakapatnam outer harbour during the years 1980-85 the average elasmobranch catch by trawl was 126 t the cpue being 4.3 kg. The percentage of sharks, skates and rays was 10, 20 and 62 respectively. The number of operations varied between 27 and 35 thousands. The estimated MSY for rays was 166 t and for sharks 14 t. As the present catch of rays and sharks were 78 t and 13 t, there is much scope for increased trawl effort for rays.

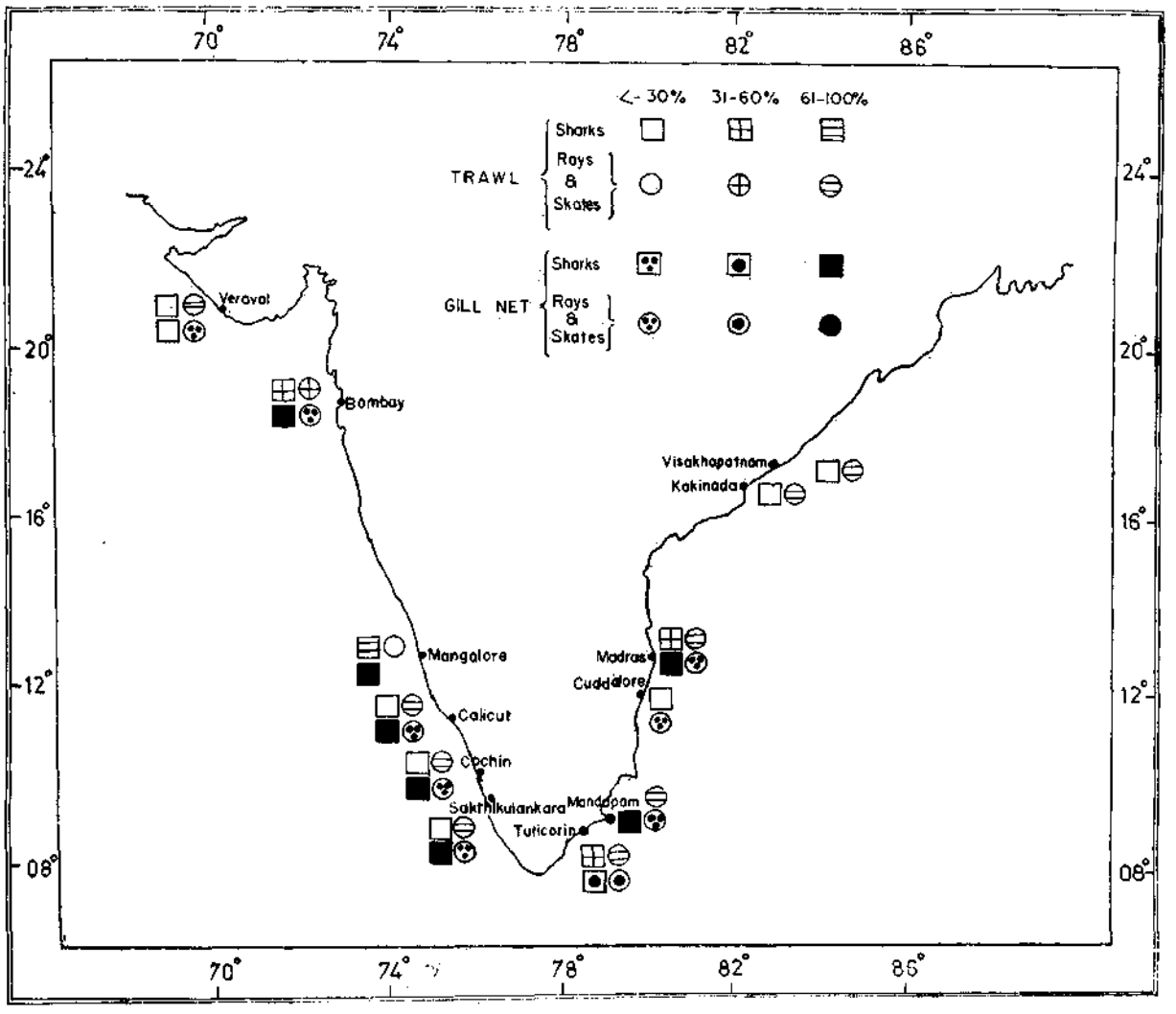

Fig. 4. Distribution pattern of sharks, skates and rays at selected centres.

