PROCEEDINGS OF THE SYMPOSIUM

ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

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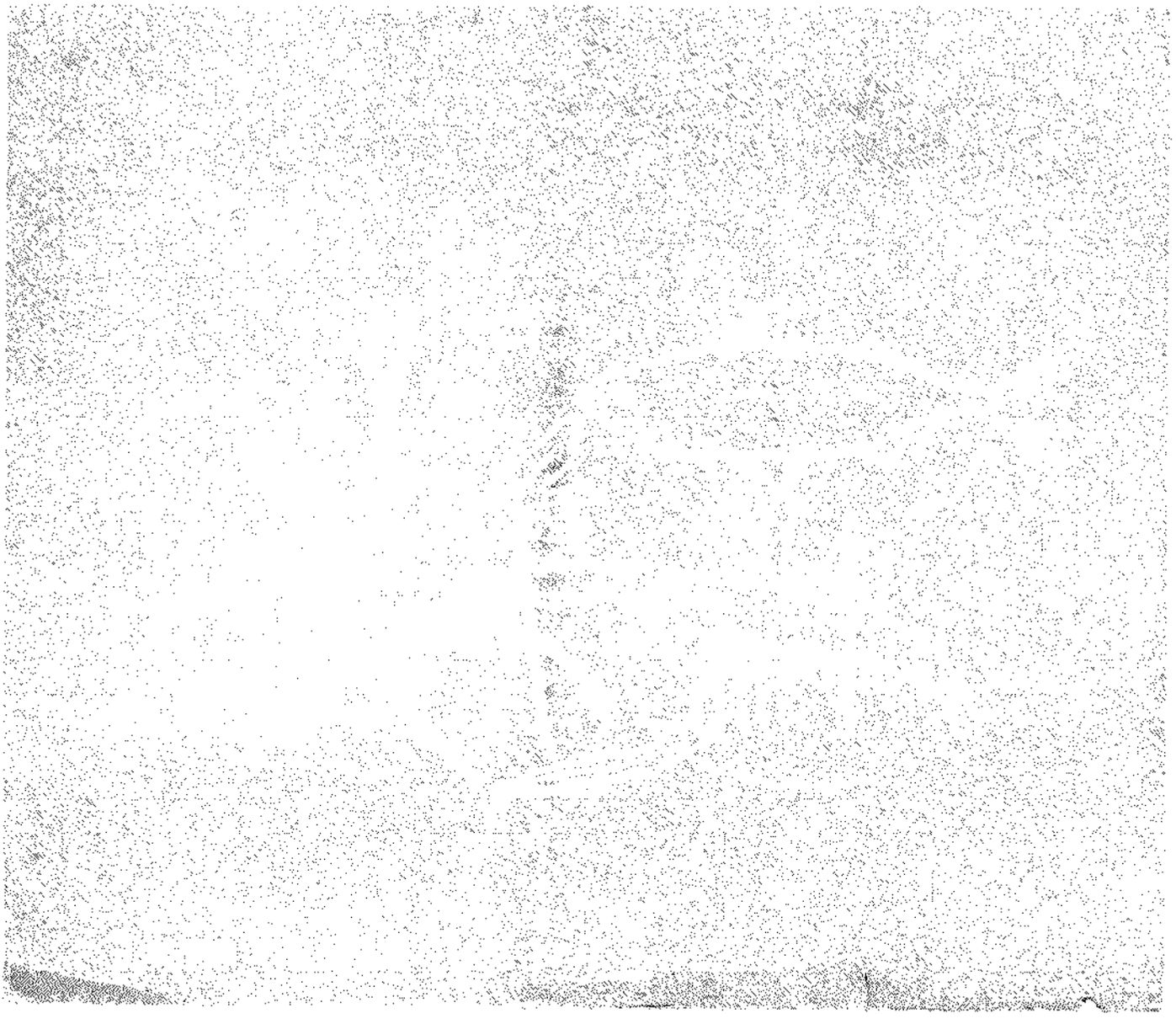

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SHARKS, RAYS AND SKATES AS A POTENTIAL FISHERY RESOURCE OFF THE EAST COAST OF INDIA

P. S. B. R. JAMES *

Central Marine Fisheries Research Institute, Mandapam Camp

ABSTRACT

The sharks, rays and skates form one of the important commercial fisheries of India, the average annual landings for 10 years (1958–67) being 33,442 m. tons. Of this, 15,537 m. tons are landed along the east coast and 17,605 m.tons along the west coast and the rest at Andaman and Nicobar and Laccadive groups of islands. Reports indicate that the Indian Ocean offers valuable fishing grounds for these fishes, especially for the larger varieties which can substantially augment the supplies of food, liver-oils, fins and shagreen.

Along the east coast, good fishery for elasmobranchs exists along the coasts of Orissa, Andhra Pradesh, Madras State and in Andaman Islands. These fishes are caught almost round the year, the sharks on hook and line and in drift gill nets at depths varying from 16 to 100 metres and majority of rays and skates in trawl nets, drift and bottom set gill nets and shore seines at depths ranging from 4 to 100 metres.

