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37 Elasmobranch resources of India

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ABSTRACT

Available information on the length-weight relationship, age and growth for some elasmobranch species was compiled and growth parameters discussed. Food and feeding habits studied for some species indicated preferences, except tiger shark, for certain food. In some cases there is shifting of food habits as the young shark grows to adulthood. Starvation of female sharks is a notable feature during advanced stage of pregnancy. The three types of development exhibited by different species are discussed. The size of litter, the relationship between the length of mother and litter size and fecundity are dealt with. Landings of elasmobranchs over the years were steadily increasing. There was spurt in landings during mid seventies. In recent years the elasmobranch production appeared to be stabilizing and a sign of stagnation in the landings is evident. Group wise, region wise and gear wise landings are discussed.

Introduction

A review of literature reveals that considerable information is available on the occurrence, systematics and distribution of sharks. Fowler's (1941) contribution on the sharks, skates and rays of Philippines and adjacent seas is a milestone in our knowledge on elasmobranchs of the Indo-Pacific region. A major advance on the early taxonomic work was a review of sharks of the Northwest Atlantic by Bigelow and Schroeder (1948, 1953). A series of reports of the oceanographic research institute of Southern Africa on sharks (Bass *et al*, 1973, 1975 a,b) and batoid fishes (Wallace 1967 a, b, c) have provided information on the elasmobranchs fauna of that region. Campagno (1984) has brought out species catalogue on the sharks of the world.

In India, Annandale (1909) studied the batoid fishes of Bengal ;

Thillayambalam (1928) studied the taxonomy of *Scoliodon;* Chidambaram and Menon (1946) on the shark fishery of Madras Presidency; and Setna and Sarangdhar (1946, 1949a) on elasmobranchs of Bombay region. Misra and Menon (1955) and Misra (1959) compiled the distributional record of elasmobranchs in Indian coastal waters. Information on the spade nose shark, *Scoliodon laticaudus* in respect of age and growth, length-weight relationship, food and feeding habits, maturity, breeding and development and population dynamics are available (Nair 1976; Devadoss 1984a, 1989; Kasim 1991).Krishnamoorthi and Jagadis (1986) collected information on the biology and population dynamics of *Rhizoprionodon acutus.* Study on the biology of other species of sharks, rays and guitar fishes is limited (Sarangdhar, 1949; Setna and Sarangdhar, 1948; Nair and Appukuttan, 1974 ; Devadoss 1977a, 1978a, 1983, 1988a ; Appukuttan, 1978).

Reports on the occurrence of whale shark (*Rhiniodon typus)* are innumerable and most of them up to the year 1986 were compiled by Silas (1986) and subsequenctly Vivekanandan(1994) reported on the whale shark fishery off Veraval. The elasmobranch resources of the Indian coast have been reported by James (1973), Devadoss (1978b, 1984b, 1995). Devadoss *et al.* (1989) and Kasim (1991). New records of elasmobranchs in the Indian coasts have been reported by Nair and Mohan (1973) on a new deep sea guitar fish *Rhinobatus variegatus,* Devadoss and Natarajan (1977b) on the smooth hammerhead shark, *Sphyrna zygaena* and Devadoss (1988 b) on the fantail ray, *Taenitura melanospila.* There is no information on the occurrence of skates in the Indian seas. A few species like *Raja springeri* and *R. stenorhynchus* are reported at a depth of 405 fathoms (Fowler, 1941).

Biology

Length-weight relationship : Information on the length-weight relationship of elasmobranchs is limited mostly to small sized species. The b values of different species of sharks ranged from 2.7314 to 3.1404 (*Table 1*). However, the b value of the sting ray *Dasyatis imbricatus* was very high (3.6907). Generally there is a marked difference between the b values of male and female elasmobranchs. This difference was marked after sexual maturity in the case of Australian school shark, *Galeorhinus zyopterus* (Ripely, 1946) and blue shark *Prionance glauca (steven, 1975).* It should be noted here that the weight of the mature female includes the weight of developing pups.