Kakinada : The contributions of elasmobranchs by trawl ranged between 310 and 469 t with an average of 384 t. Rays contributed 71% and skates and sharks 16 and 13% repectively. The estimated MSY for rays and sharks were 305 t and 44 t as against the present average of 274 t and 40 t landed respectively. To obtain the MSY for rays, a reduction of 23% and for sharks an increase of 10% effort is suggested. The present average effort was 31 thousand trawl operations.

Madras : Trawlers landed 83-560 t of elasmobranchs with an average of 259 t and a cpue of 8.7 Kg. Rays formed 53% and sharks 35% and skates 12%. In gill netters the contributions of sharks, skates and rays 71%, 24% and 5% respectively of 68 t of the average catch. The estimated MSY for rays in the trawl catch and gill net were 167 and 31 t respectively as against the present average landings of 135 t of rays and 16 t of sharks. To obtain the MSY, a reduction of 19% trawl effort and an increase in gill net effort of 93% is advised. The present average catch of sharks were 111 t and 48 t from trawlers and gill netters and the calculated MSY were 154 t and 64 t. An increase of 103% and 98% of trawl and gill net efforts is necessary to obtain the MSY of sharks.

Nagapatnam : The elasmobranchs catch fluctuated form 78 t to 605 t with an average of 344 t by trawlers. Rays and sharks contributed 90% and 7% respectively with an average cpue of 12.0 kg and 0.8 kg. The annual average catches were 319 t for rays and 19 t for sharks. The estamated MSY for sharks was found to be 21 t.

Cuddalore : The gill net fishery contributed 95-550 t of elasmobranchs, the annual average

being 252 t and cupe 159 kg. Sharks formed 90% and the rest by rays. The MSY for sharks and rays were 375.27 t and an increase of 3% efrort for sharks and 23% for rays is possible to get the MSY.

Mandapam : Among the elasmobranchs rays dominated the catch in trawlers which fluctuated between 209 and 332 t. The MSY for rays was 419 t as against the present catch of 242 t as average. An increased effort of 182% is recommended to obtain the MSY.

Rameswarem : Rays contributed the entire elasmobranch catch by trawlers which fluctuated between 2330-3453 t with an average annual catch and cpue of 2930 t and 31.8 kg respectively. The MSY calculated was 4042 t suggesting an increased effort of 108%.

Pamban: The indigenous drift gill nets from Palk Bay and Gulf of Mannar contributed an average annual catch of 70 and 118 t respectively during the years 1970-76. Sharks formed 90% from the Gulf of Mannar and 54% from the Palk Bay and the rest by rays. The average cpue of gill net for sharks was 15.2 and 2 6 kg.

Calicut : During the years 1971-80 the elasmobranch catch by trawlers fluctuated between 14-67 t, the average annual catch being 38 t. Rays formed 85% and sharks 15%. The MSY for rays was 41 t and the effort required was only 5 thousand as against the average catch of 33 t 6 thousand boat day operations. So a reduction of 19% trawl effort is necessary to get the MSY. The average gill net catch was 104 t, sharks forming 97%. Here also a reduction of 7% effort is advisable.

Bombay : At Sassoon dock, the annual average catch by trawlers was estimated as 1587 t during the period 1980-85. Sharks contributed 64% and skates and rays 10% and 26% respectively. Gill net landed an annual average catch of 309 t of which sharks, skates and rays contributed 72%, 7% and 21% respectively. To achieve the MSY of 618 and 75 t from trawl and gill net as against 416 and 65 t a reduction of trawling effort is necessary. In regard to gill net an increase of 57% effort is needed to get the MSY of 256 t of sharks from the present level of 214 t. At New Ferry Wharf, trawlers landed an annual catch of 3496 t of elasmobranchs with a cpue of 182 kg, sharks, skates and rays contributing 33%, 29% and 38% respectixely Gill nets landed 9 t of sharks annually.

Veraval : During the years 1983-84 and 1984-85 trawlers landed 956 and 974 t of which sharks, skates and rays formed 23%, 25% 52% respectively Gill nets landed 276 and 574 tonnes during the same period of which sharks shared 78% and the rest by rays.

