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First Report on Recruits of Bigeye Thresher Shark *Alopias Superciliosus* (Laminiformes: Alopidae) with Largest Birth Size from Indian Waters

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Running Head- Notes on Fetuses of *Alopias superciliosus* from India

ABSTRACT

Four embryonic bigeye thresher sharks *Alopias superciliosus* (126–158 cm total length) were collected from two females caught by bottom set gillnet and hook and line (operating in 120–800 m depth) caught from off Kanyakumari area and landed in Cochin Fisheries Harbour on 11-06-2012 . Detailed morphometric measurements are provided. The ratio of size at birth (L_b) and maximum observed length (L_{max}) in this study was 0.36, the largest when compared to earlier reports available till date. The bigeye thresher shark (*Alopias superciliosus*) is listed as Vulnerable globally because of declining population (IUCN 2007, Amorim et al. 2009). The production of a large neonate at parturition has the advantage of increased survival rate because of enhanced prey capturing and predator escaping abilities.

Keywords - *Alopias superciliosus*, Bigeye Thresher Shark, embryo, size at birth, Elasmobranch

I. INTRODUCTION

The bigeye thresher shark *Alopias superciliosus* (family Alopiidae) is a deep-dwelling species, occurring from the surface down to 250 m in the Mediterranean Sea and down to at least 500 m elsewhere in its circumtropical range (Gruber and Compagno 1981). Catch records indicate that the bigeye thresher shark typically inhabits deeper water than the common thresher shark *Alopias vulpinus*. Its reproductive biology has been studied in the eastern and western Atlantic (Stillwell and Casey 1976, Gruber and Compagno 1981, Gilmore 1983, 1993, Moreno and Moron 1992 and Taiwan (Nakamura 1935). It is ovoviviparous, oophagous in the wild and usually produces 2 pups per litter (occasionally up to 4 pups per litter); to date, there is no information on a defined pupping season or nursery areas in the northwestern Indian Ocean, and no data on their gestation period. Our aim of this study was to provide the first detailed information concerning aspects of the embryonic development, detailed morphometrics and birth size from Indian waters.

II. METHODS AND MATERIAL

Two pregnant bigeye thresher sharks were caught off Kanyakumari and landed in Cochin Fisheries Harbour on 11th June 2012 and 18th September 2012 i.e. 7^0.06'.648 N 77^0.24'.583 E to 7^0.07'.857 N to 77^0.22'.150 E .The gillnet used has a head rope length of 7 m and Dimension (Length × Depth) of 12 m with a mesh size body 8-9 mm and the hooks used for capture is of hook numbers 3 and 4. The other species caught along with the pregnant threshers included *Alopias vulpinus*, *Carcharhinius spp.* , *Mobula mobular*, Sail fish, *Arius sp.* and few seer fishes. The catch also included a few discards such as small shrimps, a dolpin and a turtle as reported by the crew of the gillnetter. One pregnant thresher was of 340 cm in Total length and weighed 51 kg and its embryos were one male with a length of 130 cm found in right uterus and the female embryo had a total length of 126 cm located in left uterus of the mother. Both the embryos weighed 5 kg each. The other parent had a Total length of 346 cm and

weighed 56 kg. Its embryos were one male in right uterus and female in left uterus. The male and female embryo had a length of 155 and 158 cm .The weights of embryos were 7 kg each. Two embryos were found in each female (Fig. 1) and the sex, mass and 39 morphometric measurements for these embryos are given in Table I. All measurements of adults and embryos were made while the shark was lying horizontally on a flat surface. Terminology and measurements follow Bass et al. 1975, Branstetter and McEachran 1986 and Gruber and Compagno 1981. Standard length (SL) was taken from the tip of the snout to the center of the precaudal pit. All weights were taken on a spring balance in the harbour itself.

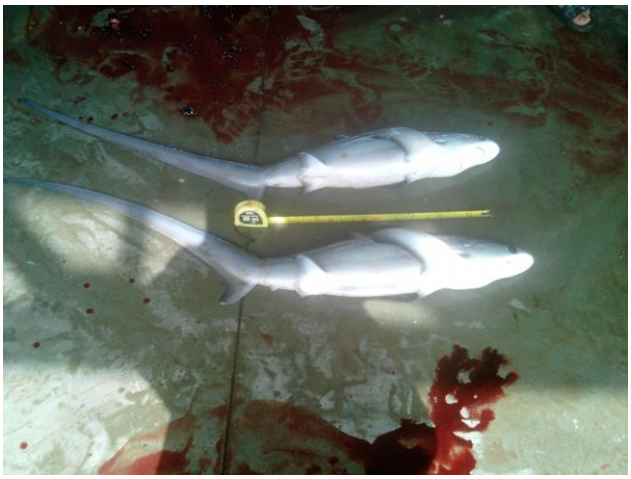

Figure1. Two *Alopias superciliosus* embryos collected from a female caught in June 2011 by a gillnetter and landed in Cochin Fisheries Harbour.