Age and growth :- Age and growth of elasmobranchs have been determined by various workers by studying the marking on the spines, zones occurring in vertebral centra and also by tagging experiments. Yokota (1952) determined the age in *Dasyatis akejei* by studying the growth of claspers which occurred in annual increments. In India, the length frequency method was followed by Nair (1976), Krishnamoorthi and Jagadis (1986) and Kasim (1991). Holden (1974,1977) modified the von Bertalanffy's growth equation and suggested a K value between 0.1 and 0.2 for elasmobranchs. By using this suggested value of K as 0.2, Krishnamoorthi and Jagadis (1986) calculated the age of *Rhizoprionodon acutus* and stated that *R.acutus* took 10 years to reach 100 cm. However by using length frequency method, several authors have reported K values higher than 0.2 for Indian sharks. Kasim (1991) calculated K as 0.6 and stated that *R. acutus* reached the maximum size of 100 cm in 5 years (*Table 2*). Devadoss (MS) estimated the K as 0.358 and 0.405 for male and female *Scoliodon laticaudus*. Hence, adoption of Holden's equation on tropical sharks, which grow faster than their temperate counter parts, is questionable.

Food and feeding habits :- Majority of sharks and rays have specific feeding habit and actively hunt their preferred prey in the pelagic and column waters. The sharp nose shark *S. laticaudus* and the grey sharks like *Carcharhinus limbatus* and *C. sorrah* prefer pelagic fishes like mackerel and sardines during September to March in the west coast and April to October in the east coast of India (Devadoss, 1977a). Pelagic sharks like the thresher shark, *Alopias* uses its long caudal fin for herding and stunning the prey before swallowing them. *C. sorrah* prefers to feed in the vicinity of rocks and reefs in South African Coast (Bass *et al.* 1973a). The sandbar shark *C. plumbeus* prefers fish, crustacean, squid, octopi and cuttle fish. It prefers fresh fish bait to stale or frozen fish (Campagno, 1984). Food preference in relation to size of *S. laticaudus* revealed interesting pattern. Young sharks prefer prawn (56-68%) and the adults change over to teleostean fishes, fast moving squids and cuttle fish. Starvation of female sharks during pregnancy is common (Devadoss 1984a).

All sharks are not predaceous or carnivores. The whale shark, *Rhioniodon typus*, the basking shark, *Cetorhinus maximus* and the mega mouth, *Meghachasma pelagios* are filter feeders. They passively float on the surface of the sea and gulp large volume of sea water into the pharynx for filtration

Table. 1 : **Length- weight relationship of sharks & rays**

Species	Location	L/W relationship	Authors
1. *Dasyatis imbricatus*	Portonovo	Male : log W=-4-3903 + 2.9838 log L	Devadoss, 1983
2. *Chiloscyllium griseum*	Calicut	combined : log W=-6.0403 + 3.6907 log L	Devadoss, 1986
3. *Scoliodon laticaudus*	Calicut	Male : log W=-5.1678 + 2.8905 log L	Devadoss, 1989
		Female :log W=-5.3094 + 2.9574 log L	
4. *Scoliodon laticaudus*	Mangalore	combined : log W=-3.7246 + 3.0748 log L	
5. *Scoliodon laticaudus*	Veraval	Male : log W=-2.3574+2.9349 log L	Kasim, 1991
6. *Carcharhinus limbatus*	Mangalore	combined: log W=-4.9203 + 2.9862 log L	Kulkarni, 1988
7. *Rhizoprionodon acutus*	Veraval	Male : log W= - 2.0159 + 2.8465 loG L	Kasim, 1991
8. *Rhizoprionodon acutus*	Madras	Comoined: log W=-2.1007 + 2.8750 log L	Krishnamoorthy and Jagadis, 1986

