

ILLEGAL TORTOISESHELL HARVEST OF HAWKSBILL TURTLES (*Eretmochelys imbricata*) IN SOUTHEAST ASIA: EVIDENCE FROM BATURUA REEF, SEMPORNA, SABAH, MALAYSIA

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Abstract: The illegal harvesting of hawksbill turtles for their shell has led to a drastic decline in the population of this critically endangered species over the past century. Despite efforts to protect them through legal frameworks and policies, the illegal trade of their shells continues to pose a significant threat to the species. While there is existing knowledge on tortoiseshell harvesting, there is limited evidence on how tortoiseshell harvesting is carried out. This study seeks to provide evidence of the ongoing illegal harvesting of hawksbill turtles for the wildlife trade in Southeast Asia. Additionally, we report the first-ever observations of carved-out carapaces from hawksbill turtles in Semporna, Sabah, Malaysia. Although we have only encountered two harvested adult female hawksbill turtles in 2018 and 2019, and conducted interviews with coastal communities between 2014 and 2019, our report provides crucial evidence that the illegal exploitation of hawksbill turtles in Southeast Asia is ongoing. The recent discovery of complete tortoiseshell scutes washed ashore on Pom Pom Island in 2021, further confirms this alarming trend. Given the critical status of hawksbill turtles, urgent measures such as strict surveillance and enforcement are needed to prevent their further decline.

Keywords: Sea turtle, critically endangered species, tortoiseshell trade, illegal harvest, foraging ground.

Introduction

The hawksbill turtle (*Eretmochelys imbricata* Linnaeus, 1966) is circumglobally distributed across the tropical and temperate oceans, like most other sea turtle species, and found at over 82 geopolitical units in foraging grounds and on nesting beaches (Baillie & Groombridge, 1996; Mortimer & Donnelly, 2008). Population sizes have sharply declined due to many anthropogenic factors, but the most profound is the harvest of its carapace scutes, known as tortoiseshell or bekko (Mortimer, 1984; Limpus, 1997; Halkyard, 2014; Miller *et al.*, 2019; Hamann *et al.*, 2022). For many centuries, tortoiseshell has historically been harvested as an aesthetic product like ivory, gold, and

gems, from Borneo, Sulawesi, and the eastern coast of Africa (Parsons, 1972; Hamann *et al.*, 2022). It was estimated that as many as 9 million hawksbill turtles were harvested over the past 150 years (Miller *et al.*, 2019), of which nearly 500,000 hawksbills were estimated to have been exported from the Asia-Pacific region (Mortimer & Donnelly, 2008). As a result, the hawksbill turtle has been listed as a critically endangered species on the IUCN Red List for Threatened Species since 1996 (Mortimer & Donnelly, 2007). In addition, this species is listed under Appendix I of the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS), where commercial trade of hawksbill turtles is prohibited (Hamann *et al.*, 2022).

Despite protective measures, the Southeast Asian population of hawksbill turtles is still in crisis (Mortimer & Donnelly, 2008; Stiles, 2008; Hamann *et al.*, 2022). There are two major rookeries of hawksbill turtles in Malaysia: The Sabah Turtle Islands Park (200-700 nest/year; Joseph, 2017) and Melaka (200-400 nest/year; Syed Kadir, 2016), and smaller populations (< 50 nest/per year) in Terengganu and Johor (Nishizawa *et al.*, 2016). In addition to Malaysia, hawksbill turtles are known to nest in several countries in Southeast Asia, including Indonesia, the Philippines, Thailand, Vietnam, Cambodia, and Singapore. The hawksbill turtle population in the Sabah Turtle Islands Park, once considered the biggest in Southeast Asia (Limpus, 1993) is now declining steadily (Chan, 2006; Joseph, 2017); however, there is a lack of evidences to link the population decline to the harvest of hawksbill turtles at foraging grounds. Sabah and Sarawak banned any trading of sea turtle parts and products under the Wildlife Conservation Enactment (1997) and Wildlife Protection Ordinance 1998, respectively (Jani *et al.*, 2020; Joseph *et al.*, 2021). Trading of sea turtle eggs in Peninsular Malaysia was permitted (Gomez & Krishnasamy, 2019), however, starting 1 June 2022, the Government of Terengganu banned the trade of all species of turtle eggs with the amendment of the Terengganu Turtle Enactment 1951 (amendment 2021) (Yong, 2021).