The common species of sharks include the blacktip-finned sharks of the genus *Carcharhinus*, species of *Scoliodon*, the hammer-head sharks, *Sphyrna* spp., the tiger-shark, *Galeocerdo cuvieri* and the zebra shark, *Stegostoma fasciatum*. The whale shark, *Rhincodon typus*, is occasionally landed. Rays of commercial importance are the cownose ray, *Rhinoptera javanica* shoals of which make frequent incursions into coastal waters of Gulf of Mannar, the butterfly ray, *Gymmura poecilura*, *Himantura* spp., *Amphotistius zugei*, *Pastinachus sephen* and the devil ray, *Mobula diabolus*. The common skates include *Rhynchobatus djiddensis* and *Rhinobatus granulatus* and the saw-fishes of the genus *Pristis*.

From the present trend, it would appear that the catches of elasmobranchs off the east coast could be substantially increased by extending fishing operations to deeper waters especially in the Gulf of Mannar and by the use of stronger nets from mechanised vessels. Fruitful results may also be expected along the east coast, including Andaman Islands by exploratory surveys to chart potentially rich grounds for these fishes.

INTRODUCTION

THE abundance of sharks, rays and skates is equally important along both the coasts of India. About 15,537 m. tons of these fishes are landed along the east coast and 17,605 m. tons along the west coast. Though not abundant, appreciable quantities are also landed at Andaman and Nicobar and Laccadive groups of Islands. The average total annual production for 10 years from 1958 to 1967 was found to be 33,442 m. tons. At present, these catches are mainly derived from different types of gear operated for other fishes. This is particularly so in the case of sharks, as most of the indigenous gear are unsuitable and not very effective for these large fishes. The poor returns and the lesser demand are also partly responsible for this fishery to lag behind.

The elasmobranch fishery in India consequently remained without a systematic study, except for a few accounts which include the shark fishery of Madras Presidency by Chidambaram and Menon (1946), selachian fauna of the Bombay waters by Setna and Sarangdhar (1946), the distribution of elasmobranchs of the Indian region in relation to the mean annual isotherms by Misra and Menon (1955). Devanesan and Chidambaram (1948) in their account of the common fishes of the Madras Presidency gave some details about sharks, rays and skates. Prater (1941), followed,

* Present Address: University of Agricultural Sciences, Fisheries College, Mangalore-1.

by a few others, gave details about the occurrence of the whale shark along the Indian coast. Feeding and breeding habits of the tiger shark were dealt with by Sarangdhar (1944). Some of the Madras Fisheries Department reports mention the occurrence and catches of elasmobranchs at different localities, based on which some of the tables in this account are prepared and referred to there. Reports of fishing experiments by the same department are given by John and Somayaji (1946) and John *et al.* (1959). The reports of the department of Andhra Pradesh for 1965–66 and 1966–67 are referred to in the tables incorporating that data. As the present account deals with the fishery and resources of elasmobranchs off the east coast, almost all references pertaining to west coast and those not relevant in the present context have not been cited.

Though the fishery was more or less neglected and the resources not estimated systematically, it is known that there is ample scope for development of this fishery if proper attention is paid. It has been found that shark meat is not inferior to other meat in nutritive value. Apart from this, the by-products like the liver-oil with a very high concentration of Vitamin A and the fins and skin accruing from an organised fishery are most invaluable.

Data on Resources

For the period 1950–67, the total catch of sharks, rays and skates along the east coast varied from 7,795–20,303 m. tons forming 33·77% (1957) and 53·35% (1952) of the total all-India catch of these fishes. While the minimum catch, 7,795 m. tons and minimum percentage contribution to total (33·7%) was in 1957, the maximum catch, 20,303 m. tons was in 1952 but the maximum percentage contribution (63·35% = 10,877 m. tons) was in the year 1953 (Table I). The average east coast total catch of these fishes for 10 years (1958–67) formed 46·04% when compared to 53·04% on the west coast for the same period. The all-India catches of elasmobranchs for the period 1950–67 varied from 15,912 (2·73%)* in 1953 to 42,997 (6·55%) m. tons in 1963 but the minimum

Table I

Catch data of elasmobranchs (m. tons) along the West Coast, East Coast, and State-wise along the East Coast of India during the period 1950–67

Percentages in the total catch of these fishes separately for each coast, state-wise within total for East Coast and percentage of all-India total in total marine fish production are given in brackets. Average for the period 1950–61 *and annual figures for the period* 1962–1967 *are given*

Sl. No.	Region	Average and percentage 1950–61	1962	1963	1964	1965	1966	1967
1	West Coast ..	13,193 (52·92)	21,469 (52·67)	24,097 (56·04)	19,342 (55·43)	12,779 (39·86)	17,485 (46·66)	16,613 (56·50)
2	East Coast ..	11,728·91 (47·05)	19,261 (47·25)	18,886 (43·92)	11,516 (44,·47)	18,345 (57·23)	18,758 (50·06)	12,067 (41·04)
	(i) West Bengal and Orissa	225·18 (1·75)	193 (1·00)	176 (0·93)	324 (2·81)	450 (2·45)	218 (1·16)	243 (2·01)
	(ii) Andhra Pradesh	3,544·33 (30·21)	7,458 (38·72)	7,928 (41·97)	5,132 (44·56)	5,824 (31·74)	5,752 (30·66)	4,225 (35·01)
	(iii) Madras ..	7,978·25 (68·02)	11,610 (60·27)	10,782 (57·08)	10,060 (87·36)	12,071 (65·79)	12,788 (68·17)	7,599 (62·97)
	All-India Total .. (Elasmobranchs) ..	24,925·58 (3·78)	40,760 (6·32)	4,2997 (6·55)	34,860 (4·05)	32,054 (3·84)	37,469 (4·20)	29,401 (3·40)

* Percentage of total marine fish production.

percentage contribution (2·63% = 23,081 m. tons) was in 1957 and the maximum (7·2% = 38,005 m. tons) was in 1952 (Table I). Average for 10 years from 1958–67 was 33,442 m. tons forming 4·45% of the total marine fish production in India.

