Shark Resources of India, with Notes on Biology of a Few Species

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Abstract

The annual production of elasmobranchs in India during 1982-83 to 1984-85 period was around 59,000 t, of which sharks accounted for 37,500 t (64%). Tamil Nadu, Gujarat, Maharashtra and Kerala together take the bulk of the catch. Of the 65 species reported from Indian waters, over 20 species (families Carcharhinidae and Sphymidae) contribute to the fishery. Feeding and breeding habits, intra-uterine embryos and growth characteristics of a few species are described here.

Introduction

Sharks are of great fishery importance the world over, apart from being a significant link in the marine ecology. In India the present annual shark production is around 37,500 t (average for 1983-84 and 1984-85) obtained as a bycatch in a variety of gears. Though they are commercially important, no serious attempts have so far been made at any targeted exploitation of this resource. Our knowledge on the species composition of the shark landings and their relative gear-season and regionwise abundance in the fishery is scanty, except for the gross catch statistics, statewise and on all-India basis available for recent years. Except for some taxonomic studies and fishery aspects, information on the biology and ecology of most species of sharks is meagre. The scope of this paper is to project the present status of the shark fishery in India, to provide a list of all the species recorded from Indian waters and to present the additional data collected by the authors on the biology of a few species.

Material and Methods

The data on the shark landings in India for 1983-84 and 1984-85 are available from published records (Marine Fisheries Information Service, No. 67, Central Marine Fisheries Research Institute). For the earlier years they have been included under the group 'elasmobranchs'. Therefore in this paper the shark landings in India and in the maritime states for the years 1971-83 were calculated on the basis of average values computed from the 1983-85 data. The authors' observations reported here on the biology and fishery of sharks were carried out at Mandapam and nearby areas during 1971-73 and at Bombay during 1971-74. Though some of these results were reported earlier (Nair and Appukuttan, 1973, 1974; Nair et al., 1974; Nair, 1976; Appukuttan, 1978) much remained unpublished; those relating to food, maturity, intrauterine embryos and growth of some species are presented here.

Results and Discussion

Sharks of the Indian seas

Of the many references on the rich selachian fauna of India, the most recent ones are by Talwar and Kacker (1984) describing 35 species and by Compagno (1984a, 1984b) cataloguing the sharks of the world among which 65 species are known to occur in Indian waters. All these species are listed in Table 1. Of these, about 20 species contribute to the shark fishery, and among them 7 species account for the bulk of the landings.

Shark fisheries of India

Among elasmobranchs which contribute over 4% to the marine fish landings in India, sharks amounted to 39,019 t which formed 55% of the elasmobranch landings in 1983-84. The shark landings in India for the years 1971 to 1984-85 are shown in Fig. 1. Over this period the annual landings varied between 26,000 t 39,000 t; since 1974 they were always more then 30,000 t (except in 1976), contributing 2.1 to 2.8% of the total marine fish landings.

Andhra, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu account for about 85% of the shark landings in the country (Fig. 2). About two-thirds of the shark landings (69% in 1983-84, 63% in 1984-85) come from the west coast.

While there are several types of gear that take sharks as incidental catch, the important among them are trawl net and gill net. There are no informations on the gearwise landings of sharks on all-India basis. However, data available on shark production by mechanised boats at major fishing centres show that during 1982-83 to 1984-85 trawl net accounted for 59.6% of the total shark landings, followed by gill net with 38.5%. Purse seine in Cochin and Mangalore, hooks and line in Cochin and Sassoon Docks, 'thangu vala' (bottom-set gill net) in Cochin and 'dol' net in Sassoon Docks take a very small fraction of the catch. New Ferry Wharf and Sasson Docks in Maharashtra, Pudumanai-
kuppam in Andra, Tuticorin in Tamil Nadu and Veraval in Gujarat are centres of good landings by trawl net, Pudumanaikuppam, Cuddalore, Tuticorin, Sakhikulangara, Cochin, New Ferry Wharf, Sassoon Docks and Veraval by gill net.

No clear variation in landings according to seasons is discernible for most of the centres for which data are available. However, at Sakhikulangara and Cochin the catch during the monsoon months (July-September) was the highest for both the years; at New Ferry Wharf and Sassoon Docks the highest catch was in the post-monsoon months (October-December).