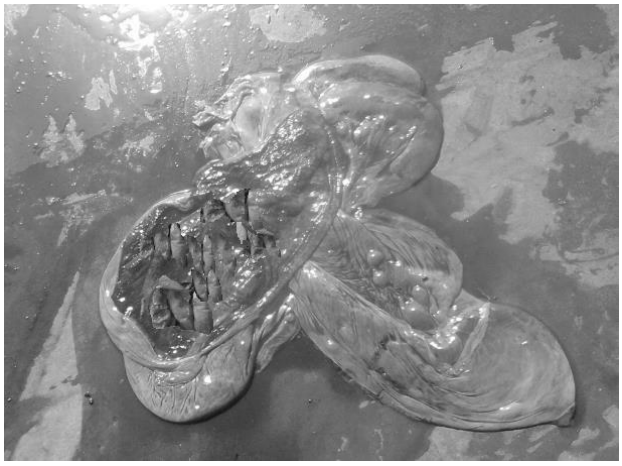

Figure 2. Egg capsules from uterus

Figure 3. Infertile, horny eggs of *Alopias superciliosus* found in the oviducts along with the embryos.

III. RESULTS AND DISCUSSION

In the uterine cavity of a pregnant female along with both the embryos there were 42 yolk filled egg capsule 57.01 mm to 275.98 mm in length, 15.13 mm to 21.87 mm in width and weighed 5.48 g to 15.79 g (Fig.2 & 3). The capsule numbers were less here as the embryos were large and appeared to be term fetuses. The ovary weighed 235 g and contained approximately 727 ova varying 1.3 mm to 3.9 mm in diameter. Horny infertile eggs are deposited in each oviduct and the embryo consumes these as development proceeds (Cadenat 1956, Gubanov 1972).

The embryonic nutrition and growth of bigeye thresher sharks have been studied and reported by several authors (Gruber and Compagno 1981, Gilmore 1983, Monreno and Moron 1992). However, only Gilmore (1983) gave a detailed description of embryonic development.

The size at birth of bigeye threshers has been reported variously between 60 cm TL to 140 cm TL by various authors (Table 2). During this study, the largest embryo observed was 158 cm TL, which was near parturition. Variations in size at birth may be due to environmental factors (Moreno and Moron 1992). However, the sizes at maturity under 100 cm, reported by Bigelow and Schroeder (1948), Cadenat (1956) and Osipov (1968) were likely to be underestimations, which might have resulted from small sample sizes. The ratio of size at birth (L_b) and maximum observed length (L_{max}) in this study was 0.36 which is a bit near to studies in bigeye thresher by Chen et al.(1997) but larger than previous records which ranged from 0.16- 0.25 (Table II) , suggesting that the bigeye thresher in Indian waters has a larger birth size than in other waters. The benefit in having large neonates is enhanced prey capturing and predator-escaping abilities, thus improving their survival

chances after parturition (Branstetter 1990). Species with low fecundity always breed larger neonates and the ratio of size at birth (L_b) and maximum observed length (L_{max}) are usually also high (Branstetter 1990).

Litter size has been reported as two in *Alopias superciliosus* as reported by most authors (Nakamura 1935, Cadenat 1956, Stillwell and Casey 1976 , Gruber and Compagno 1981, Gilmore 1983). Similar results have been observed in the present study as well. But in studies reported by Chen et al. (1997) in bigeye threshers only one embryo was found in each of the two uteri in all gravid females. However such cases are rare and usually litter size of *Alopias superciliosus* ranges from two to four. Moreno and Moron (1992) reported similar observations as well.

All of the bigeye thresher embryos were covered with a smooth epithelium covering the well-developed dermal denticles of the second epithelial layer. This outer layer probably protects the highly vascularised uterine lining from the sharp denticles of large active embryo and may also aid in allowing the embryo to make a smooth exit during parturition. The smooth outer epithelial layer has not been described for other alopid embryos and may be a character only found in *A.superciliosus* (Nakamura 1935, Gubanov 1972, Hixon 1979). The juvenile of *A.superciliosus* examined had well developed spinous denticles, therefore apparently necessitating the presence of a smooth and protective outer epithelium. The embryo was considered to be near term as no encapsulated ova were found in the oviduct, indicating that ovulation was declining or has ceased. The parental ovary was reduced in size, further indicating that this embryo had just passed through the period of maximum oophagy and was nearing parturition.

These facts indicate that in Bigeye threshers the embryos were nourished by the ova from the maternal fish and so are oophagous (egg eaters) by nature. There were no connection or structures like placenta between them intra uterine wall of mother and the embryo. They are aplacental viviparous species. When compared to other oophagous lamnoid sharks , bigeye thresher shark embryos do not acquire large distended yolky stomachs. Bigeye thresher embryos are externally well formed and partly pigmented when they are only about 60 cm. The fully formed external appearance of embryos has caused researchers to therefore overestimate how close enbryos are close to birth and to underestimate the birth size. It is only after examining a decent number of gravid females is one able to confirm whether it is term fetus or early one (Castro 1983). However, in the presents study the size of embryos at birth were the highest value ranging from 130-158 cm in total length when compared to all other previous records.