The main threats to the hawksbill turtle in Southeast Asia are the exploitation of shells for curio trade (Nijman *et al.*, 2012; Nijman, 2019) and intensive egg harvesting (Shanker & Pilcher, 2003; Teh *et al.*, 2018; Hemelikova *et al.*, 2021). Aside from threats such as by-catch (Chan *et al.*, 1988; Chan & Liew, 2001; Pilcher *et al.*, 2008) and consumption of sea turtle eggs (Chan, 2006; Joseph *et al.*, 2021), harvesting of sea turtles in Sabah persists, mainly caused by the demand from traders in China and Vietnam (Stiles, 2008; Lam *et al.*, 2011; Gomez & Krishnasamy, 2019). Hawksbill turtles are poached for their tortoiseshell at their foraging grounds to supply this demand (Stiles, 2008). However, the trade remains poorly described in the literature (Miller *et al.*, 2019), and market surveys did not observe

any tortoiseshell products in Malaysia (Gomez & Krishnasamy, 2019). On the other hand, the green turtles were reported to be poached primarily for their meat at foraging grounds off Semporna (Syarifuddin, 2018; Taiming, 2019).

However, very little information is available on hawksbill turtle poaching in the area. Hainan fisheries enforcement data specifies Malaysia as one of the countries involved in the illegal trade of sea turtles caught as by-catch or intentionally by locals (Lam *et al.*, 2011). Seizures of tortoiseshell in Vietnam indicate that Malaysia and Indonesia are potentially active trade sources (IOSEA, 2014). TRAFFIC recently reported that the illegal trade of sea turtles still occurs in the region despite lower reported cases, as it has moved more to underground markets (Gomez & Krishnasamy, 2019). While the threats to hawksbill turtles in Southeast Asia are well known, limited evidence exists on the actual carving of the hawksbill turtle carapace for tortoiseshell products. Identifying hotspots where the harvest of tortoiseshell occurs is paramount in strategizing for enforcement. Hence, the aim of this study is to provide direct evidence of illegal tortoiseshell harvesting of hawksbill turtles at Baturua Reef, Semporna, Sabah, Malaysia, and to shed light on this hidden harvest hotspot. Our aim is to highlight the need for strict surveillance and enforcement measures to prevent the further decline of this iconic species.

This paper reports direct evidence of post-harvest hawksbill turtles in Semporna through opportunistic encounters from field activities by the Tropical Research and Conservation Centre (TRACC), Semporna. In addition, information obtained from a series of interviews conducted with coastal communities from 2014 to 2019 in Kudat, Sandakan, and Semporna was included to provide detailed information on the poaching of hawksbill turtles in Sabah. Our objectives are to raise awareness of the ongoing illegal tortoiseshell harvesting of hawksbill turtles in Southeast Asia, specifically at Baturua Reef, Semporna, Sabah, Malaysia, and to call for strict surveillance and enforcement measures to prevent further decline of this iconic species.

The justification for this work is the urgent need to protect hawksbill turtles and their habitats from illegal activities, especially in Southeast Asia, where the population of this species is still in crisis despite protective measures in place. Despite the rarity of observed incidents of hawksbill turtle harvesting, the severity of the situation underscores the urgent need for conservation efforts to protect this species.

Materials and Methods

Observation Sites

The study involved direct observations and collection of case reports of possibly harvested hawksbill turtles within the reef area of Baturua Reef (4°31'44.6 N, 118°49'05.7 E) and tortoiseshell evidence at Pom Pom Island (4°35'57.8 N, 118°51'50.0 E), located approximately 30 km off Semporna, Sabah, Malaysia (Figure 1). Baturua Reef covers an area of approximately 924 hectares, with an extensive reef flat and gradual reef slope. The reef has a relatively high hard coral cover and large areas of soft corals, but fish abundance is low (Kirishnamoorthie Jeethvendra *pers. obsr.*, 2019). Local fishermen come from neighbouring islands (e.g., the nearest island, Kalapuan, where the community has about 200 Bajau families) and engage in artisanal fishing activities. Commercial fishing practices and destructive fishing techniques such as blast fishing also occur in the area (Wood & Ng,

2016; Kirishnamoorthie Jeethvendra *pers. obsr.*, 2021). In-water sea turtle abundance is unknown, and there are no nesting females due to the lack of sandy beaches at Baturua Reef. During a series of 27 irregular diving trips conducted for TRACC's marine biodiversity surveys between 12 May 2018 and 24 May 2019, a significant numbers of green and hawksbill turtles, mostly juveniles, but with some adults were observed aggregating in the Baturua Reef area.

During each survey, sea turtles were observed visually from the boat and through SCUBA diving. Biometric information was derived solely from visual estimates, as sea turtles were not captured. Species identification was based on morphological features, with hawksbill turtles identified by the presence of 2 pairs of prefrontal scales, serrated marginal shields, and a narrow beak. The maturity status of hawksbill turtles was visually determined using straight carapace length (SCL), with adult turtles having an SCL greater than 70 cm. Sex was determined through direct observation of tail dimorphism, where a mature male has a longer tail compared to a female (van Dam & Diez, 1998; Migliaccio *et al.*, 2020). In 2021, we obtained direct evidence of an ongoing tortoiseshell harvest by discovering a complete set of raw hawksbill turtle carapace scutes sealed in plastic washed ashore at Pom Pom Island. Using simple morphometric analysis, we estimated the size of the harvested turtle. In addition, we investigated hawksbill turtle