NOTES ON THE BIOLOGY OF SOME IMPORTANT SPECIES

Sharks of the family carcharhinidae are the most important groups dominating the fishery all over the world. Similarly *Carcharhinus* formed the bulk of the catches of our coasts also. The following species are commonly reported in the Indian coasts.

Carcharhinus limbatus: This shark is cosmopolitan in distribution in the inshore regions of tropical waters. It is capable of tolerating reduced salinities, but never penetrates into fresh water. Feeds primarily on fishes like sardines, mackerels, croackers and soles; cephalopods and crustaceans are also taken. Devadoss (1977) recorded that mackerels formed the main diet during the mackerel season, April-June at Porto Novo. Grows to maximum of 2.5 m. Males mature at 140-150 cm and females at 150-160 cm producing an average of 6 embryos per litter and the size at birth is 55-60 cm. They are usually caught in drift gill net, hooks and line and bottom set net.

C. sorrah: This is also a common shark fished along the coasts of India and it often frequents coral reefs. A short and sturdy species, it grows to around 1 5 m. Feeds on bony fishes like mackerels, flying fishes, sardines, squids and prawns. Males mature at 115 cm and females at 120 cm (Devadoss, 1977). Litter size is 2-6 young and size at birth is 40 cm when they are delivered during March-May in Indian coasts.

C. dussumieri A small, common species of shark in the inshore waters, often confused with its closely resembling cousin *C. sealie* (= *C. Meni sorrah*). Feeds on small fish squids and

crustaceans. It grows to a meter long; males maturing at 65 cm and female at 76 cm. Size at birth is 35 cm Breeding throughout the year in East Indies (Teshima and Mizue 1972). Development, viviparous method, having a litter size of 2 embryos

C. melanopterus: A wide ranging Indo-pacific tropical shark and is capable of migrating into estuaries and brackish water for the purpose of delivering their pups. Grows to 2-2.5 m Young ones just born with fresh umbilical scar, 45-50 cm in total length were often recorded during November-December in the estuary of the river Chaliyar, South of Calicut city. The young were taken in the gill net set with in a kilometer range from the river mouth. Feed includes a veriety of fishes like mullets, silver bellies, anchovies, hilsa, skates, prawn and *Squilla*. It is commonly fished by drift gill net and long line.

C. macloti: A small medium sized shark grown upto a little over a meter in length. Fished by drift gill net and hooks and line, marketed fresh, sometimes salt-dried. Its diet consists of small fish, crustanceans and squids Males matuer at 60 cm and females at 70 cm producing 2 young per litter, young measure 35 cm at birth.

Galeocerdo cuvieri: The largest recorded measured 740 cm. A widely distributed tropical shark capable of cruising in mid ocean. It shows nocturnal movement into bays and esturaries. Feed includes a wide variety of marine and terrestrial form. Fishes eaten included all kinds, eels, cat fishes, parrot fishes flat fishes, flat heads, flying fishes, procupine fishes, puffers, skates and rays. Marine reptiles eaten are sea turtles, green logger heads and ridley turtles. Even sea snakes are not spared Sea birds including cormorrnts and pelicane are other items of the diet. Marine mammals taken by this shark are sea lions, seals and dolphins, carrion from terrestrical birds and mammals is common. Inanimate objects which may by accidental inclusions in their stomach are leather bags, pieces of coal and wood, cans and small barrels.

Tiger shark is one of the dangerous sharks known for attacking divers and swimmers and boats. Among tropical sharks tiger shark has worst reputation as man eater.

Development is ovoviviparious, litter size is very large, 10–82 and size at birth is 50-75 cm pupping is reported in November - January in Bombay waters (Sanagdhar, 1944).

Scoliodon laticaudus : An abundant species in west coast and southern part of east coast of India. It is very rare in the North Tamil nadu coast. It grows to 65 cm but majority of males grow up to 50-55 cm and female up to 65 cm. This is mainly caught in trawl. But those caught in drift gill net are females above 50 cm. Maturity at 30 cm and 35 cm for males and females respectively. Development is viviparous with yolksac placenta, breeding almost throughout the year, and produces upto 20 embryos per litter. Size at birth is 14.5 cm. Food consists of small fishes, crustaceans and squids.

Rhizoprionodon acutus : A medium sized shark in the inshore regions, grows to a little over one meter. It is more abundant in west coast during September to February and in East coast during summer months. Feeds on small fishes, squids and cuttle fish, crabs and shrimps. Viviparous mode of development with yolk sec placenta number of young varies from 2-6. Parturition takes place during summer months on the east coasts, size at birth is 26-27 cm.