Apart from the information available on the distribution of different species of sharks that support the fishery (James, 1973; Rao, 1973; Talwar, 1974), data have been collected on the species composition and abundance of sharks landed at Pamban and Kilakkarai near Mandapam on the southeastern coast of India for 1971-73 period and also from Bombay area (Table 2). A number of species contribute to the fishery at these centres, among which Carcharhinus limbatus (Valenciennes) and Rhizoprionodon oligolinx Springer respectively were the most abundant. In Bombay region Scoliodon laticaudus Muller & Henle taken in trawl net was the dominant species during 1971-74; among larger sharks landed by gill net and hooks and line C. limbatus (Valenciennes) was the most common and others included C. dussumieri (Valenciennes), C. melanopterus (Quoy & Gaimard), C. macloti (Muller & Henle) and Chaenogaleus macrostoma (Bleeker).

**Biology of Indian sharks**

1. *Echinorhinus brucus* (Bonnaterre)
   
   One female shark measuring 1.875 m length and weighing 41.9 kg (Pl. I.A) collected on 19-2-1972 at a depth of 265-275 m from the Gulf of Mannar, had half-digested deep sea fishes in the stomach. The specimen was mature with round eggs of 39-70 mm diameter, 11 in the right uterus and 6 in the left (Pl. I.B); nidamental gland was not well developed. This species is ovoviviparous and both the uteri are functional.

2. *Centrophorus uyato* (Rafinesque)
   
   One gravid female shark measuring 930 mm collected from the Gulf of Mannar at a depth of 275 m had one 183 mm embryo in the left uterus and a 42 mm fully yolked egg in the right uterus (Pl. I.C.D.E).

3. *Chiloscyllium griseum* Muller & Henle
   
   This shark is oviparous and deposits the egg in oval egg cases on the sea bottom; mostly feeds on invertebrates. The breeding season is from January to March.

4. *Rhiniodon typus* Smith
   
   According to Compagno (1984a) the maximum total length of this whale shark is uncertain; it may grow up to 18 m but most specimens are less than 12 m. From Indian waters there are only two records of the whale shark measuring over 12 m (Silas, 1986). This species is an omnivorous suction filter-feeder. There is no information on the size at first maturity, mode of reproduction whether viviparous, oviparous or ovoviviparous, and reproductive potential.

5. *Halaelurus hispidus* (Alcock)
   
   This shark feeds on fishes, squids and crustaceans; juveniles prefer crustaceans to fish and squids. Adult males have a size range of 240-260 mm and adult females 220-290 mm. There is no information on the mode of development. Sexual segregation is noticed in this species.

6. *Eridacnis radcliffei* (Smith)
   
   The food of this species is mainly deep-sea fishes, crustaceans and squids. Only the right ovary is functional. This shark is ovoviviparous. During development though a shell membrane is formed in the initial stage, the embryo is found free inside the uterus connected to a fairly large yolk sac which is resorbed by the embryo before birth. Only one embryo is found in each uterus (Pl. I.F). The full-term embryos are of great size (101-107 mm) compared to their mother which may become pregnant at 166 mm.

7. *Iago omanensis* (Norman)
   
   This is a viviparous species with yolk-placenta, and feeds on fishes, crustaceans and squids. Adult males are smaller than adult females showing great sexual dimorphism in size.

8. *Chaenogaleus macrostoma* (Bleeker)
   
   This is a viviparous shark with well-developed yolk-sac placenta. Only the right ovary is functional. Mature ova are over 15 mm in diameter. Gestating females of 821-933 mm from the Gulf of Mannar had one embryo in the range 307-445 mm in each uterus. Embryonic store-chamber is well developed. The yolk-sac persists even in advanced stages and gets convoluted and becomes attached to the uterine wall. The umbilical cord has a number of appendiculae, crowded and highly arborescent towards the yolk-sac end (Pl. I.G). Breeding on the southeast coast of India seems to be in November-February. The food of this shark is not known.

9. *Hemipristis elongatus* (Kunzinger)
   
   This is a viviparous shark with yolk-sac placenta. There are 6-8 young per litter. The food of this shark includes anchovies, cat fish, Bombay Duck, mackerel, carcharhinid sharks and butterfly rays (Compagno, 1984a).

