


RESEARCH ARTICLE | DECEMBER 27 2019

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AIP Conf. Proc. 2202, 020085 (2019)

<https://doi.org/10.1063/1.5141698>



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# Blacktip Reefshark (*Carcharhinus melanopterus*) Individual's Identification in Morotai Waters using its Fin's Natural Markings

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**Abstract:** As part of conservation means, ecotourism on shark watching activities has been popular for the last 10 – 25 years. Achieving rank fourth in the shark tourism world, shark watching tourism in Indonesia begins to play as an economically important for gross national products (GDPs). Morotai, as one of the prominent shark diving and shark research site in Indonesia is became popular in recent years. However, the precise number of blacktip reef shark living in Morotai's most famous dive site, blacktip point is unknown. The knowledge of shark individual marking and their number is important for developing ecological assessment, shark diving carrying capacity, and shark behavior observation. DOV (Diver Operated Video) is employed to visually identify the blacktip reef shark's fin marking, its patterns and its changes over time. Analysis of hundreds of photographs and video of the *Carcharhinus melanopterus* during SCUBA diving – from February 2015 to March 2019 – reveals the precise number of these blacktip reef shark living in the proximity of blacktip point area. Study also shows that the photo identification shark fin's natural marking can be used effectively to recognize unique individual of blacktip reef shark.

## INTRODUCTION

In the era of social media, an ecotourism that offers adrenaline experience – such as shark diving or shark watching tourism – is often a major attraction for the new generation – the millennials and Z generations [1]. However, coral reef ecosystem loss has been suspected as one of the factors that caused fast declining of shark population in the ocean [2]. In the era of apex predator ecotourism [3], shark diving plays role as a conservation tool to prevent further damage of coral reef habitat [4]. In respective to their nature as one of the shy animal [5], a lure – such as shark feeding – is practiced to invite the shark in a close encounter with SCUBA diver. Approximately 40% of all shark sighting tourism [6] are using provision as a method to interact with sharks. The controversy for shark provisioning has been existed since the practice were introduced in 1980-1990s, most notably due to its animal welfare critics, fitness and bioenergetics factors, and shark watcher safety [7]. Despite its potential bite risks [8] during shark diving or watching, behavior shifting on a specific reefshark – e.g. *Carcharhinus perezi* – that has been affected by prolonged provisioning were considered as ‘no evidence’ [9].

On the contrary with its status as first rank country that practicing shark catches and finning [10], Indonesia regains their good reputation as rank fourth in the shark sighting tourism world [11]. Most of the East Indonesia: Morotai [12], Cenderawasih Bay [13], Raja Ampat, Gorontalo, Banda Island, and Derawan Islands offers the shark diving and shark encounter tourism. With the economic value of approximately 49 million USD, shark diving has a spacious room for improvement since it only contributes 0.33% of all tourism economic value [14].

In contrast with its noteworthy status as a conservation and tourism attraction, there is a little known of the reef shark individual identification. The information of reef shark individual natural marking and identification is important for the ecological assessment, shark biology, and shark site fidelity evaluation. In particular, the natural marking identification of blacktip reef shark (*Carcharhinus melanopterus*) has never been scientifically assessed.

This paper is intended to investigate the effectiveness and suitability of photo-identification of shark fin's natural marking to be used as the unique recognizing of shark individuals of blacktip reef sharks.

## BLACKTIP REEF SHARKS AND FIN'S NATURAL MARKING IDENTIFICATIONS

### Blacktip Reef Shark

Indonesia is one of the place inhabited by the blacktip reef shark (*Carcharhinus melanopterus*, Order Carchariniiformes). This shark has size ranging from approximately 0.48 m FL (fork length) during its birth to 1.80 m FL when matured [17]. *Carcharhinus melanopterus* are known to prey primarily on small reef fishes, crustacean, and molluscs [18] and also feeds on snakes, bird, and rats in a specific location like North Australia, Seychelles and French Polynesia [19][20]. Inhabiting the eastern Hemisphere from Indo-Pacific region [21] to Eastern Pacific [23], blacktip reef shark also lives in eastern part of Mediterranean Sea [22].

Despite its naming as 'reef shark' group, blacktip reef shark can also be found in inshore shallow waters and mangroves area [23]. Considered as the most abundant sharks in their coral reef habitat [25][26], they may have the important role in controlling the trophic level [26]. The reproduction type for blacktip reef shark is viviparous, with newly born of pups up to 4 individuals, its gestation period is approximately 7 – 16 months [16][17]. Despite its size relatively small compared to great white shark, *Carcharhinus melanopterus* attacks to human comprise of 3% of total shark attack cases [27].