Guitart Manday (1975) reported that most large females throughout the year contained embryos. If the reproductive pattern is similar to that of the common thresher (Gubanov 1972, 1979) then mating occurs throughout the year.

This study provides the first detailed biological data of term fetuses for this species form Southwest coast of India and also highlights the highest birth size of the recruits for this species in Indian waters. The larger size of the neonates is found beneficiary as it improves survival rate after parturition .Not enough data are available for the bigeye threshers to demonstrate seasonality and more research focussing and monitoring the pregnant bigeye threshers are needed to fill up the lacunae. The results of this study can be used as biological input parameters for further evaluation of the bigeye thresher stock in the Southwest coast of India.

TABLE I: Sex, total length (TL), mass and other morphometric measurements for four embryos of *Alopias superciliosus*

Sr. No	Morphometeric measurements (cm)	Parent 1	Male Embryo	Female Embryo	Parent 2	Male Embryo	Female Embryo
1	Total length(TL)	340	130	126	346	155	158
2	Standard length (SL)	111	63	64	190.3	73	72
3	Pre-orbital distance	9.3	6.8	6.7	18	7	7
	Post-orbital distance	18	10	10.5	29	12	10
4	Gillslit Area (GA)	7.5	5.5	4.5	16	6.5	6

5	First Gill slit length	6	3.3	3.5	13	4.5	4.2
6	Eye Diameter (ED)	3.5	2.8	3	7	2.8	2.8
7	Eye length (EL)	4	3.8	2.5	8	2.5	3.2
8	Mouth length (ML)	6.5	3.4	3.8	12	4.3	4
9	Mouth Width(MW)	8.5	5	4.5	22	6	5.8
10	Snout to Pectoral distance	40	21	22	64	26	24
11	Snout to 1st Dorsal	53	35	36.5	103.3	41	40
12	Pectoral to Pelvic distance	29	20.5	21.5	59	25.3	24.5
13	Pelvic to Anal distance	13	6	5	12	8.6	8.2
14	Anal to Caudal distance	4.5	3	4	8	3.4	3
15	First to second dorsal space	30	16	15	38	23.4	21.8
16	Caudal upper lobe length	121	67	64	150	78	76
17	Caudal lower lobe length	14	8	9	23.4	10	8.3
18	Caudal upper lobe ventral side length	112	60	58.5	138	73	70
19	Second Dorsal to Caudal fin length	11	5	6	15	6.5	6.2
20	Finlet length	3	1.8	2.2	11	2	1.8
21	Pectoral fin length	17	9.5	9.6	13	11	9.9
22	Pectoral fin height	39	20	18.2	66	23.5	21.8
23	Pectoral fin base	15	8	8	24	8	7.2
24	First Dorsal fin length	14	9	8	27	9.6	9
25	First Dorsal fin height	6.5	9.5	8.5	25	9.5	9.2
26	First Dorsal fin base	11.2	6	6.2	22	7.5	7.2
27	Second Dorsal fin length	5	3	3	8.4	3.2	3
28	Second Dorsal fin height	5.5	1.5	2	4	2	1.5
29	Second Dorsal fin base	1.8	0.7	0.6	3	1	0.8
30	Pelvic fin length	16	7.5	7.2	30.4	9.5	9.2
31	Pelvic fin height	14	7	7.5	28	9	9
32	Pelvic fin base	6.7	5.5	6	22	7.5	7.2
33	Anal fin length	5.5	2.9	3.7	10	3	2.5
34	Anal fin height	3	2	2.8	5	2	1.8
35	Anal fin base	2	0.6	0.8	4	1	0.9
36	Body Girth	17	38	35	142	42.8	42
37	Snout to mouth (ventral)	10	6.5	7.7	16	8	72
38	Clasper or Cloacal opening length	16.8	3.2	8.5	31	3.5	3
39	Weight (g)	51	5	5	58	7	7

TABLE II. Summary of size at birth of *Alopias superciliosus*

Author (s)	Size at birth(cm)	L_b / L_{max}
Bass et al.(1975)	100-103	-
Bigelow and Schroeder (1948)	64	0.18
Cadenat (1956)	68	0.17
Gilmore (1983)	64-106	0.18
Gruber and Compagno(1981)	105	-
Gubanov (1978)	100-103	0.25
Moreno and Moron (1992)	100	-
Nakamura (1935)	100	0.23
Osipov (1968)	72	0.16
Cadenat (1956)	60-62	-
Chen et al.(1997)	135-140	0.32
This study	130-158	0.36

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