

Galapagos sharks (*Carcharhinus galapagensis*) at the Bassas da India atoll: first record from the Mozambique Channel and possible significance as a nursery area

N. Hammerschlag^{a,b*} and C. Fallows^c

This paper reports the first record of *Carcharhinus galapagensis* in the Mozambique Channel from 54 individual sightings and describes their association with the oceanic atoll, Bassas da India. The geographic distribution of *C. galapagensis* is updated and the importance of the atoll to this species as a nursery area within the Mozambique Channel is discussed.

Introduction

The Galapagos shark, *Carcharhinus galapagensis*,¹ is circum-tropical in its distribution; however, it occurs discontinuously throughout this range and is commonly found in association with oceanic islands.²⁻⁶ Bass *et al.*³ summarized the geographic distribution of *C. galapagensis* in the eastern Pacific, western Atlantic and Indian Ocean. Compagno⁵ updated its distribution to include the central and eastern Atlantic and the western and central Pacific. *C. galapagensis* has also been documented at Saint Paul's Rocks in the mid-Atlantic,⁴ off Chile,^{8,9} Japan,¹⁰ at the Azores¹¹ and at Glover's Reef atoll in Belize.¹² In the Indian Ocean, *C. galapagensis* has been recorded only from the Walters Shoal to the south of Madagascar.^{2,3,13} This paper documents the first record of *C. galapagensis* in the Mozambique Channel and describes the possible significance of the oceanic atoll Bassas da India as a nursery area for this species in the channel.

^aPew Institute for Ocean Science, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149, U.S.A.

^bReefQuest Centre for Shark Research, P.O. Box 48 561, 595 Burrard Street, Vancouver, BC, V7X 1A3, Canada.

^cApex Images cc, 14 Thibault Walk, Marina Da Gama, Cape Town 7945, South Africa.

*Author for correspondence. E-mail: nhammerschlag@rsmas.miami.edu

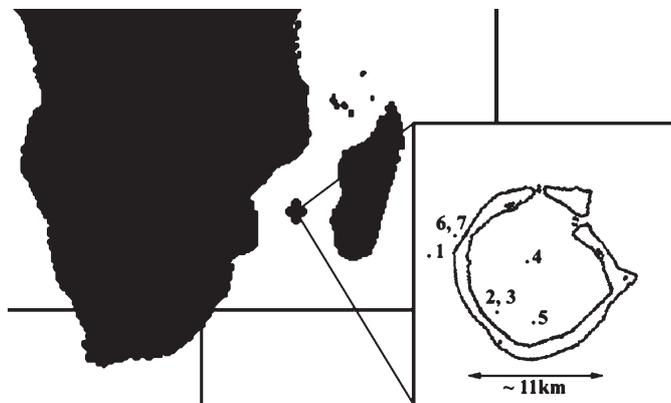


Fig. 1. Bassas da India is situated in the Mozambique Channel between Mozambique and Madagascar. The approximate sites where *Carcharhinus galapagensis* was observed around the atoll are indicated and cross-referenced with the indices in Table 1.

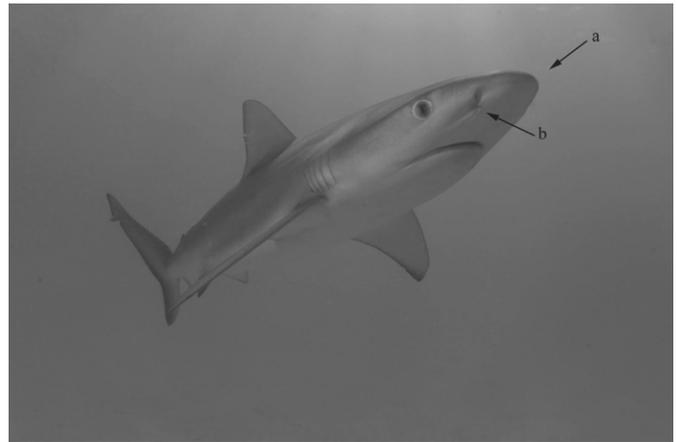


Fig. 2. A juvenile female *Carcharhinus galapagensis* swimming in Bassas da India. (a) The shark's body is slender and its snout is relatively long and rounded. (b) The anterior nasal flaps are low and poorly developed.

Sampling and species identification

During October 2003, a shark diversity survey was conducted at several locations in the Mozambique Channel, including Bassas da India (21°30'S, 39°50'E), which is an 11-km-wide atoll, with a perimeter of 35.2 km, situated roughly 450 km east of Mozambique (Fig. 1). The lagoon inside the atoll is shallow (<20 m) and the bottom sandy; however, the inner perimeter is covered by patch reefs dominated by Scleractinian corals of *Porites* species, *Pocillopora* sp. and *Acropora* sp. The outer edge of the atoll drops off steeply.