Along the east coast, good fishing grounds for elasmobranchs exist off the coasts of Orissa, Andhra Pradesh, Madras and Andaman and Nicobar Islands. The resources off West Bengal are comparatively limited. The catches for the period 1950–67 in West Bengal and Orissa together varied from 57 to 450, in Andhra Pradesh from 1,228 to 8,220 and in Madras State from 5,440 to 15,870 m. tons (Table I). In Andaman and Nicobar Islands, about 20 m. tons were landed an year (1966 and 1967).

The resources of elasmobranchs in the various states along the east coast are described below:

West Bengal and Orissa.—Along the West Bengal coast, rays and skates are generally more abundant, especially the former, than the sharks. The exploratory fishing trials in the Sunderbans area revealed the occurrence mainly of *Himantura bleekeri, H. uarnak, Pristis cuspidatus* and *Carcharias laticaudus.* In this area, elasmobranchs are caught in trawls, drift gill nets, hook and line and long lines. Trawling off Black Pagoda Point and Sandheads region also indicated occurrence of these fishes. Catch composition in trawls landed at Calcutta during the year 1960–61 included skates 294, saw-fish 118 and rays 3,423 kg. In the year 1962–63, along the West Bengal and Orissa coasts the catch rate in trawls of sharks was 0·1–7·6, rays 0·2–10·6 and skates 2·2 kg. per hour. Maximum for sharks was obtained off Mahanadi, Puri and Eastern Channel, for rays at Sandheads and Matlah and for skates off Mahanadi.

Along the Orissa coast, sharks are reported off Chilka, Puri and river Devi. Three species of sharks, five species of rays and one skate have been reported from Chilka Lake (Jones and Sujansingani, 1954). According to them, sharks occur in the mouth area of the lake, 2–10 ft. in length, the main season extending from October to January. However, no special fishing is done for them. Annual catches of sharks are estimated at approximately 9 m. tons. Rays occur in almost all parts of the lake, the season extending from January to April. About 54 m. tons are caught in the main season. In February 1964, surface schools of large sharks were reported off Chilka Lake. At this time trolling lines may prove to be effective for these fishes. The catches of sharks in West Bengal and Orissa varied from 72–204 tonnes during 1961–67.

Andhra Pradesh.—The elasmobranch fauna of this State is quite rich. Annual landings of sharks alone between 1961–67 varied from 2,765 to 5,836 m. tons. Separate statistics for skates and rays are not available but generally these two groups are also plentiful as seen from the trawl fishing records. The catches of elasmobranchs off Andhra and Orissa coast during the year 1960–61 (*Ann. Rep., C.M.F.R.I.,* 1960–61) indicate a predominance of sharks and availability of fairly good quantities of rays and skates. The results of trawling off the coast of Visakhapatnam and adjacent areas from 1961–62 to 1967 (*Ann. Rep., C.M.F.R.I.,* 1961–62 to 1967) indicated the catches of all elasmobranchs together form 2·6 to 11·3% of the total catches giving a catch rate of 1·60–9·42 kg. per hour during this period in this region. Best catch rates in the area may reach 83·33 kg. per hour.

The elasmobranch catches at three important centres in the Visakhapatnam region, *viz.*, Bhimilipatnam, Lawson's Bay and Pudimadaka during the period November 1959 to April 1960 were 3·11, 18·27 and 8·73 per cent respectively of total catch. Of the elasmobranch catches of local fishermen in indigenous gear, sharks form about 5% of total. In this area, sharks are caught on hook and line mainly during February to March and June to October. At Lawson's Bay alone about 25 tons of sharks were caught in 1958–59. Attempts to catch sharks on large hooks from bigger vessels were reported to be successful, obtaining fishes 10–15 kg. in weight. These trials open possibilities of fuller exploitation of these fishes by this method, in the area. The common species of sharks inhabiting the area include *Scoliodon sorrakowah, S. palasorrah, Chiloscyllium indicum, Sphyrna zygaena, S. blochii, Carcharhinus limbatus, C. melanopterus*; skates include *Pristis cuspi-*