Table : 2. **Growth parameters in** *S.laticaudus* **and** ***R. acutus***

			Length at ages (mm)							
Anuual K	Loo	t_o	1	2	3	4	5	6	7	Authors with locations
S. laticaudus										
0.2731	755 mm	-0.5664	260	380	470	530	590	-	-	Prabhakaran Nair '76
										Bombay
1. 0822	680 mm	0-0.0110	452.5	602.9	653.9	-	-	-	-	Kasim, 1991
										Veraval
0.8818	749 mm	0.-0123	438.9	622.0	696.4	-	-	-	-	Kasim, 1991
0. 4046	676 mm	0-0.590	321	439	518	570	606	629	645	Devadoss
03580	715 mm	0-0.590	310	432	517	576	618	647	667	Calicut
0.63	740 mm	0	358	545	655	-	-	-	-	Raje
0.48	726 mm	0								Bombay present study
R. acutus										
0.20	1000 mm	1.78	417.3	522.9	609.4	680.2	738.2	-	903.7	Krishnamoorthy
(adjusted)								(10 years)		Jagadis, 1986
										Madras.
0.6457	1054 mm	0-0.0526	591.8	774.0	907.2	977.0	1013.6			Kasim, 1991
0.6046	1065 mm	0-0.0556	502.4	757.7	897.1	973.3	1014.9			Veraval.

and thus feed on small copepods, barnacles, decapod larvae, fish eggs and other smaller organisms. Guiter fishes and rays are mostly adapted to bottom mode of life. They lie buried on the bottom soil. Some of them are known to hunt for their prey and are highly piscivorous. *Dasyatis uarnak*, *D. alcockii* and *D. sephen* consume a wide variety of bony fishes. Prawns, *Thenus* and crabs formed a sizable quantity of their diet (Devadoss, 1978c). In *D. imbricatus* the food consisted of polychaete worms to the tune of 34% besides crustaceans (65%) which included mysids, amphipods, isopods and crabs.

Maturity, breeding and development :- Sex in elasmobranchs could be distinguished in very early developing stage as the males develop claspers which are used as intromittent organs. Determination of sexual maturity in males is based on the growth of claspers, testes and collection of seminal fluids in the seminal vesicles and in females on development of ovary and oviduct (Springer, 1960). Devadoss (1977a, 1978a, 1982, 1984a, 1988a,c) made a detailed survey on the maturitiy, breeding and development in nine species of sharks, four species of guitar fishes, three species of electric rays and eight species of sting rays. Fertilisation in all cases is internal and three types of development have been recognised. There is no larval stage in the development of elasmobranchs.

I. Oviparity :- Eggs with horny shells called mermaid purses, are provided by tendrils at each end of the case. When cast outside, they entangle to any object to keep from drifting. Development and hatching take place outside. Bull head sharks (*Heterodontus*), the whale shark *(Rhiniodon)*, zebra shark (*Stegostoma*), bamboo shark (*Chiloscyllium*), nurse shark (*Gynglymostoma*) and scyliorhinid sharks and skates of the family Rajidae are oviparous. In *Cephaloscyllium*, *Scyliorhinus*, *Apristurus* and *Galeus* only one egg capsule is formed in each oviduct during the period of pregnancy and so two capsules is laid outside at a time.

II. Ovoviviparity or aplacental viviparity :- In this case, the egg capsule which is soft, is not cast outside, but is retained inside the uterus. The embryo emerge from the capsule with the yolk sac intact and further development is completed inside the uterus without any placental connection with the mother. The young is delivered outside when fully formed. Frilled sharks and cow sharks (Hexanchoids), the bramble sharks, squalid and centrophorus sharks, tiger shark, electric rays, all sting rays, guitar fishes and saw fishes exhibit this kind of development.