### Shark Natural Marking Identifications

There are numbers of sharks (*Carcharodon carcharias*, *Cetorhinus maximus*, *Triaenodon obesus*, *Rhincodon typus*, *Carcharias Taurus*, and *Ginglymostoma cirratum*) have been identified using individual photo identification and they displayed a unique characteristic between individuals. Compared to cetaceans, identification of elasmobranchs using photo-ID are relatively new [28]. History of natural marking identification of sharks starts with the using photo identification as a method to analyze an alternative re-sighting of two white shark in California [29]. Computer applications were using in 2000s to aid the identification of visual fin of white sharks [30]; [31].

Despite its success to determine basking shark individual difference, the accuracy of photo- identification method to produce estimation of basking shark (*Cetorhinus maximus*) population depends on number of identified individual shark re-sighting [32]. Community-contributed photographs – or citizen science – helps to identify fisheries interaction, reproductive seasonality, and movements of whitetip reef shark, *Triaenodon obesus* [33].

Collaboration between citizen scientist were organized to estimate the structure, population size, and residence time for whale shark - *Rhincodon typus* [34]. The idea of collaboration was initiated since the whale shark is having long migration path covering wide area from Mozambique to Philippines. Similar works have been done in photo-identifying the population demography and connectivity of whale shark in the Western Atlantic Ocean [35]. Thus, monitoring whale shark population and their aggregation sites using photo-identification (as well as conventional tagging) was key to the local and global conservation effort.

Castro and Rosa [36] enlisted the visuals of natural marking such as scars and marks which is generally found in dorsal, caudal, and pectoral fins of the nurse shark (*Ginglymostoma cirratum*) can be used for individual recognition. Once the natural markings were found, it was photographed, visualized with the drawing and recorded to be compiled as the basis for further identification. Other method such as marking of natural pigment of the body of the spotted raggedtooth shark (*Carcharias Taurus*) – combined with the interactive pattern-matching – was used to identify the difference between individuals [37].

# METHODOLOGY/MATERIALS

## Study Area

Morotai is considered as the best place for elasmobranch siting such as blacktip reef shark and mobula [25][15]. Pulau Mitita is often selected as research station for blacktip reef shark observation due to its high chance of shark sighting [25][40]. This research location is situated in N 01o 58' 13.4" E 128o 14' 03.6", northwestward of Pulau Mitita, Morotai Island.

## Methods

Two divers assisted the research by luring the sharks with feeding and also as cameraman for research recording and photographing. The research divers applied the Professional Association of Diving Instructors (PADI) safe diving practices and liability release. The feed consisted of *Katsuwonus pelamis* (skipjack tuna) flesh and tissues for attracting the blacktip reef sharks and handled by the professional feeder. The shark armor (steel chained special clothing) worn by the feeder as the safeguard means during the feeding.

Video and photographs were captured and recorded (with Diver Operated Video method) from February 2015 to March 2019 to document the fin's natural marking and body pattern of *Carcharhinus melanopterus*. At least two (2) sets of basic SCUBA dive gears for the feeder and cameraman were used for the research, as well as an underwater camera (Nikon D800 camera in Nauticam ND800 housing or Sony RX100 Mark IV in Nauticam RX100MKIV housing), and analysis was conducted in a computer with video player application.

## Analysis

The photographs that had been shot were collected during the research-diving. Photographs of the whole body of the shark including dorsal fin, pectoral fins, and caudal fins were analyzed using Photoshop<sup>TM</sup> software. In order to detect additional distinctive signs, the grey pattern of the outer body of the blacktip reef shark were also assessed. Comparison of two photographs of the same individual of blacktip reef shark – that has been documented in the difference time – were also conducted to conclude whether they are the same or different individuals.

# RESULTS AND FINDINGS

## Natural Fin's Markings

Documentation of 103 videos and 957 photographs from February 2015 to March 2019 were collected and analyzed in this research. The analysis of natural marking of blacktip reef shark dorsal and caudal fins are shown in the Figure 1 and Figure 2 below.