datus, *P. perotteti*, *Rhynchobatus djiddensis*, *Rhinobatus granulatus* and the rays include *Pastinachus sephen*, *Amphotistius zugei*, *Gymnura poecilura* and *Aetobatis narinari*. In the Kakinada area, elasmobranchs are caught in surface bottom nylon gill nets (40–50 metres long, 6–12 metres in height with 3–6" mesh) from country crafts or mechanised boats at night, about 10 miles off the shore at about 60 metres depth. Elasmobranchs form 15% of the surface gill net catches and 20–25% of the bottom gill net catches, almost throughout the year. The most common species include *C. melanoptera*, *C. limbatus* (70–120 cm., 15–50 kg)†, *S. sorrakowah*, *S. palasorrah* (25–40 cm.). Species of *Sphyrna* (30–100 cm., 50 kg. common), *Rhynchobatus*, *Rhinobatus* (80–150 cm., 50 kg. common)‡ and *Pastinachus* (20–40 cm. across) are reported to be caught often while those of *Pristis* (120–150 cm., 50–100 kg.), *Gymnura* (20–35 cm. across) are occasionally or rarely caught. In this area, about 200 units are at present operating gill nets, with an average catch of 80–160 kg. per day per boat. Important centres for elasmobranchs in the area are Yetimoga, Dummulapeta, Uppada, Vodalarevu, Moolapeta, Perumalapuram, Pentakota. Fishing in the area indicates that operation of gill nets in depths more than 60 metres may yield better catches of sharks. While the major part of elasmobranch catch is by gill nets, they are also caught on hook and line from catamarans, trawls, boat seines and shore seines. Hook and line catches at 10–20 metres consist of species of *Carcharhinus* and *Scoliodon*, forming about 10% of total catch and average of 4 kg. per boat per day. About 150 units operate in the area. In trawls, elasmobranchs are rare but occasionally *Rhynchobatus* and *Rhinobatus* measuring one to one and half metres across of either sex are caught. Small specimens of *Scoliodon*, *Carcharhinus* and *Pastinachus* are also found. In all the other gear very meagre amounts of elasmobranchs are caught.

A survey of the fishery resources of the Bay of Bengal in 1959–60 (Naumov, 1961) indicated the occurrence of about 12 different species of skates and rays and a few sharks. These observations coupled with the catch composition of elasmobranchs by indigenous gear in inshore areas and trawl fishing by larger vessels in open sea indicate that these fishes are extensively distributed along the Andhra Pradesh coast as also elsewhere along the entire stretch of the east coast. Along the Andhra Coast, exploratory fishing trials during the period December 1963 to November 1964 have indicated that the abundance of sharks, skates and rays increases progressively from the south to north.

Madras State.—From the elasmobranch resources point of view, perhaps this State ranks first along the east coast. Although, as in other areas, there is no organised fishery for sharks, rays and skates in this State also, the catches have been fairly good, forming about 6% of the total annual marine fish landings. From the present methods of exploitation and areas covered, it is doubtless that the catches could be increased several fold by the organisation of the fishery on modern lines.

In the State, experimental fishing indicated good shark fishing grounds off Madras, Sadras, Kadapakkam, Cuddalore, Nagapattinam, Adirampatnam, Nambuthalai, Pamban, Periathalai, Kuttappuli, and Punnakayal. The catches of sharks alone during 1961–67 varied from 3,623 to 7,686 tonnes. Rays and skates are abundant in the Palk Bay and Gulf of Mannar regions and off Cape Comorin. Sharks are also known to concentrate near the mouths of rivers where several plankton feeding fishes which form their food are found.

The important species of sharks along the coast of this State include *Carcharhinus limbatus*, *C. melanopterus*, *C. menisorrah*, *C. gangeticus*, *Scoliodon palasorrah*, *S. sorrakowah*, *Galeocerdo cuvieri*, *Sphyrna zyagena*, *S. blochii*; the rays include *Pastinachus sephen*, *Himantura bleekeri*, *H. uarnak*, *Amphotistius zugei*, *Rhinoptera javanica*, *Mobula diabolus*, *Gymnura poecilura*; and the skates include *Rhynchobatus djiddensis*, *Rhinobatus granulatus*, *Pristis cuspidatus* and *P. perotteti*.

† Common size and weight for each genus.

‡ Two genera together.

At Madras sharks are caught at 10–35 metres but frequently in 30–35 metres. The tiger shark is reported to be quite common. According to available information, off Tanjore small sharks and large and small rays are reported to be caught. South of Point Calimere, good results are obtained with R.C. hooks where continuous fishing seems possible throughout the year. Around the Rameswaram Island sharks, rays and skates are caught almost round the year. While the Gulf of Mannar region is rich in all the three varieties, rays are more than skates and sharks in Palk Bay. During 1952–53 elasmobranchs about 79·98 tons forming 5·17% and in 1953–54 about 156·02 tons forming 9·60% of the total catch were estimated to have been landed in this area (Krishnamurthi, 1957). According to him, the peak season was January in both the years.

Off Pamban, in Gulf of Mannar about half a dozen species of sharks are commonly caught in drift nets at 20–60 metres of which the most important are *Sphyrna zygaena, Carcharhinus limbatus* and *Scoliodon palasorrah.* Occasional catches of the tiger shark and whale shark are also on record in this area, recent instances being a specimen of the former about 12 ft. long, weighing 192·3 kg. (without viscera) landed on 28–8–1968 in a drift net and a specimen of the latter, 5,580 mm, female caught in drift net and towed to shore on 14–4–1967. The size frequency of the five important species of sharks and the catch data for elasmobranchs in drift nets off Pamban (Palk Bay and Gulf of Mannar) and in the trawl nets off Mandapam (Palk Bay) are given in Tables II to IV.