10. *Carcharhinus dussumieri* (Valenciennes)
    
    In this shark only the right ovary is functional. Mature ova measure 25 mm in diameter. The yolk-sac placenta is formed by deep convolutions in the uterine wall and the placental connection is pocket type. The placental cord is plain without appendicula (Pl. I.H.) and contains three channels, umbilical artery, umbilical vein and ductus vitellintestinalis. The embryo is covered with embryonic membrane even when the placental connection is established. The number of embryos is usually two, one in
each uterus, very rarely four. In the Gulf of Mannar the
peak parturition period is March-April.
11. *Carcharhinus hemiodon* (Valenciennes)
Gravid females of this species collected in March from
the Gulf of Mannar had a length range of 825-887 mm and
had 300-335 mm embryos in advanced stages. The right
ovary alone is functional and the diameter of ova is 5-12
mm. Placentation is by interdigitation of uterine and yolk-
sac walls. Placental cord is without appendiculae (Pl. I.I.).
There were 1-2 embryos in each uterus.

12. *Carcharhinus limbatis* (Valenciennes)

This shark feeds on a variety of fishes, crustaceans and
cephalopods. Right ovary alone is functional. Viviparous
with yolk-sac placenta. Mature eggs covered with shell
membrane are 25-35 mm in size. Shell membrane store-
chamber is noticed in this species. Smaller embryos with
functional yolk-sac were found to possess external gill
filaments (Pl. II, A.B). Placenta is highly vascularised and
the cord is without appendiculae. The embryos (70-365 mm)
are in uterine compartments, usually 2-4 in each uterus.
The gestating mothers ranged from 890 to 1550 mm.

13. *Carcharhinus macloti* (Muller & Henle)

This is viviparous with yolk-sac placenta, having 1-2
embryos to a litter. The male matures at about 69 cm and
female at 76-89 cm. One gravid female of 875 mm collected
from the Gulf of Mannar had two embryos of 329 and 432
mm in advanced stage. Yolk persisted even at this stage.
Placental cord was without appendiculae.

14. *Carcharhinus melanopterus* (Quoy & Gaimard)

Viviparous with yolk-sac placenta, this species has
usually 4 young in a litter, one in each uterine
compartment. Gestation period is about 16 months. A
variety of fishes, cephalopods and crustaceans are the
main food items. Males mature at 91-100 cm and females at
96-112 cm. The cord of the yolk-sac placenta (Pl. II.C)
is without appendiculae.

15. *Loxodon macrorhinus* Muller & Henle

This is a viviparous shark with yolk-sac placenta. Food
includes small bony fishes, cephalopods and crustaceans.
In sharks (441-888 mm) collected from the east and west
coasts of India the mature egg is 15 mm in diameter.
Embryos in early stages have external gill filaments. In
most of the specimens observed there was one embryo
(142-465 mm) in each uterus. Placental connection with the
mother was noticed when the embryo was 142 mm, and its
appendiculae characteristic with fleshy ribbon-like lobes as
outgrowths enlarged towards the yolk-sac end (Pl. II, D.E).
This is a unique taxonomic feature (Nair et al., 1974).
Gravid females were collected in July on the east coast,
while on the west coast newly born young were obtained in
August.

16. *Rhizoprionodon acutus* (Ruppell)

The food of this shark collected from the southeast coast
of India consisted mainly of a variety of fishes, among
which silverbellies were found to be the most important;
other items included crustaceans and cephalopods. This
shark breeds almost round the year as evidenced by the
females with embryos in various stages of development
during January-April, June and October-December on the
east coast. Placentation of this viviparous shark begins in
the late stage of development by the interdigitation of yolk-
sac and the uterine wall. The placental cord has short,
highly vascularised and closely packed appendiculae,
broad at proximal and narrow at distal ends (Pl. II,F.G).

A curvilinear relationship exists between the placental
cord and the intra-uterine embryo (Fig. 3). The relationship
is

\[ \log W = 0.5587 + 0.6665 \log L \]

where 'W' is the length of placental cord and 'L' the length of embryo. The length of the placental cord varied between 51 and 185 mm, and that of the embryo between 55 and 340 mm.

17. *Rhizoprionodon oligolinx* Springer

This shark feeds on pelagic fish, crustaceans and
cephalopods. The males mature at 29-38 cm and the
females, which grow larger, at 32-41 cm. The right ovary
alone is functional. The mature egg is 15 mm in diameter.
The shark is viviparous with yolk-sac placenta. The
placental connection of the embryo with the uterine wall is
established by the formation of trophonema. Placental cord
has highly branched and closely packed appendiculae,
each branch being swollen at the terminal end (Pl. I.I). The
number of embryos is 3-6 per litter. Gravid females with
advanced embryos were observed in January-April, July
and October, indicating that this shark also breeds almost
throughout the year. The curvilinear relationship (Fig. 4)
between the embryo size and the length of placental cord
is

\[ \log W = 0.6038 + 0.6562 \log L \]

where 'W' is the length of placental cord and 'L' the length of embryo.