To provide prolonged and repeated observations of sharks, a submerged burlap bag and milk crate, each filled with between 5 and 10 kg of yellowfin (*Thunnus albacares*) and/or skipjack tuna (*Katsuwonus pelamis*) fillets, was used to attract sharks to the boat by means of odour corridors. Shark species identification was made underwater, by divers examining diagnostic features including body and snout shape, body colour, fin position and shape, and the presence of an interdorsal ridge. To confirm identification, digital underwater photography was conducted *in situ* and later analysed against published descriptions.

C. galapagensis was identified at the atoll (Figs 2, 3) and distinguished from similar-looking carcharhinid sharks by comparing diagnostic features. *C. galapagensis* is slender-bodied with a moderately long and broadly rounded snout: internarial width is 1 to 1.3 times pre-oral length (Fig. 2a).⁵ Its eyes are circular and moderately large, their diameter 1.3–2.4% of total length

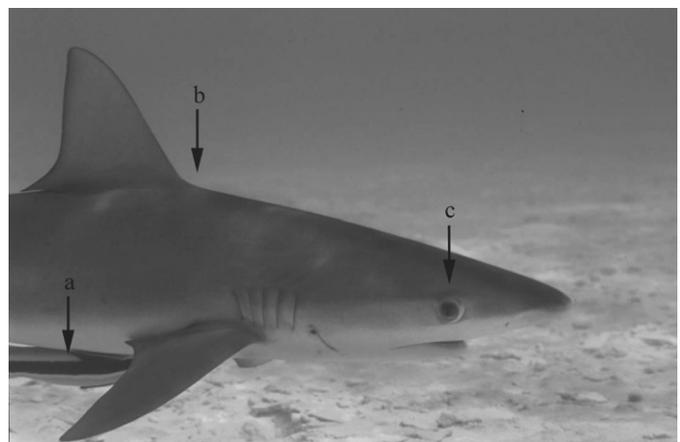


Fig. 3. A juvenile male *Carcharhinus galapagensis* accompanied by (a) the shark sucker, *Echeneis naucrates*. (b) The first dorsal fin's origin is in front of the inner pectoral corner. (c) The eyes of *C. galapagensis* are circular and relatively large compared to other carcharhinid sharks.

Table 1. *Carcharhinus galapagensis* recorded at Bassas da India between 24 and 31 October 2003.

Index	Date and time	Location at Bassas da India	GPS	Depth at location (m)	Habitat characteristics	Number and size (L_T in m) of Galapagos sharks observed
1	24 October 10:00	Outside, northwestern edge of atoll	21°26'55.2"S, 039°38'35.1"E	200	Surface temp: 25.7°C PAR: 22.3µE Reef bottom	2 individuals (<2 m)
2	24 October 13:30	Inside, western side of atoll	21°30'43.5"S, 039°40'15.8"E	8	Sandy bottom	5 individuals (<2 m)
3	26 October Morning	Inside, western side of atoll	21°30'43.5"S, 039°40'15.8"E	8	Sandy bottom	6 individuals (<2 m)
4	26 October Evening	Inside atoll	21°26'59.3"S, 039°41'30.5"E	8	Sandy bottom	3 individuals (1.2 m, 2.8 m, 2.2 m)
5	27 October All night	Inside atoll	21°30'57.0"S, 039°41'30"E	8	Sandy bottom	1 individual (<2 m)
6	29 October	Outside, northwestern edge of atoll	21°26'14.5"S, 039°40'31.8"E	18	Reef bottom	3 individuals (2.1 m, 2.2 m, 2.2 m)
7	31 October	Outside, northwestern edge of atoll	21°26'14.5"S, 039°40'31.8"E	18	Reef bottom	1 individual (<2 m)

(Fig. 3c).⁵ The anterior nasal flaps are low and poorly developed; upper labial furrows short and inconspicuous (Fig. 2b).^{5,6} A low interdorsal ridge is present and its first dorsal fin is moderately large and falcate.^{3,5-7} Its colour is brownish-grey above and pale below.^{3,5,6} The fin tips of some individuals are dusky, but do not have distinguishable markings.⁵ The combination of interdorsal ridge and lack of a conspicuous colour pattern distinguishes *C. galapagensis* from other carcharhinid species within the southern Indian Ocean except the silky shark *C. falciformis*, the sandbar shark *C. plumbeus* and the dusky shark *C. obscurus*.^{3,7} The first dorsal fin origin is anterior to the inner pectoral corner in *C. galapagensis* (Fig. 3b), whereas in *C. falciformis* it is behind the inner pectoral corner.^{3,7} The first dorsal fin of *C. plumbeus* is higher with its origin further forward than that of *C. galapagensis* (snout to first dorsal origin more than 2¼ times first dorsal height in *C. galapagensis*, less than 2¼ times in *C. plumbeus*).^{3,5,6} *C. galapagensis* can be distinguished from *C. obscurus* by the shape and position of its pectorals and first dorsal fins.⁷ The pectoral fins of *C. obscurus* are narrower and more falcate than in *C. galapagensis*. The first dorsal fin of *C. galapagensis* is more erect than in *C. obscurus* and sits midway between the pectoral axil and the inner pectoral corner while that of *C. obscurus* is usually over the inner pectoral corner.^{3,5-7}