TABLE II

Size range and sex-ratio of five common species of sharks in drift net catches off Pamban in Gulf of Mannar (July to October 1968)

Month	Species									
	Spyrna zygaena		*Scoliodon palasorrah*		*Scoliodon sorrakowah*		*Carcharhinus limbatus*		*Carcharhinus menisorrah*	
	Size radge*	Sex-ratio†	Size range	Sex-ratio	Size range	Sex-ratio	Size range	Sex-ratio	Size range	Sex-ratio
July ..	500–1700	..	500–700	..	815	..	200–900	..	500–900	..
August ..	400–2100 (800–900)	63 : 71	200–700 (500–600)	30 : 53	300–1200 (700–900)	29 : 30	300–1200 (400–500)	23 : 18	300–700 (400–500)	3 : 10
September ..	600–2100 (1100–1200)	3 : 4	200–700 (400–500)	20 : 46	400–900 (700–800)	19 : 12	300–1300 (700–800)	12 : 14	750	..
October ..	500–1100 (900–1000)	13 : 14	200–900 (700–800)	15 : 9	500–900 (700–800)	21 : 9	400–800 (700–800)	12 : 6	590	..

* Size groups (or actual size) in millimetres (total length); † males; females: parentheses indicate dominant size group.

The deeper areas of Gulf of Mannar off Pamban appear to be potential fishing grounds for a number of sharks, especially for the hammer-head (*S. zygaena*), which is observed to breed in this area. Females of *S. zygaena*, 1500–2170 mm., 42–80 kg. (including weight of 11–24 embryos of the size range 400–500 mm. each weighing 0·45 kg.) were recorded in March, May and October. However, no information is available for the other months.

The butterfly ray, *Gymnura poecilura* which contributes to a good percentage of the catches of rays in Palk Bay off Mandapam also breeds in the area almost throughout the year. The Tuticorin region is rich in elasmobranchs. The common sharks include species of *Scoliodon, Car-*

charhinus and *Sphyrna*; rays of the genera *Himantura, Gymnura*; skates of the genera *Pristis, Rhynchobatus* and *Rhinobatus*.

The catch composition of these fishes in different types of gear in this area indicates that bottom-set gill nets in the area give good returns of sharks (12·7–76·4%)§, rays (0·5–22·4%) and skates (0·7–15·5%) and long lines quite effective for sharks, the percentage composition of sharks in the total catch ranging from 7·3–50·0. The catch rates of sharks by R.C. hooks do not seem to be encouraging as also the shrimp trawl catches of skates and rays (*Ann. Rep., C.M.F.R.I.*, 1961–62). Off Tuticorin, sharks are reported to be attracted by shoals of sabre fish and cause considerable damage to gill nets. Large sharks were reported to be present in 16–30 metres depth off Punnakayal, Tuticorin, Overi and Idinthakarai and at 80–100 metres depth off Manapad and Trichendur. Catches are reported to be good from October to April in this area.

In the Cape Comorin area, elasmobranchs are caught mainly during January to April and August, September and December. For the period 1958–63, these fishes totalled 203·081 tonnes, average being 33·847 tonnes forming 1·9% of total catch (Chacko *et al.*, 1967). It was found that operation of R.C. hooks in the exposed waters off Cape Comorin is ineffective and hooks were often lost, perhaps dragged away by some large sharks. Under such circumstances provision of anchors at end of the chains and reduction in length of individual links might be helpful.

Off the coast of Pondicherry in 1963–64, trawling in 9–24 metres depth gave a catch rate of 8·91–18·18 kg. per hour of rays. Operation of bottom-set gill nets at 15–31 m. depth indicated predominance of sharks with a catch rate of 5·00–39·66 kg. per set.

Though there are no definite records of resources of the elasmobranchs in the Andaman and Nicobar Islands, there are indications that there is scope for fishing hammer-heads, saw-fishes, the black finned sharks (*C. melanopterus* and *C. limbatus*) and a few other sharks (*Triaenodon obsesus, Isurus glauca*) and rays (*H. uarnak*) on hook and line and gill nets. Comparatively, skates are reported to be uncommon in this region. The overall contribution of elasmobranchs is estimated to be 2–4% of total fish landings. A report of the capture of a female saw-fish (*Pristis zijsoron*), 5·13 metres (20 ft. 2 inches) on 1–6–1967 at Ross Island near Port Blair, is interesting in this connection (Marichamy, personal communication). A male specimen, 4·31 metres (about 17 ft.), was also reported to have been landed on 24–7–1963 in the same area. However, elasmobranchs are locally not consumed much and therefore there is no demand for them and hence the lack of impetus to develop the fishery.

Along the east coast of India, at several places, gravid sharks and rays are found in coastal areas, backwaters and estuaries in a number of months which habitat they may be frequenting for protection and shelter for young ones which otherwise may fall prey to larger fishes in open waters.

Results of bottom trawling in Indian seas by R.V. *Anton Bruun* in 1963 for Bay of Bengal region (Hida and Pereyra, 1966) indicate abundance of rays in Andaman Islands, Burma and Indian regions and skates off East Pakistan region. While trawling does not give a good idea of the abundance of sharks, the results indicate that skates and rays are mostly confined to 15–37 m. depth except in Andamans region where they are found up to depths of 110 metres.

Notes on the Bionomics of Important Sharks, Rays and Skates Caught off the East Coast of India

Sharks

Carcharhinus gangeticus.—Grows to about 9 ft. It is known to chase shoals of cat-fishes, perches and of rock-cod (*Epinephelus* spp.) in particular. Ascends rivers even beyond tidal influence.