Next to grey sharks, hammer head sharks form a sizable fishery. Of the four species recorded. Only *Sphvrna lewini* is very common. *S. blochii* and *S. mokarran* are less important.

S. lewini: This is most common hammer head shark in our coasts. A highly migratory form found in the tropical region of the oceans. Instances of sexual segregation are reported. Feeds on fishes like sardines, anchovies, mackerel, eels, milk fish, soles etc. Sharks and rays are also eaten. Development is viviparous with yolk-sec plecenta and a litter size of 15-30 pups. A maximum of 20 pups was observed (Devadoss 1977) in our coast. The size at birth is 45-55 cm and grows to 4.2 m.

Saw fish : - *Pristis microdon* and *P. cuspidatus* are sporadically caught. The former is reported to grow to 25 feetm but actually specimens upto 5 m are often met with. The season for the saw fish fishery is during March - September in the east coast, gravid females were caught during

TABLE 4.

Annual avarage catch, effort and CPUE for the years 1980-85 and estimited MSY, effort (fmsy) and catch per effort (Y/f) for rays in trawl (T) and gill net (G) catches in different centres.

Center	Name of Unit	Catch (t)	Effort (x 1000)	CPUE (kg)	MSY (t)	f msy (x 1000)	y/f (kg)	Effort to MSY
Visakapatnam	T	78	31	2.6	234	166	1 4	+442%
Kakinada	T	274	40	7.0	305	31	9.9	— 23%
Madras	T	135	32	6.0	167	26	6.6	— 19%
	G	16	2	11.9	31	4	7.8	+ 98%
Nagapatnam	T	319	26	12.0	—	—	—	—
Cuddalore	G	19	2	11.1	27	3	9.1	+ 26%
Mandapam	T	242	45	5.4	419	127	3.3	+ 182%
Rameswaram	T	2530	93	31,8	4042	193	20.9	+ 108%
Tuticorin	T	321	40	8.8	462	27	17.4	— 33%
Sakthikulangara	T	312	132	2.3	—	—	—	—
Calicut	T	33	6	6.3	41	5	8 1	— 19%
	G	2	3	0.8	2	3	0.9	— 7%
Bombay Sassoon Dock	T	416	22	18.6	618	14	43 2	— 36%
	G	65	4	17.2	75	3	25.7	— 26%
Bombay New Ferry Wharf	T	1666	24	70.3	—	—	—	—

TABLE 5.

Annual average catch, effort and CPUE for the years 1980-85 and estimated MSY, effort (f msy) and catch per effort (y/f) for sharks in trawl (T) and Gill net (G) in different centres.

Centre	Name of unit	catch (t)	Effort (x 1000)	CPUE (kg)	MSY (t)	f msy (x 1000)	y/f (kg)	Effort to MSY
Visakapatnam	T	13	31	0.4	14	33	0.4	+ 6%
Kakinada	T	48	40	1.2	50	44	1.1	+ 10%
Madras	T	111	32	3.5	154	65	2.4	+ 103%
	G	48	2	25.6	64	4	17.1	+ 96%
Nagapatnam	T	19	26	0.8	21	29	0.7	+ 36%
Cuddalore	G	226	2	165.5	375	2	161.1	+ 3%
Tuticorin	T	280	40	7 0	379	26	14.6	— 35%
Sakthikulangara	T	38	132	0.3	—	—	—	—
Calicut	T	5	6	0.8	—	—	—	—
	G	31	3	10.3	—	—	—	—
Bombay Sassoon Dock	T	1018	22	45.4	—	—	—	—
	G	214	4	56.9	256	6	41.8	+ 57%

May - July when they move shoreward for delivering their pups.

Other Skates : *Rhonchobatus dieddensis* and *Rhinobatus granulatus* are commonly fished. *R. dieddensis* grows to more than 3 m and mature at 1.5 m. Females carry full term embryos in the uterus as well as fully developed ova 10-12 cm in the ovaries at the same time. Upto 12 embryos in a litter were recorded at Madras. Feeds on fishes, prawns, molluscs and polychaete worms. Fishes included apogonids, juvenile eels, thread fins and flat heads. Highly priced among sharks and skates, its fins have good export value. *Rhinobatus granulatus* grows to 2.5 m in our waters. The smallest female with developed ovary and large ova measured 120 cm. Mature ova and full term embryos exist at the same time inside a female suggesting a quick succession of ovulation and fertilization after birth of young. The maximum of 14 embryos observed were equally distributed in both uteri. It has an extended breeding season, gestation period is about 6 months. Feeds on small crustacean like amphipods, *squilla*, small crabs and prawn.