Results and discussion

C. galapagensis was identified from 54 individual sightings in and along the outer edge of the atoll at five different localities (Fig. 1, Table 1). Several of the Galapagos sharks were accompanied by shark suckers, *Echineis naucrates* (Fig. 3a).

C. galapagensis appears to follow the common pattern of young sharks living in shallow water (<20 m). Limbaugh¹⁴ showed that at Clipperton Island, young *C. galapagensis* were caught over a depth range of 2 to 25 m, but were most common in the shallower parts of this depth range.¹⁴ Adult sharks were caught only in deep water down to 180 m.¹⁴ Kato and Carvallo¹⁵ noted that juvenile Galapagos sharks were restricted to shallow water at the Revillagigedo Islands and that adults rarely occurred with juveniles.¹⁵ In the Indian Ocean, *C. galapagensis* has been caught only in shallow (<20 m) parts of the Walter's Shoal and all sharks were juvenile, varying in total length (L_T) from 78 to 170 cm, the majority between 100 and 150 cm L_T .³ Limbaugh¹⁴ considered eastern Pacific *C. galapagensis* up to 2.6 m L_T to be immature. Galapagos sharks documented within and around Bassas da India atoll were observed in shallow water (<20 m). Individuals

were less than 2.2 m L_T and appeared to be immature; however, one 2.8 m L_T individual was observed of undetermined maturity stage.

The Mozambique Channel is a harsh pelagic environment dominated by large anti-cyclonic eddies (diameters >300 km) that reach to the channel bottom and propagate southward, while an undercurrent flows equatorward along the continental slope.¹⁶ Bassas da India is isolated within the channel by hundreds of kilometres in all directions. Because large numbers of juvenile *C. galapagensis* of both sexes occupy the atoll in shallow (<20 m) water, it appears that this lagoonal habitat may serve as a nursery area, offering shelter and protection within the Mozambique Channel.

Shark nursery grounds are discrete sheltered areas where young individuals are birthed and/or live for weeks, months or years before entering the adult population.^{17,18} Castro¹⁷ recognizes shark nursery areas as having both gravid females and neonates present. Bass¹⁸ designated shark nursery areas as either primary nurseries (where parturition occurs and neonates and young-of-the-year are found) or secondary nurseries (where older juveniles of age 1+ years reside). During this study, no gravid females or neonates were observed. Their absence during the survey does not preclude the presence of a nursery area, as they may occupy areas of the atoll that differ from the five sites sampled or during times when sampling did not occur. However, the adolescent sharks documented were likely born in the atoll, which they probably inhabit for several years before moving into the surrounding pelagic environment, following the life-history pattern of conservation of neonatal energy stores toward somatic growth rather than extensive migration. Most carcharhinid sharks double their birth length in their first year.¹⁹ *C. galapagensis* is born at a total length of about 57–80 cm^{3,5,6,15} and the sharks observed at Bassas da India were likely between two and three years old. Thus, juvenile Galapagos sharks probably live in the atoll for the first several years of their life, where they grow rapidly before recruiting into the Mozambique Channel.

Over the last two decades, the commercial value of shark body parts from longline fisheries, especially fins, has been increasing globally²⁰ and has been an important contributor to the over-exploitation of pelagic elasmobranch populations.²¹⁻²⁹ In just two years, international longline fleets have already depleted shark stocks along the Mozambique coast and current surveys demonstrate that longlining vessels are setting hooks deeper into the channel, closer to Bassas da India (M. Kroese, pers. com., 2004;

direct observation, 2004). Because shark nursery areas are important for maintaining recruitment of individuals to parental stocks, the delineation and characterization of these areas has been identified as one of the highest priorities for elasmobranch conservation.^{12,17,30,31} The shark fauna of Bassas da India and other remote oceanic atolls in the Mozambique Channel and surrounding Indian Ocean remain inadequately documented, as demonstrated by this study, and these sites may play an important role in the life-cycle of commercially exploited elasmobranchs in the area. As such, further quantitative research efforts should be directed towards identifying nursery areas and describing the elasmobranch fauna found in the Mozambique Channel and surrounding areas.

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