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Report on the landing of the critically endangered Rhinobatid *Acroteriobatus variegatus* (Nair & Lal Mohan, 1973) with some insights into its reproductive biology

Livi Wilson[1]*, P. U. Zacharia[1], Shoba Joe Kizhakudan[2], T. M. Najmudeen[1], B. Santhosh[3], Ambarish P. Gop[3], M. Radhakrishnan[1], K. T. S. Sunil[1] and S. Pakkri Muthu[1]

[1]ICAR-Central Marine Fisheries Research Institute, Kochi-682 018, Kerala, India.

[2]Research Centre of ICAR-Central Marine Fisheries Research Institute, Chennai-600 028, Tamil Nadu, India.

[3]Research Centre of ICAR-Central Marine Fisheries Research Institute, Vizhinjam-695 001, Kerala, India

*Correspondence e-mail: liviwilson@gmail.com

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Original Article

Abstract

A single specimen of a gravid female of the stripenose guitarfish, *Acroteriobatus variegatus* was landed as by-catch by a tuna hook and line at Sakthikulangara, Kerala from a depth of 110-130 m. The species is categorized as 'critically endangered' by IUCN. The morphometric characteristics of *A. variegatus* are described for the first time since its original description by Nair and Lal Mohan (1973) from Gulf of Mannar. The present study provides preliminary insights into its reproductive biology. The mode of reproduction in *A. variegatus* is aplacental yolk sac viviparity with low uterine fecundity.

Keywords*: Stripenose guitarfish, morphometric characteristics, aplacental yolk sac viviparity, low uterine fecundity*

Introduction

Guitarfishes are mainly landed along the Kerala coast as bycatch in commercial fishing activities like trawling and gill netting, as well as in artisanal gears. The estimated landing of guitarfishes along the Kerala coast in 2019 was 32.8 t which recorded a major slump of 72.20% compared to the previous year. More than 50% of the species of elasmobranchs within the Arabian Sea region were considered as threatened due to fishing pressure from the artisanal and industrial sector with bycatch considered to be the biggest menace (Jabado *et al*., 2017). Unfortunately, lack of species-specific information and an increase in fishing effort within this region is a cause of concern for fishery management (Jabado *et al*., 2017). Limited species-specific reporting combined with unregulated fishing has led to the depletion of many chondrichthyan fishes throughout the worlds' oceans (Dulvy and Reynolds, 2002; Sulikowski *et al*., 2007) and continues to hamper the progress of management plans (Hoff and Musick, 1990; Leaman, 1991; Munk, 2001).

The genus *Acroteriobatus*, earlier known as *Rhinobatos*, is represented in the western Indian Ocean by eight species (Last *et al*., 2016a): *Acroteriobatus annulatus* (Müller and Henle, 1841), *A. blochii* (Müller and Henle, 1841), *A. leucospilus* (Norman, 1926), *A. ocellatus* (Norman, 1926), *A. salalah* (Randall & Compagno, 1995), *A. variegatus* (Nair and Lal Mohan, 1973) *A. zanzibarensis* (Norman, 1926) and *A. omanensis* Last, Henderson and Naylor, 2016. The stripenose guitarfish, *Acroteriobatus variegatus* is a small to medium-sized guitarfish that occurs on the continental shelf at depths between 10 and 40 m along the Northern Indian Ocean, commonly occurring in the south-west and south-east coast of India (Last *et al*., 2016b; Kizhakudan *et al*., 2018). Even though the habitat reported

is primarily inshore, the holotype specimen was reportedly collected from 366 m (Nair and Lal Mohan, 1973). There is also some information that relates its association with the coral reef environment (Jabado *et al.*, 2017). Owing to intensive fishing pressure and decline in the quality of coral reefs, a population slump is expected over the next three generations (2017-2032) which led to its designation by the IUCN (International Union for the Conservation of Nature) as critically endangered. It is the only Rhinobatid species endemic to the Arabian Sea region which is considered as critically endangered (Jabado *et al.*, 2017). Since its original description from Gulf of Mannar (Nair and Lal Mohan, 1973), information pertaining to this species has been limited to systematic, distribution studies and assessing conservation status (Last *et al.*, 2016; Jabado *et al.*, 2017; Kizhakudan *et al.*, 2018; Fernando *et al.*, 2019). This article describes some reproductive characteristics of the species.