§ Percentage in total catch by the gear.

Known to be one of the most ferocious sharks. Its liver-oil, especially of males, is of high vitamin potency.

TABLE III

Average catch of elasmobranchs per boat per day landed by drift nets operated from Tuticorin type of boats off Pamban in the Palk Bay and the Gulf of Mannar during the period August 1967 to December 1968

(PB: Palk Bay; GM: Gulf of Mannar)

Month	Region	Total No. of boats observed	Total catch (Kg.)	Total catch of sharks (Kg.)	Total catch of rays (Kg.)	Average catch per boat (Kg.)	Average catch of sharks per boat (Kg.)	Average catch of rays per boat (Kg.)
1967								
August ..	PB	135	5073·75	15·30	9·00	37·57	0·11	0·06
	GM	25	2065·50	517·05	..	82·62	20·65	..
September ..	PB	131	4567·05	..	46·35	34·86	..	0·35
	GM	14	963·00	204·75	33·75	68·78	14·62	2·38
October ..	PB	144	6112·80	320·40	43·20	42·43	2·22	0·29
	GM	69	4490·05	1736·10	181·35	72·31	25·15	2·61
November ..	PB	35	3234·15	16·65	..	92·38	0·47	..
	GM	47	5211·00	725·85	70·20	110·87	15·43	1·48
December ..	PB	40	2387·70	143·55	88·65	51·88	3·10	1·89
	GM	..	No fishing	..	..	..	..	..
1968								
January ..	PB	35	2574·45	..	29·25	73·53	..	0·83
	GM	9	525·15	272·25	..	58·32	30·15	..
February ..	PB	154	23939·55	391·50	152·55	155·44	2·52	0·99
	GM	14	1885·50	854·55	..	134·65	61·32	..
March ..	PB	416	51075·45	2314·35	591·30	122·76	5·56	1·39
	GM	51	5854·05	2016·90	107·10	114·75	39·51	2·09
April ..	PB	151	15408·00	396·00	100·35	102·03	2·61	0·66
	GM	161	17919·90	1639·80	39·60	111·30	10·18	0·29
May ..	PB	27	1684·80	31·50	..	62·37	1·17	..
	GM	147	17450·55	2309·40	49·50	118·71	15·70	0·33
June ..	PB	8	535·05	..	..	66·87	..	..
	GM	27	1164·15	539·10	6·75	43·11	19·93	0·24
July ..	PB	10	559·35	..	..	55·93	..	..
	GM	82	7574·85	1642·50	121·05	92·34	20·02	1·47
August ..	PB	130	9450·45	234·00	248·40	72·67	1·80	1·90
	GM	118	8954·10	4948·65	..	75·87	41·85	..
September ..	PB	36	2324·25	..	..	64·53	..	..
	GM	47	4025·70	1291·95	658·80	85·63	27·45	13·95
October ..	PB	111	8191·70	20·25	3·60	74·70	0·18	0·01
	GM	118	18265·05	6547·95	76·95	154·75	55·48	0·64
November ..	PB	70	5255·55	123·75	48·60	75·64	1·75	0·67
	GM	93	7579·80	1691·55	88·20	81·45	18·18	0·94

TABLE IV

Average per catch (kg) per boat per day of elasmobranchs in trawl nets operated from mechanised boats off Mandapam in Palk Bay and Gulf of Mannar

Total number of boats operated and total number of boats observed are also given

	1964*			1965			1966			1967			1968		
	Total No. of boats operated	Total No. of boats observed	Average catch per boat/ day	1	2	3	1	2	3	1	2	3	1	2	3
January ..	1	1	12·28†	..	..	..	1	1	23·22	69	69	26·55	51	51	27·43
February ..	2	2	2·58†	..	..	..	1	1	20·58	120	101	20·65	151	124	46·38
March ..	2	2	18·87†	1	1	51·68	..	90	32·19	299	122	12·81	290	137	31·50
	1	1	23·00	..	..	..	..	..	..	..	..	..	..	..	..
April ..	2	2	29·00	..	74	36·43	..	123	40·93	308	142	12·71	608	128	22·58
May ..	2	2	46·86	..	151	47·61	..	193	41·01	516	137	17·81	684	138	26·89
June ..	2	2	14·75	..	166	42·78	..	184	29·25	590	117	231·18	1104	129	28·47
July ..	2	2	24·62	623	152	26·46	..	185	30·33	713	143	18·61	1219	143	21·32
August ..	2	2	30·68	746	142	25·91	756	146	14·28	659	130	11·09	958	137	19·34
September ..	2	2	43·38	367	146	29·75	483	134	15·84	501	113	9·67	290	121	10·93
October ..	2	2	28·00	122	121	29·70	220	128	18·11	369	93	17·32	372	79	15·62
November ..	2	2	29·30†	..	47	39·16	150	144	17·68	..	..	..	42	32	19·54
													218	112	15·07†
December ..	2	2	40·26†	..	..	..	92	92	15·67	..	..	..	..	..	..

* Data from INP medium boats; † = Particulars for Gulf of Mannar.