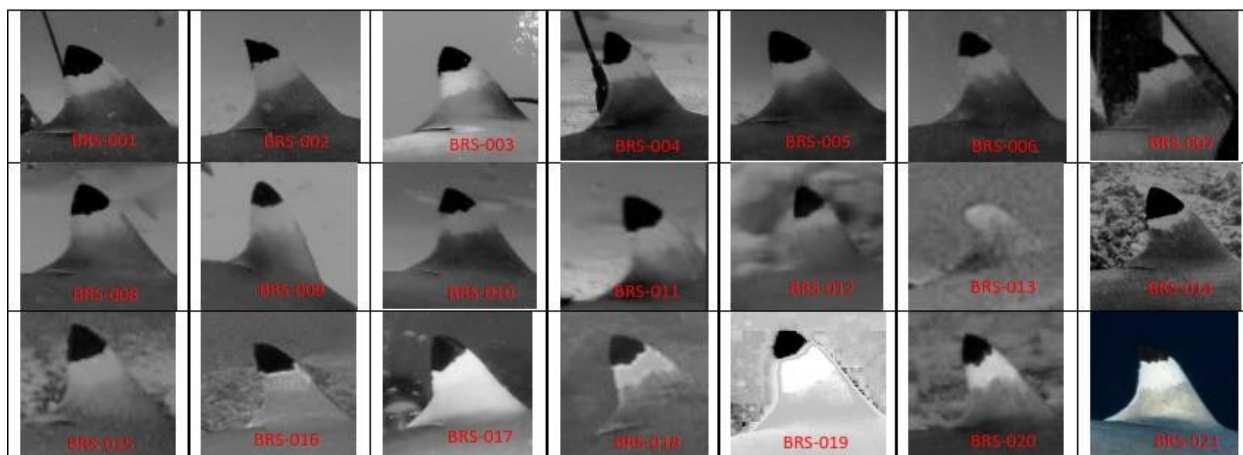
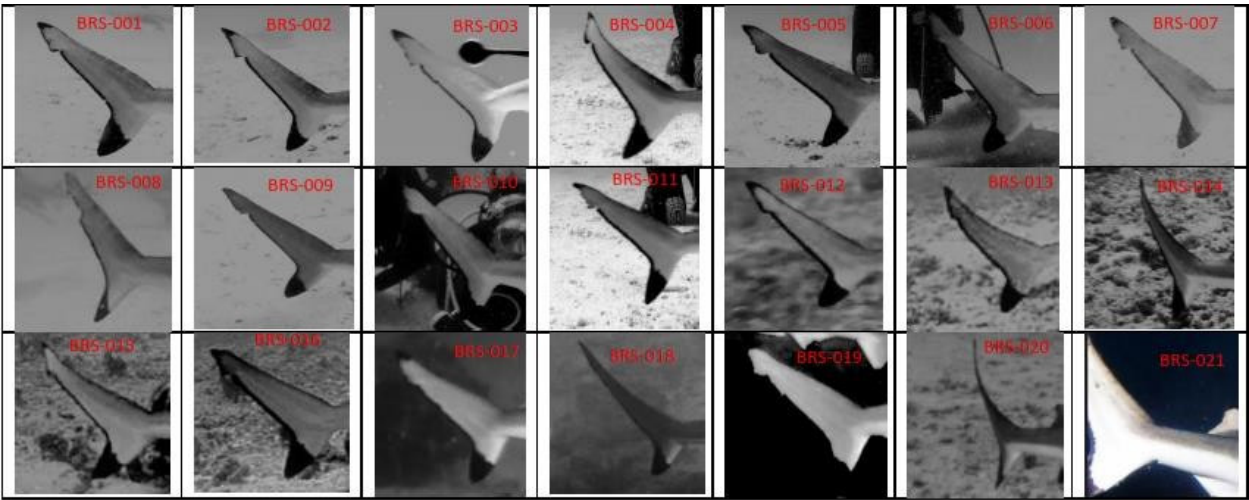


FIGURE 1. Dorsal Fin Patterns for Different Individuals of Blacktip Reef Shark at Morotai



**FIGURE 2.** Caudal Fin Patterns for Different Individuals of Blacktip Reef Shark at Morotai

As observed in the Figure 1 and Figure 2 above, among 957 photographs, there are only 21 different individuals were identified during the 4 years of research. It was believed that more than 21 individuals of blacktip reef sharks lived in Blacktip Point, Mitita Island. However due to low quality of photographs, low visibility during research diving, and shyness of several individuals during interaction with the SCUBA divers, the actual numbers of *Carcharhinus melanopterus* in Blacktip Point were difficult to be determined. Unique patterns of dorsal fins and caudal fins were effective to be used as natural marking signature for each blacktip reef shark.