Material and methods

A single gravid female specimen of the stripenose guitarfish, *A. variegatus* (Nair and Lal Mohan, 1973) was collected from the Sakthikulangara Fishing Harbour (08° 56′ N; 76° 32′ E), Kerala in November 2019. It was landed as by-catch from a tuna hook and line, operated at a depth of 110-130 m. The guitarfish measured 672 mm in total length (TL), 202 mm in disc width (DW) and weighed 1.12 kg. The morphometric measurements of the pregnant female were measured with a Mitutoyo Absolute digital vernier caliper with an accuracy of 0.01 mm. Morphometric characteristics were compared with the published literature of the holotype specimen (Accession No.GA.11.14.2.3) from the Gulf of Mannar (Nair and Lal Mohan, 1973). The ovaries and uteri were removed and embryos from the uteri were preserved in 10% formaldehyde for further studies. Fecundity was estimated from the number of mature ova and also the number of embryos present (Devadoss, 1998). Morphometric characteristics of the recovered embryos were studied. The embryos have been deposited in the National Marine Biodiversity Referral Museum at CMFRI, Cochin, India (accession number CMFRI. DNR. No.MISC.39).

Results and discussion

The stripenose guitarfish, *A. variegatus* is identified by the variegated markings (yellow with bluish lines) in the pectoral and pelvic fin margins with a characteristically flattened wedge-shaped disc (Fig. 1). The pale translucent snout is triangular with yellow bars and the anterior nasal flaps extend well into the internasal space. Ventral surface is pale with a distinct pigmentation on the snout tip. The dorsal fins are broadly spaced and the first and second dorsal fin bases are of equal size. Dorsal fins are subtriangular in shape and interdorsal space is about 2.4 times the length of first dorsal fin base. Eye diameter

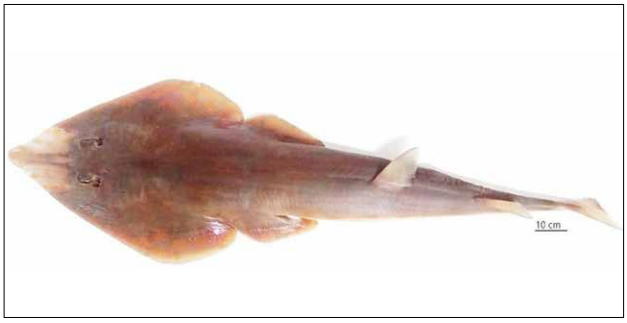

Fig. 1. Dorsal view of *A. variegatus* (Nair & Lal Mohan, 1973)

Table 1. Morphometric comparison (% of total length in mm) of *A. variegatus* (Nair & Lal Mohan, 1973) captured off Sakthikulangara, Kerala (present study) with the holotype specimen from Gulf of Mannar (mm)

Parameter	Present study Arabian Sea (off Sakthikulangara)	(Nair & Lal Mohan, 1973) Gulf of Mannar
Total length	672	645
Disc width	30.06	30.8
Pre-orbital length	13.01	12.8
Orbit- horizontal diameter	2.68	2.6
Corneal eye length	1.19	-
Inter-orbital space	3.72	3.2
Pre-spiracular length	16.14	-
Spiracle length	1.2	1.2
Spiracle width	1.79	1.9
Inter-spiracular space	4.76	4.8
Eye spiracle space	0.89	-
Nostrils length	2.81	2.8
Inter-narial space	2.68	-
Anterior nasal flap length	1.34	-
Distance between inner extension of flaps	-	1
Nostril to snout edge	12.65	-
Mouth-breadth	5.95	6.2
First gill slit height	1.2	1.4
Second gill slit height	1.34	1.2
Third gill slit height	1.48	1.4
Fourth gill slit height	1.34	1.2
Fifth gill slit height	1.04	0.9
Pre first dorsal length	60.71	-
First dorsal fin length	9.52	7
First dorsal fin base	4.72	4.5
Pre second dorsal length	75.89	-
Second dorsal fin length	8.48	6.8
Second dorsal fin base	4.76	5
Inter-dorsal space	11.18	13
Pre-pelvic length	35.37	-
Pelvic fin length	6.7	-
Dorsal-caudal space	7.07	7.1
Pelvic-caudal space	46.58	-
Caudal peduncle length	16.07	-
Caudal peduncle width	1.91	-

is 72% of interorbital space and interorbital space is 28.6% of preorbital length. Spiracle length is 25.2% of interspiracle width and interspiracle width is 36.6% of preorbital length. Nostrils are oblique with nostril length nearly equal to inter-narial space. Mouth is medium sized with teeth arranged in close-set, rhombic pattern. Teeth are wide based with short smooth-edged cusp. The morphometric characteristics of the present specimen matches with the holotype specimen described from the Gulf of Mannar by Nair and Lal Mohan (1973) (Table 1). A slight disparity was observed in the dorsal fin morphometrics, which may be due to geographical variation and size difference.