18. *Scylliodon latiaudus* Muller & Henle

The dietary habits of this shark of Bombay waters show
that this is a bottom feeder, eating cephalopods, a variety
of crustaceans (squilla, prawns and crabs) and fishes
(sciaenids, Bombay Duck, threadfins, *Nemipterus* and
*Platycephalus*). Incidence of empty stomachs was more in
gravid females. Breeding takes place throughout the year.

19. *Eusphyra blochii* (Cuvier)

This is a viviparous shark with yolk-sac placenta. The
placental cord is with appendiculae which are unique in
that they are flattened, leaf-like and bilobed or trilobed,
becoming smoother towards the yolk-sac end (Pl. II,H). Spent
adults were found in the Gulf of Mannar during
March-April and gestating females of 150-155 cm during
November.

20. *Sphyra zygaena* (Linnaeus)

This species also is viviparous with yolk-sac placenta.
Placental cord is with flattened single-lobed appendiculae.
The number of embryos is between 29 and 37 per litter.

The paucity of work on the biology of Indian sharks is
probably due to the difficulty in getting adequate samples;
as there is no regular fishery for sharks, their availability is only incidental. Added to this is the unwieldy size of many species. According to Krishnamoorthi and Jagdis (1986), out of 77 publications on elasmobranchs from India, only one deals with the age and growth; the rest are mainly on faunistic and taxonomic studies, apart from some isolated biological details of a few species.

Since whatever is obtained as bycatch is a multispecies catch of sharks in a multigear fishery, no serious effort has been made to assess the catch composition or the species estimates of the landings on an all-India basis or for the major landing centres. In addition to this is the paucity of adequate information on biology, especially growth characteristics of most species. These factors may explain the lack of attempts on population dynamics. The work of Krishnamoorthi and Jagdis (1986) is the only attempt at stock estimation of a shark. Devaraj (1983) estimated the growth parameters (to, L = and K) for five species of sharks that are of fishery importance, but the estimation of stock is not possible in the absence of any catch and effort data.

Holden (1973) has indicated that the average fecundity is very low, and it might be expected that the elasmobranch stocks would be very susceptible to effects of fishing. In most sharks fecundity varies from 1 to less than 10, rarely more than 10, and the gestation period is generally long. Because of this the natural mortality and the fishing mortality are expected to be high. Discussing the effects of fishing on squallus acanthias in British waters, Holden (1974) states that the female part of the stock must be given considerable protection if recruitment is not to be affected. Fortunately, such a situation does not exist for sharks of the Indian waters as the present exploitation is meagre.

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Table 1. Sharks recorded from Indian Waters. (Complied from Compagno, 1984a and 1984b).