Rays: Among the rays the species of *Dasyatis* dominate the fishery. Besides, other groups of rays like *Aetobatus*, *Aetomylus* and Rhinoptera also from an occasional fishery. *Dasyatis uarnak* is a large ray the maximum recorded by the authors at Madras measured 1.8 m. A predator, it causes extensive damage to the fishery. Feeds on a wide variety of fishes and other animals (Devadoss, 1978). For instance one ray had consumed about 140 nos. of prawns, fishes, crabs, *Squilla*, *Thenus* squids, gastropods, bivalve and jelly fish. *D. sephen* is another large and heavy ray which grows to more than 1.6 m. Males mature at 70 cm and females at 80 cm. Development is by ovoviviparity without any yolk-sac placenta. Litter has 2 embryos and the size at birth is 25 cm across disc. The diet consisting of crustaceans, molluscs and fishes. Polychaete worms are also prefered (Devadoss, 1978). *D. alcockii* grows to moderate size of around 1.25 m. This ray feeds on polychaetes, crustaceans, molluscs and sea squirts. *D. imbricatus* is the smallest among the sting rays and is common in our coasts. It is a bottom feeder, feeding on small burrowing and buried crustaceans and polychaetes (Devadoss, 1984 a). It develops both ova and embroys simultaneously. Breeding extends over a period of six months producing one to two young per litter by ovoviviparious mode with a size at birth of 75 mm. It grows to 22 – 23 cm and maturity is determined at 16.0 - 17.0 cm for males and 17.0 to 18.0 cm for females. *D. zugei* is another smaller ray which grows to 26.0 to 30.0 cm and is fished along with *D. imbricatus* by trawl.

Aetobatus narinari: A tropical species of Indo-Pacific and Atlantic oceans, this ray is fished by gill net and trawls. It is capable of making extensive journeys across the open sea. Generally known to grow to 6 feet across disc (Wallace, 1967) but a female measuring 225 cm was caught at Madras. The males mature at a size of 130 cm and females at 150 cm across disc respectievely. Produce three embryos and the size at birth is 250 mm. The diet consists of clams, oysters and *perna*.

Aetomylus nichofii: Indo-Pacific in distribution, this ray has the habit of migrating to salt lakes, estuaries and backwaters. It grows to around 2 m in Madras and upto 3 embryos were recorded in a litter and size at birth ranges 200 - 235 mm. Feeds on crustaceans like Thenus, Acetes other prawns and crabs, teleostean fishes are also included. Apogonids, *Nemipterus* and soles, squids and gastropods formed a considerable portion of the diet.

Rhinoptera javanica : The species forms an occasional fishery during November to March on the east coast, September to April on the west coast. Often huge shoals of this ray with a size of 150 cm have been exploited in the near shore region. It is said to make disastrous raids on the pearl oyster beds in the Gulf of Mannar between November and February when the oysters are in full maturity stage (James, 1973). Females outgrow males and no male is observed to grow more than 150 cm during our observations. Females grow over 170 cm. Female around 100 cm are seen carrying embryos. The size at birth is 30 cm.

REMARKS

It is evident from the data gathered and presented in the text that the west coast ranks

high in shark production. This abundance has been correlated with the availability of pelagic fish stock like, sardines and mackerel during the period of September – November. Devadoss (1977) pointed out that pelagic sharks like *C. limbatus* ann *C. sorrach* were actively feeding on these fast moving pelagic shoals. The appearance of sharks is very often noted in the east coast during April-September during which period mackerel and sardines occurred in plenty in the commercial catches. It is also observed that the pupping season for sharks of different species coincides with this, from September on the east coast. The carnivorous nature of feeding of the adults is well seen in the life of young sharks and rays also. An interesting observation on shark landings is that though sharks were obtained in all the traditional gears used for fishing, more than 80% of sharks were contributed by gill nets.