III. Viviparity :- In this type, egg capsule hatches very early inside the uterus as the yolk stored in the egg case is insufficient for full development of the foetus and further development is possible only when contact with the uterus of the mother is made through the yolk sac placenta. The grey sharks and the hammerhead sharks exhibit this mode of development. Members of the family Triakidae exhibit both ovoviviparity and viviparity. Sharks of the genera *Furgaleus, Galeorhinus, Hemitriakis, Gogolia* and *Triakis* are ovoviviparous while *Hypogaleus, Iago* and a few species of *Mustelus* are viviparous.

Sharks of the family Lamnidae are reported to be ovophagy, a sort of cannibalism *in utero*. Eggs from ovaries enter the oviduct and while in transit in the oviduct they are fertilized and encased in groups . A maximum number of 16-23 fertilized eggs enclosed in egg case are reported in *Eugomphodus taurus*. At times, only one embryo of its group prevails, possibly by devouring its cousins *in utero* (Campagno, 1984).

The litter size or fecundity is very much limited in elasmobranchs and the mother provides maximum security to the developing young ones. The litter size depends on the size of the mother. Thus the small sized sharks like *Carcharhinus dussumieri, C. macloti, Rhizoprionodon oligolinx, R. acutus* and *Iago omanensis* produce less number of young ones ranging from 2 to 8, whereas the large sharks like the tiger shark, *Galeocerdo cuvier* produce up to 82 young ones and hammerhead sharks 20- 31 young ones. All rays except butterfly ray, produce one to three young ones only.

In species like *C. limbatus, Eusphyra blochii, Rhinobatus granulatus* and *Narke dipterygia*, the number of ova or young ones produced was found to be directly related to the length of the adult (Devadoss, 1977a). Another characteristic feature of the elasmobranch reproduction is the existence of both ovarian and uterine cycles functioning side by side. While the embryos develop inside the uterus, the ovary is active in producing ova which spawn immediately after termination of the current pregnancy. The guitar fishes, saw fishes and the sting rays exhibit this type of simultaneous ovarian and uterine cycles (Holden, 1974). The viviparous sharks and electric rays have their uterine cycle functioning either after termination of ovarian cycle or the ovarian cycle becomes active only after the parturition of the young ones (Devadoss, 1977a).

Present status of exploited elasmobranchs

The elasmobranchs, as a group have been found distributed all along the Indian coast constituting about 4% of the national marine fishery resources. The landings fluctuated from 23,081 t in 1957 to 69,207t in 1983. There was steady increase in the catches till the seventies. The introduction and expansion of mechanisation of fishing has resulted in substantial increase in the catches. The landings of elasmobranchs for the period 1960-94 showed increase in catches from 44, 917 t during 1973 to 66, 054 t during 1974 (47%). After 1974 the catches were steady, but for periods of spurt catches in 1982-1983, and 1992-1993. The average annual catch for the decades were 24, 941 t, 33,539 t, 53,912 t and 57,159 t respectively during (*Table 3)* fifties, sixties, seventies and eighties *and 57,501 in* 1990-94. Hence the annual average production during 1990-94 did not increase compared to the average landings of 1980-89. This is probably an indicator that substantial increase in the yield may not be possible in the present area of exploitation.

Table 3. **Decadal trend in Elasmobranchs landings (tonnes) during 1950-94**

Period	Range	Peak (year)	Average catch
1950 -59	23081 - 38005	38005 (1952)	24941
1960 - 69	29401 - 42983	42983 (1963)	33530
1970 - 79	41348 - 66054	66054 (1974)	53912
1980 - 89	49979 - 69207	69207 (1983)	57159
1990 - 94	49820 - 66423	66423 (1993)	57501

The sharks, rays and guitar fishes form multispecies fisheries. The major species constituting the fishery are *Carcharhinus limbarus, C. sorrah, C. melanopterus, C. macloti, C. dussumieri, C. hemiodon, Scoliodon laticaudus, Rhizoprionodon acutus, R. oligolinx, Loxodon macrorhinus,* the mackerel shark *Isurus oxyrhinchus,* hammerhead shark *Eusphyra blochii, Sphyrna lewini, S.mokarran,* the guitar fishes *Rhynchobatus djeddensis, Rhinobatus granulatus,* the sting rays *Dasyatis uarnak, D. sephen, D. jenkinsii, D. zugei, D. imbricatus,*

D. kuhli, *D. alcockii*, *D. marginatus*, *Aetobatus narinari*, *Aetomylus nichoffii*, *A. maculatus*, the cow nose ray *Rhinoptera javanica*, the butterfly ray *Gymnura poecilura*, *G. micrura* etc. Some species like the whale shark, thresher shark, the bamboo shark and saw fish are caught occasionally.