Carcharhinus melanopterus.—Grows to about 8 ft. are more. Feeds on silver-bellies, horse mackerel, anchovies, skates, gizzard shad, hilsa, prawns and *Squilla*. Maximum of 40 young ones were recorded in a shark of 8 ft., each young one measuring one foot. Liver weighs up to about 20% of total weight of fish, females possess larger livers and yield large quantities of oil. Quantity of liver less in sharks, less than 5 ft. long. It is caught on botom-lines from April to July, 30–40 at a time. The species is reported to be common off the coast of Visakhapatnam, Nagapattinam and Periathalai.

Carcharhinus limbatus.—Grows to about 7 ft., common along the entire east coast. Liver yields oil of a moderate Vitamin A value. Food includes fishes, cuttle fishes, etc.

Carcharhinus teminckii.—Grows to about 8 ft., in length. Liver oil is reported to be of high potency.

Scoliodon palasorrah.—Attains about 4 ft. Quite common throughout the east coast. Contributes to a good percentage of catches of sharks at many places.

Scoliodon sorrakowah.—Attains about 2½ ft. and becomes mature at about 18 inches. Common at a number of places along east coast, usually inhabiting rocky areas. Better taken on hook and line. Known to move in shoals composed of one sex. Feeds voraciously on prawns, shrimps and

a variety of small fishes. Breeds throughout the year. Peculiar, strong odour is known to emanate from them even in fresh condition making it a useful bait for larger fishes.

Galeocerdo cuvieri.—Distributed throughout the east coast. Common during June to March. Specimens up to 20 ft. are known from the seas around India but 8–13 ft. individuals are common. Females, 10–13 ft. with 26–44 young ones are on record. Feeds on all kinds of fishes, cuttle fishes, sea-snakes, turtles and several other odd things getting the name of the scavenger of the sea. Weight of the liver is about 20% of weight of fish, producing considerable quantity of oil of good quality having a fairly high potency of Vitamin A.

Sphyrna zygaena.—Fish about 20 ft. are frequently caught off Visakhapatnam and one to two metres long are common in Gulf of Mannar off Pamban where it also breeds. Gravid females are caught in February and May in the north and in March, May and October in the south. About 24 young ones are produced by a fish. Food includes a wide variety of fishes like sardines, ribbon-fishes, mackerel, white-bait, pomfrets, cat-fishes, small sharks and cuttle fishes. Good liver-oil of high Vitamin A potency is obtained.

Sphyrna blochii.—Attains about 5 ft., fish about one and half metres are frequently caught. Compared to *S. zygaena* it is less abundant in the Gulf of Mannar off Pamban. One female, 1,330 mm. with 11 embryos (8 male and 3 female), 331–364 mm. was caught in a drift net on 5-2-1964 off Rameswaram in Palk Bay. Feeds on a variety of fishes and cuttle fishes. Good liver-oil of high Vitamin A potency is obtained.

Stegostoma fasciatum.—This species is not of a very high commercial value but specimens ranging from 176–220 cm. in total length are quite often caught in the Gulf of Mannar on hook and line and bottom-set gill nets, in December-January period. It is known to feed on molluscs.

Rhincodon typus.—It is reported to attain a size of about 60 ft., the minimum and maximum sizes landed along the Indian coast being 13 and 29 ft. respectively. The species is more common along the west coast than on the east coast, occurring usually between January and April. It is reported to migrate long distances in search of abundance of zooplankton which forms its chief food. Their rare occurrence along east coast was explained by Prater (1941) as due to the direction and movements of the surface currents in the Bay of Bengal and along the coasts of India and Ceylon at the time these sharks start their migration.

Skates

Saw-fishes.—These fishes are abundant in the southern region but good grounds are indicated in the north also. They are caught from 3–20 miles off the coast but large ones are available 10–20 miles off. The saw-fishes are also known to enter large estuaries and may travel beyond tidal influence. Commonly found in sheltered bays with sandy bottom. Feed on a number of fishes like horse mackerel, jew fishes, ribbon-fishes, seer fishes, pomfrets, sabre fish, small sharks and molluscs. Gravid females are caught from May to July with maximum number of 30 young ones, during which time they are known to come closer to the shore into sheltered waters. They possess very large livers up to about 50% of weight of fish, yielding large quantities of oil of high Vitamin A potency. Saw-fishes grow to a large size of about 25 ft. Two species, *Pristis cuspidatus* and *P. microdon* are more common and commercially important than the third, *P. zijsron*. One specimen of *P. microdon* caught in trawl net off Mandapam in Gulf of Mannar at about 25 metres depth on 19-12-1966 was 3,051 mm. in length, 150 kg,, male, in the running condition. The claspers were enlarged, 540 mm. in length, golden yellow in colour.

Rhynchobatus djiddensis.—It grows to about 6 ft. Feeds on burrowing molluscs. Common in the southern section, in Palk Bay and Gulf of Mannar. Abundant off Cape Comorin, fish 800-

1270 mm. in length quite common in bottom-set gill nets and trawls in the area. Valuable from the point of view of export of its quality fins.

Rhinobatus granulatus.—Specimens about a metre in length are frequently caught in Palk Bay and Gulk of Mannar but less common than *R. djiddensis.*

Rays

Pastinachus sephen.—Common in shallow waters with sandy or muddy bottom. Feeds on small fishes, prawns, crabs and molluscs. Specimens 75 cm. in disc width are often caught in Palk Bay and Gulf of Mannar. The ray is known for its ferociousness, lashing its tail in defence, inflicting severe wounds, in which process the spine breaks and remains embedded in the flesh of vicitims (fishes, including saw-fishes, sea cows, etc.). The tearing of flesh of this ray by saw-fish is often reported in Gulf of Mannar area near Mandapam. The liver-oil of this ray is also of high vitamin A potency.