Catch statistics worked out reveals the possibility of the existence of a rich ground for pelagic sharks off the coast of Bombay, Mangalore, Calicut, Cochin and Sakthikulankara, and for Skates and rays off Visakhapatnam, Kakinada, Madras, Mandapam and Tuticorin. So rays and skates of east cost constituted 65.6% of the national resources of elasmobranchs. Here also the availability of rays is closely associated with the variety of demersal fisheries. Since the rate of reproduction in rays is exteremely low, maximum caution should be observed in exploitation. For it is likely that the rays may not withstand such a high degree of exploitation. It is evident that more trawling effort had been concentrated in most of the centres, as a result the catches declined considerably. So it is suggested that a reduction effort is highly essential to maintain the MSY.

It is seen from the figures presented that sharks fins are one of the contributors for foreign exchange which steadly showed an increase increase from Rs. 44.3 lakhs in 1976 to Rs. 217.9 lakhs in 1984. it is also interesting to note that quantity of fine exported remains more or loss constant over the years and increase in price is only due to the increased market value of the fins and not due to any increase in the quantity.

There is plenty of scope for increasing the shark fishing in India by an increase in gill net operations which is clearly shown from the data presented from Bombay, Madras and Calicut. The bottom set gill net used for catching rays in Tamilnadu and parts of Southern Andhra coast proved to be effective gear for rays and skates.

ACKNOWLEDGEMENT

We wish to place on record our sincere thanks to Dr. P. S. B. R. James, Director C. M. F. R. I., for all the facilities and help given during the course of this investigation and also our thanks are due to Shri C. Mukundan, Head, Demersal fisheries for valuable suggestions. The first author gratefully acknowledges the help and guidance from Dr. R. Natarajan, Professor, CAS in Marine Biology, Portonovo.

REFERENCES

CMFRI, 1982 Trends in marine fish production in India-1981. *Mar. Fish. Infor. serv. T. and E. SER* No. 41: pp. 32.

CMFRI, 1983 Trends in marine fish production in India-1982 - 83. *Mar. Fish. Infor. Serv. T. and E.* Ser No. 52: pp. 20

CMFRI, 1986 Marine Fish Production in India during 1983-84 and 1984-85. *Mar. Fish Infor. Serv. T. and E. Serv. No. 67*: pp. 79.

DEVADOSS, P. 1977 Studies on the elasmobranchs of Porto Novo coast *Ph. D. thesis, Annamalai Univ. Chidambaram.*

DEVADOSS, P. 1978a A preliminary study on the Bateid fishery of Cuddalore coast with a note on the biology. *Indian J. Fish., 25*; 180-187

DEVADOSS, P. 1978b on the food of rays, *Dasyatis uarnak*, D. alcockii and *D. sephen. Indian J. Fish.* 25; 9-13.

DEVADOSS, P. 1979 Observations in the maturity, breeding and development of *Scoliodon laticaudus* M. and H. off Calicut coast. *J. Mar. Biol. Ass. India.*, 21: 103-110

DEVADOSS, P. 1984 Further observations on the biology of the sting rays, *Dasyatis imbricatus* (Schn.) at Portonovo. *Matsya, 9 and 10*: 129-134.

DEVADOSS, P. 1984 On the incidental fishery of skates and rays off Calicut. *Indian J. Fish* 31 (2): 285–292.

JAMES, P.S.B.R. 1973 Sharks, Rays and skates as a potential fishery resource of the east coast of India. *Proc. Symp. Living resour. seas around India*. Special publication CMFRI, Cochin. 483-494.

RICKER, W. E. 1975 Computation and interpretation of biological statistics of fish populations, *Bull. Res Bd. Can., 119*; pp. 382.

SARANGDHAR, P. N 1944 Tiger shark, *Galeocerdo tigrinus* M and H. Feeding and breeding habits. *J. Bombay nat. Hist. Soc.* 44; 102-110.

SETNA, S. B. AND P. N. SARANGDHAR 1949. The breeding habits of Bombay elasmobranchs. *Rec. ind. Mus.*, 47: 107–124

TESHIMA, K. AND K. MIZUE 1972 Studies on sharks. I. Reproduction in the female sumitsuki shark, *Carcharhinus dussumieri. Marine Biology*, 14 (3) : 222-31

WALLACE, J. H. 1967 The Batoin fishes of of the east coast of southern Africa Part II: Manta, Eagle ray and sting rays. *Invest. Rep. Oceanog Res. Inst. South Africa*: 1-55.