Resources along the east and west coast :- Production on both east and west coast for the 10 years period from 1985 to 1994 shows that the average production in the east coast is 24,226 to and that of west coast 31,892 t with a ratio of 43:57. The same trend was observed earlier during 1976-85 also by Devadoss *et al.* (1989b). Exception to this general pattern was observed during the year 1987 when the catch from the east was more than that of the west coast (52%).

Groupwise landings:- Data on sharks, rays and guitar fishes were analysed separately for the ten years period 1985-94. Sharks are the dominant group with 63% in the total elasmobranchs landings followed by rays 33% and the remaining by the guitar fishes. Eventhough the catch was fluctuating from year to year, the west coast has emerged as the major centre for shark fishing where 75% of the sharks are landed and the east coast lands mostly batoids . A close scrutiny of the catch trend revealed that landing patterns of sharks on one hand, rays and guitar fish on the other hand fluctuate, so much so, whenever the sharks landings increased the landings of batoid fishes decreased and vice versa. During 1987 and 1990 the catch of sharks came down from the earlier years and that of batoid have gone up. In general the landings of elasmobranchs have gone up steadily over the years.

Statewise landings :- All along the Indian coast good fishing grounds for elasmobranchs exist off Puri, Chilka lake, Sandheads in Orissa; off Visakhapatnam and Kakinada in Andhra Pradesh; off Madras, Cuddalore, Adirampatnam, Rameswaram, Gulf of Mannar and Kanyakumari in Tamil Nadu on the east coat. On the west coast, important centres where elasmobranchs are landed in good quatity are Neendakara, Cochin and Calicut in Kerala; Dakshin Kannada coast in Karnataka; Ratnagiri and Bombay in Maharashtra; Cambay and Veraval in Gujarat.

Contributions to the elasmobranchs fishery by the maritime states is shown in Figure1. Among the states Gujarat ranks first (26%) followed by Tamilnadu (23%) and Maharashtra (17%) . The contributions from the states of West Bengal, Orissa, Karnataka and Goa together formed around 9% while