Gymnura poecilura.—The species is very common in Palk Bay near Mandapam, in shallow waters at 10–30 metres depth with sand or muddy bottom, commonly caught in trawl nets or bottom-set gill nets. Occurs almost round the year, abundant between January and May. Dominant size range 350–700 mm. disc width, breeds almost throughout the year, peak period being April to October. Maximum number of young ones observed in a female was seven. Females outnumber males in commercial catches. Appears to feed on small fishes, crustaceans and molluscs. Size of young ones at birth 237–256 mm. across and females reproduce at 410 mm. Largest specimen recorded was a female, 915 mm. disc width caught on 5–5–1966 from Palk Bay.

Rhinoptera javanica.—A few specimens of this species are occasionally landed along with other rays of commercial importance at the fishing centres along Palk Bay and Gulf of Mannar. But incursion of enormous shoals of this species into inshore waters of Gulf of Mannar during December to January period is of considerable importance from the commercial fishery point of view. On such occasions, huge landings are made in routine shore seine hauls, the shoals without being sighted on surface. In each haul about 500 or more rays are captured, each measuring on the average about 150 cm. The females, which are larger than males, carry at this time young ones about 31 cm. in disc width. These rays mainly feed on molluscs. Great shoals of this gregarious oyster-eating ray are known to have their chief centre on the Cape Comorin banks, whence may come the disastrous raids on the pearl banks, clearing millions of maturing oysters between November and February.

Himantura spp.—Two species, *H. bleekeri* and *H. uarnak*, are of common occurrence at several localities on the east coast. Specimens of *H. bleekeri* about 105 cm. (21 kg.) and *H. uarnak* about 140 cm. in disc width (72 kg.) are often caught in the Palk Bay and Gulf of Mannar regions from within about 25 metres depth.

Amphotistius zugei.—Forms a fishery of local importance at some places, especially in the Palk Bay region. Average size is about 18 cm. disc width in the commercial catches. The species does not appear to attain a large size and is caught almost throughout the year.

Mobula diabolus.—Occasional catches of large specimens are reported from Gulf of Mannar area in drift nets at 40–60 metres depth usually in September–October period. Size range of such specimens varies from 572–1,624 mm disc width and weight 14–44 kg. It is known to feed on fishes.

Conclusions

From the foregoing account of the abundance, distribution and fishery yields, it is clear that there are rich resources of elasmobranch fishes off the east coast. Although the waters off

west coast are supposed to be richer in these fishes, adoption of better methods of exploitation on the east coast may lead to harvesting equal, if not greater, quantities of elasmobranchs off the east coast. While the shark fishery of west coast seems to be dependent on large species, the fluctuations of the catches of which are said to be related to the abundance of shoals of their food fishes like sardines and mackerel, that on the east coast is likely to yield steady results as it does not seem to be much affected by such factors. Observations so far made also reveal that many potentially rich grounds for saw-fishes, hammer-heads, the tiger shark and the shovelnose rays which are economically important for extraction of liver-oil and export of fins, remain poorly exploited and offer scope for intense fishing.

Depredation of pearl oyster beds by shoals of the cownose ray, the reported danger from ferocious sharks like *C. gangeticus* and the tiger shark during pearl fisheries operations in the Gulf of Mannar and the large-scale attack of sharks on shoals of pelagic fishes like tunas in the open waters of Indian Ocean thereby depriving catches of better quality fishes also stress the need for effective fishing for these fishes in the seas around India.

These facts show that the two questions (i) is it expedient to intensify shark fishing and is there a market for them and (ii) is the resource large enough to justify organisation of special shark fisheries are to be answered positively.

Sharks, rays and skates are amongst the largest fishes regularly caught from the seas around India. Total annual catch of elasmobranchs from Indian Ocean which offers valuable fishing grounds for larger varietes is about 75,000 metric tons but the catch from India is only about half this quantity. Approximately a million and a half pounds of shark liver-oil is extracted every year and 1–3 lakh kg. of shark fins and fish maws obtained. In order to develop the fishery, the following aspects of shark-based industry need special attention: (1) proper use of shark meat has to be guaranteed by preparing products like fish sausage as in Japan, odourless protein and other products, (2) turn the skin into useful leather goods, (3) quality of fins exported to be improved and standardised and (4) devise means to convert liver-oils into more palatable products and side uses.

In view of the great potentialities of fishing for elasmobranchs and for developing the related industries, it is clear that these resources can be exploited on a larger scale than at present by extending fishing operations to deeper waters, by intensifying fishing in the sheltered waters of the Palk Bay and the Gulf of Mannar and around Andaman Islands using stronger gill nets and longlines with suitable hooks and further exploratory fishing to chart new grounds for sharks, rays and skates to provide more food and earn increased foreign exchange by export of quality products. Without fear of overfishing, it may be advantageous to catch these fishes in greater quantities, for it not only helps the industry but keeps in check the populations of these destructive fishes from their ravages on important pelagic fisheries.

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