<table>
<thead>
<tr>
<th>Family and valid name of species</th>
<th>Distribution</th>
<th>Habitat</th>
<th>Size at birth (cm)</th>
<th>Maximum size (cm)</th>
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<td>Inshore and river mouths</td>
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<td>Inshore; estuarine riverine</td>
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<td><em>Carcharhinus limbatis</em> (Valenciennes)</td>
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<td>Epipelagic; oceanic</td>
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<td><em>Carcharhinus limbatis</em> (Poe)</td>
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<td><em>Carcharhinus macculli</em> (Muller &amp; Henle)</td>
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<td>Inshore</td>
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<td><em>Carcharhinus melanopterus</em> (Quoy &amp; Gaimard)</td>
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<td>Inshore, in coral reefs</td>
<td>33-52</td>
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<td><em>Carcharhinus plumbeus</em> (Nardo)</td>
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<td>Pelagic; inshore and offshore</td>
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<td><em>Carcharhinus sorrah</em> (Valenciennes)</td>
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<td>Inshore</td>
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<td><em>Galaxiurus cuvier</em> (Perron &amp; Lesueur)</td>
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<td>Pelagic; inshore</td>
<td>51-76</td>
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<tr>
<td><em>Cymbaceus gansaticus</em> (Muller &amp; Henle)</td>
<td>Bengal coast; east and west coasts</td>
<td>Inshore, riverine, fresh water</td>
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<td>204</td>
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<td><em>Lamna nasica</em> (Muller &amp; Henle)</td>
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<td>Inshore</td>
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<td><em>Lamna nasica</em> (Poe)</td>
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<td>Inshore</td>
<td>40-43</td>
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<td><em>Lamna nasica</em> (Muller &amp; Henle)</td>
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<td>Pelagic; offshore</td>
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<td><em>Rhinopristis brevirostris</em> (Bleiweiler)</td>
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<td>Inshore and offshore</td>
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<td><em>Rhinopristis remigis</em> (Springer)</td>
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<td><em>Scaphirhinus indicus</em> (Muller &amp; Henle)</td>
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<td>Inshore</td>
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<td>213</td>
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<tr>
<td><em>Sphyra glauca</em> (Ruppli)</td>
<td>East and west coasts</td>
<td>Inshore</td>
<td>32-45</td>
<td>152</td>
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<tr>
<td><em>Sphyrna lewini</em> (Griffith &amp; Smith)</td>
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<td>Pelagic; inshore</td>
<td>42-35</td>
<td>370-430</td>
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<tr>
<td><em>Sphyrna mokarrani</em> (Ruppli)</td>
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<td>Pelagic; inshore and semi-oceanic</td>
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<td>550-610</td>
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<td><em>Sphyrna zygaena</em> (Linneman)</td>
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<td>Pelagic; inshore and semi-oceanic</td>
<td>50-61</td>
<td>370-400</td>
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*Fishery importance: X Nil XX - Limited fishery; XXX - Regular fishery; XXXX - Abundant regular fishery.*
Table 2. Shark landings (kg) at Pamban and Kilakkarai during 1971-73

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<td><em>Loxodon macrorhinus</em></td>
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<tr>
<td><em>Rhizoprionodon acutus</em></td>
<td>8,492</td>
<td>9,474</td>
<td>5,392</td>
<td>4,729</td>
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<td><em>R. albigularis</em></td>
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<td><em>Carcharhinus limbatus</em></td>
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<td>8,880</td>
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<td>C. sorrah</td>
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<td>C. dussumieri</td>
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<td>C. hemiodon</td>
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<td>Euphyra blochii</td>
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<td>1,894</td>
<td>2,994</td>
<td>873</td>
<td>175</td>
<td>996</td>
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<tr>
<td>S. lewini</td>
<td>181</td>
<td>715</td>
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<td>Total</td>
<td>39,975</td>
<td>33,078</td>
<td>43,322</td>
<td>17,937</td>
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![Graph showing shark landings in India, 1971 to 1984-85.](image)

Fig. 1. Shark landings (tonnes) in India, 1971 to 1984-85.
Fig. 2. Shark landings (tonnes) in maritime states of India.

Fig. 3. Relationship between lengths of intra-uterine embryo and placental cord in *Rhizoprionodon acutus*. 
Fig. 4. Relationship between lengths of intra-uterine embryo and placental cord in *Rhizoprionodon acutus*.

Legend to Figure 5, Plate – I and Plate – II

**Fig. 5. Plate – I**
A. *Echinorhinus brucus*
B. Eggs of *Echinorhinus brucus*
C. *Centrophorus uyato*
D. Egg of *Centrophorus uyato*
E. Intra-uterine embryo of *C. uyato*
F. Intra-uterine embryos of *Eridacnis radcliffei* – one in each uterus.
G. Intra-uterine embryo of *Chaenogaleus macrostoma*
H. Intra-uterine embryo of *Carcharhinus dussumieri*
I. Intra-uterine embryo of *Carcharhinus hemiodon*
J. Early stages of intra-uterine embryos of *Rhizoprionodon acutus*

**Fig. 5. Plate – II**
A. Intra-uterine embryo of *Carcharhinus limbatis*
B. Early stage of embryo of *C. limbatis* with external gill filaments.
C. Intraputerine embryo of *C. melanopterus*
D. Intra-uterine embryo of *Loxodon macrorhinus* showing the characteristic ribbon-like lobes of appendicula.
E. Intra-uterine embryo of *L. macrorhinus* showing placental attachment.
F. Intra-uterine embryos of *Rhizoprionodon acutus*
G. Placental attachment of embryos of *R. acutus*
H. Placental connection of *Eusphyra blochii* showing the nature of placental cord.
Fig. 5. Plate I
Fig. 5, Plate II