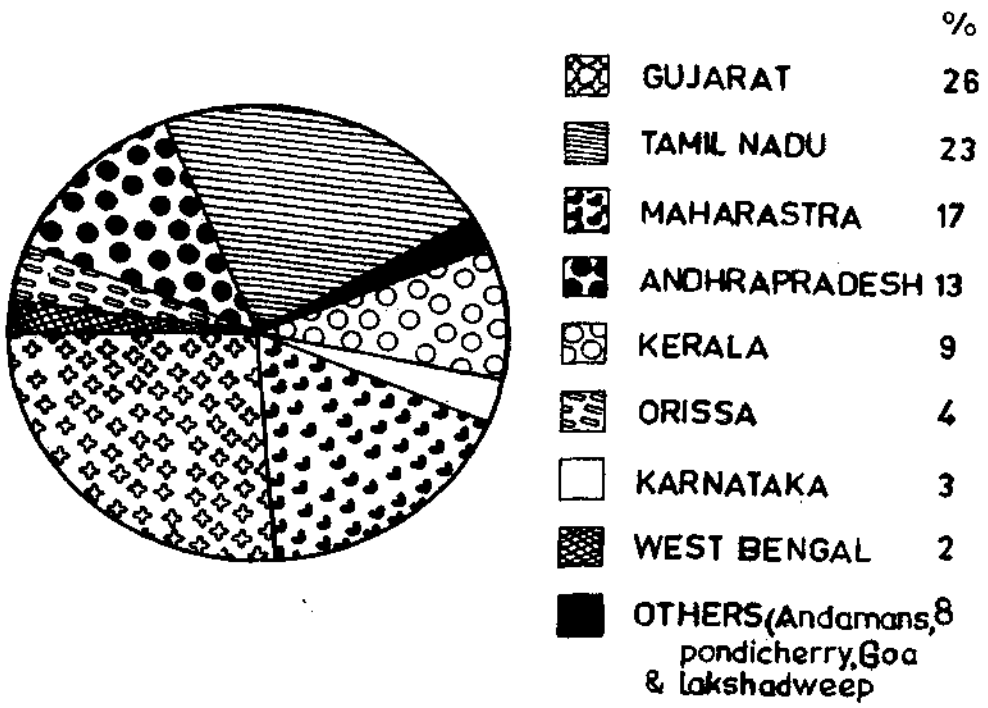

Fig. 1. **Contribution from the maritime states to all India Elasmobranchs landings**

those of Pondicherry, Andamans and Lakshadweep formed 2%. The peak landings recorded during the year 1992 and 1993 were due to increased catch from the states of Gujarat, Tamilnadu, Andhra Pradesh and West Bengal and it is clear from the data on hand that there is scope for increased production from Gujarat and West Bengal.

Along the east coast the main fishing season differed from state to state and from northeast to southeast regions. In the north eastern region comprising the states of West Bengal and Orissa there is no difference in the main fishing season. The main season extends from October to March accounting for 88% of the annual catch in West Bengal and 63% in Orissa. In Andhra Pradesh the peak season is January to March when 37% of the annual catch is effected followed by the second season April to June with 23%. In Tamilnadu there is not much fluctuation in the catches from one quarter to another although the peak season is during July to September when 29% of the catch is accounted, closely followed by the second Quarter April to June with 25%.

The same pattern is seen in Pondicherry also.

In Kerala on the west coast, the peak season is from October to December when 42% of the annual catch is recorded. The main season in Karnataka extends from October to March accounting for 66% of the annual catch with peak during October to December with 35%. The same pattern is observed in Goa. In the northwestern states of Maharashtra and Gujarat, the main fishing season extends from October to March when 67% of the catch is accounted in Maharashtra and 63% in Gujarat. There is striking similarity in the main season for the northeast and northwest regions extending from October to March.

Gear wise landings:- The elasmobranchs are caught by trawl, gill net operated from machanised and non-mechanised boats, hooks and lines and dol net. About 45% of the total elasmobranchs are landed by trawl net, 24.7% by gill net operated from mechanised boats, 18.2% by non mechanised gill net 9.6% by hooks and line and 2.1% by dol net. About 65% of batoid fishes and 33% of the sharks landings are from the trawlers. Whereas the catch and catch rate of sharks from trawlers have increased over the years, the catch rate from mechanised gill net declined over the years after registering a peak during 1985. The catch and CPUE of sharks from non mechanised gill net, and from hooks and lines showed a fluctuating trend.

Regarding the batoid fishes, the landings by trawlers showed an increasing trend from 1985 onwards, while the catch rate fluctuated. The catch and catch rate from hooks and lines also increased up to 1991. On the other hand there was declining trend in catch and catch rate from gill nets.

Export of shark fins:- Shark fins constitute one of the valuable foreign exchange earning commodities among the marine products in India. The quantity of fins exported was fluctuating from 96 t in 1985 to 192 t in 1989 and after a steep fall in the following year, it went up again to 185 t in 1994. However, the increase in quantity is not substantial. On the other hand, the value of export went up considerably from Rs. 13 million in 1985 to Rs. 70 million in 1994. So the increase in export value is mainly due to increase in

market value of fins and not due to increase in the quantity of fins exported (MPEDA, 1994) .

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