Biological information pertaining to this species is limited. The present specimen was a gravid female with five uterine embryos; 2 in the left lobe and 3 in the right lobe (Fig. 2). There was no placental connection between the embryo and the mother; the embryo was nourished by egg yolk which suggests aplacental yolk sac viviparity in this species. A pair of ovaries and uteri were present and the uteri were characterized by numerous longitudinal folds that support rich vascularization. Uterine capsules appeared to be enclosed in a brownish translucent case. Large rounded eggs were also present, packed with viscous yellow yolk and the number of ova recorded was five. Simultaneous development of ova in the ovary and embryos in the uteri (Fig. 3) indicates a quick succession of ovulation and fertilization after parturition (Devadoss, 1998). The embryos lay closely packed, one over the other and there was no uterine compartmentalization in which uterine flaps approach each other to form a separate uterine compartment for each embryo as seen in the case of some sand tiger sharks and requiem sharks. Similar observations on low uterine fecundity in *Rhynchobatus djiddensis* from the north-west coast of India was reported by Das *et al.* (2011) and Purushottama *et al.* (2018). Uteri were thin and embryos were visible through the transparent walls even before dissection. The total length and weight of the embryo ranged between 167.93 to 175.91 mm and 15.4 to 20.9 g respectively. Amongst the five embryos, three had completely filled yolk sac and the other two had shriveled yolk sacs. The two embryos with

Fig. 2. Embryos recovered from pregnant female

Fig. 3. Ova and uteri of *A. variegatus*

shriveled yolk sacs were of larger size (175.6 and 175.9 mm TL) and were possibly full-term embryos that have already utilized the nutrient-rich yolk and was about to eclose (emerge). The stomachs of each were distended with yolk. Thus the embryos were exclusively yolk reliant and developed inside the uteri. Yolk sacs of the embryos measured 26.77-33.40 mm in diameter and the cord lengths ranged from 25.03 to 32.83 mm. Out of the five embryos, four were male with the external edge length of claspers varying between 6 and 8 mm (Fig. 4) and the remaining one was female; the embryonic sex ratio (M:F) observed was thus, 4:1 (Table 2). Pigmentation on the ventral side of the snout was distinct in the embryos which is

Fig. 4. Closer view of claspers (pointed arrows) in a recovered male embryo

Table 2. Morphometric measurements of embryos recovered from *A. variegatus*, off Sakthikulangara, south-west coast of India

Sl. No.	Total length (mm)	Disc length (mm)	Disc width (mm)	Weight (g)	Yolk sac diameter (mm)	Length of yolk sac cord (mm)	Sex
1.	175.91	67.04	64.35	17.2	-	29.54	M
2.	175.62	67.62	59.86	15.4	-	32.83	M
3.	175.51	68.55	61.63	20.9	29.44	28.74	M
4.	167.93	67.71	60.61	19.7	26.77	30.57	F
5.	172.58	69.81	60.69	19.3	33.40	25.03	M

Fig. 5. Distinct pigmentation on the ventral side of snout in embryos

characteristic of the species (Fig. 5). Variegated markings on the pectoral and pelvic fin margins had not yet developed in the embryos. During 2014, in the southern tip of south-west coast of India (west coast of Kanyakumari District, Tamil Nadu) similar incidence of landing of a pregnant *A. variegatus* (Fig. 6) was observed with six full term embryos (Fig. 7). The size of the gravid female then recorded was bigger than the present report. It measured 732 mm in total length (TL) and weighed 2.2 kg (Santhosh and Ambarish pers. comm.). Data on fecundity is very important to understand the reproductive potential of a particular species or population and also for predicting the future stock size (Figueiredo *et al.*, 2008). As Kyne and Bennett (2002) stated, the fecundity of shovelnose guitarfish is generally low, which is reliable with the overall condition found in elasmobranchs. Fecundity of *A. variegatus* collected from Sakthikulangara, Kerala and west coast of Kanyakumari District, Tamil Nadu was similar; five and six respectively.

The biological observations recorded in the present study for the critically endangered and a poorly known guitarfish *A. variegatus* provides preliminary insights into its reproductive

Fig. 6. Pregnant *A. variegatus* landed on west coast of Kanyakumari District, Tamil Nadu

Fig. 7. Recovered embryos of *A. variegatus* landed at Kanyakumari District, Tamil Nadu

biology. The mode of reproduction in *A. variegatus* is aplacental yolk sac viviparity with low uterine fecundity. A significant decline of 86% was documented in the collective landings of wedgefishes and guitarfishes from 2002-2007 at a landing site in Tamil Nadu. This specifies a decline of 97% for *A. variegatus* over the past 15 years. The species' entire distribution range in southern India is subjected to intense fishing pressure with large numbers of trawlers as well as other fishing gears (Jabado *et al.*, 2017), besides landings as by-catch in several artisanal gears. Knowledge of embryonic development, fecundity, maturity stages and reproduction will be helpful in understanding the resilience competency of the species that could contribute towards the development of appropriate stock management strategies (Sen *et al.*, 2018). The critically endangered status coupled with evidence of population decline of this endemic species warrants formulation of suitable guidelines for conservation and sustainable exploitation of this resource.

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