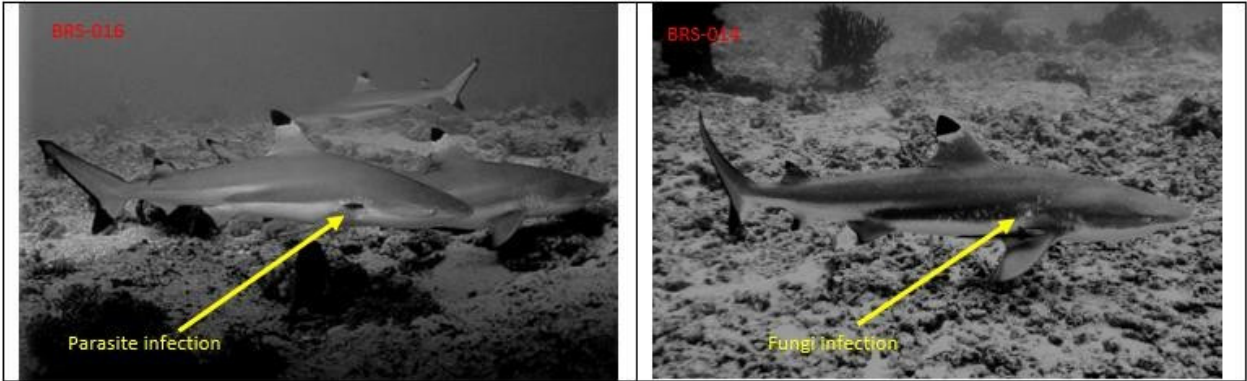
### Unique Markings

Despite they were not consistently shown on each individual, there are at least four other unique marking which can also be used for identifying individuals of blacktip reef sharks: crescent shape bite mark, parasite on the gill, fungi on the body, and birth mark. Male reef sharks are known to bite its partner during mating. During mating, male reef shark tends to follow female reef shark and grab one of female pectoral fins [38]. Blacktip reef shark individual number 13 (BSR-013) showed the crescent shape bite mark on its dorsal fin, possibly injured during mating. However, BSR-021 – male blacktip reef shark has bite marks on its right pectoral fin with unknown cause.



**FIGURE 3.** Bite Marks on Blacktip Reef Shark BSR-013 and BSR-021

Parasite and fungus infection were common as the disease for elasmobranchs including reef shark [39]. There were at least two sharks infected by parasites in their gill observed in Blacktip Point. Figure 4 visualize the parasite and fungus infection on blacktip reef shark in Morotai.



**FIGURE 4.** Fungi and Parasite Infection on BSR-014 and BSR-016

Like other animal, blacktip reef shark may have a birth mark shown on their outer body. It was observed during the study that blacktip reef shark BSR-001 has unique pattern – presumably as birth mark (white mark) on its 1<sup>st</sup> right gill.



**FIGURE 5.** Birth Mark shown on Blacktip Reef Shark BSR-001

## CONCLUSION AND WAY FORWARD

Hundreds (957) photographs of blacktip reef sharks in Blacktip Point, Morotai Islands revealed the unique fin's natural marking of *Carcharhinus melanopterus*. Natural marking on dorsal fin of blacktip reefshark can be used as an effective variable to differentiate the individuals of sharks. During the study, there are twenty-one (21) different individuals of blacktip reef shark were known to live in Blacktip Point. However, the actual number may be higher than 21, as several factor hindered the shark's fin marking observations.

Blacktip reef shark individuals can also be identified by using their unique marking such as fungi and parasite disease on their outer body, the presumably birth mark, and its crescent shape mating bite. It is advised that further work with higher quality of underwater camera may reveal more small details on the unique marking of blacktip reef sharks.

Software application may be needed to quickly analyze the patterns of Blacktip reef shark dorsal fin, record it and use it as a data base for re-sighting identification in the future. Blacktip Point's site fidelity assessment should be able to be conducted using the re-sighting data of this blacktip reef shark.

## ACKNOWLEDGEMENTS

We thank the hibah PITTA 2019 for the opportunity, supports, and materials offered for this research as well as to Morotai Island's research team for their helps and assistances during photographs collection. We also thank the Universitas Indonesia's Marine Science Master Program staffs, lectures, and students for support and encouragement during the study.

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