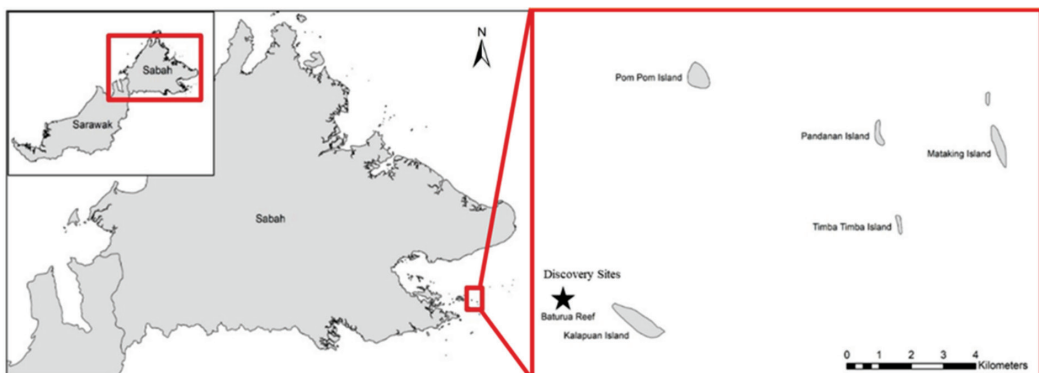


Figure 1: Location where the two hawksbill turtles (*Eretmochelys imbricata*) were found at Baturua Reef and the discovery of raw complete tortoiseshell scutes at Pom Pom Island

strandings at Pom Pom Island between 2018 and 2021, obtaining SCL measurements and estimating the likely cause(s) of death. All turtle carcasses were buried at Pom Pom Island.

Morphometric Analysis

To estimate the size of the individual hawksbill turtle from the recovered carapace scutes, we first weighed all 13 scutes together using the SF-400D Electronic Compact Scale (500 g x 0.01 g). The 13 pieces were then reconstructed to represent 1 complete carapace set. To determine the turtle's SCL, we measured the width of the first right costal scute and used the equation $Y=4.077X$ (0.871), where Y is SCL and X is the width of the first right costal scute. This equation was derived from Limpus and Miller (1990) for the West Pacific hawksbill turtle population and reported by Kobayashi (2004).

Interview Surveys with the Coastal Community and Bajau Laut

Between 2014 and 2019, one of our co-authors, James Alin, conducted a series of informal interviews with coastal communities and Bajau Laut in Kudat, Sandakan, and Semporna to gather information on the exploitation of marine resources. It is important to note that there were no specific questions made for the exploitation of sea turtles during these interviews, as the interview questions were general in nature. However, during these conversations, the poaching of sea turtles was brought up, leading to the discovery of the carving of hawksbill scutes.

A total of 15 respondents were interviewed, with only 3 reporting knowledge of scute removal from hawksbill turtles. Respondents requested anonymity for security and privacy reasons, and the information they provided could not be verified. Nevertheless, based on some information gathered through these interviews, James Alin was able to inform authorities about the mass slaughtering of sea turtles in Pulau Tiga, Kudat in 2014 (Joseph *et al.*, 2019), as well as assist the Sabah Wildlife

Department in raiding an illegal mini zoo in Kudat for keeping a green and hawksbill turtle without a permit (The Star Online, 22 March 2014; Daily Express, 15 November 2014). While the information gathered through the informal interviews may have contained some inaccuracies, it nevertheless served as a valuable tool for raising awareness and aiding conservation efforts.

Results and Discussion

Observation and Collection of Case Reports

During TRACC marine biodiversity surveys at Baturua Reef between May 2018 and May 2019, evidence of tortoiseshell harvest was found on 2 adult female hawksbill turtles. The first encounter was on 14 July 2018 at 0824, when a mildly decomposed adult female hawksbill turtle carcass was found floating near Baturua Reef [Figure 2 (A)]. The turtle had a visually estimated SCL of 70 cm, and a rope with overgrown seaweed was tied around its neck. Its shell had been carved out from the carapace, with clear cuts around the inner scutes, but the marginal carapace scutes were intact.

The second encounter was on 19 May 2019 at 1345, when a live adult female hawksbill turtle with indications of its tortoiseshell having been harvested was observed swimming in the same area [Figure 2 (B)]. The SCL was visually estimated at around 70 cm, and a rope was tied to the turtle's neck. The shell had been neatly carved out, except for the marginal scutes of the carapace, but the rope was clean from any biofouling. The turtle was observed resting at the coral reef without any signs of stress or disordered behaviour. After removing the rope, the turtle swam off to rest again. Due to strong currents and the unpreparedness of the dive group, the turtle was not captured for observation and rehabilitation. These encounters provide valuable evidence of the ongoing threat of tortoiseshell harvest to hawksbill turtles, highlighting the urgent need for conservation efforts to protect this critically endangered species.

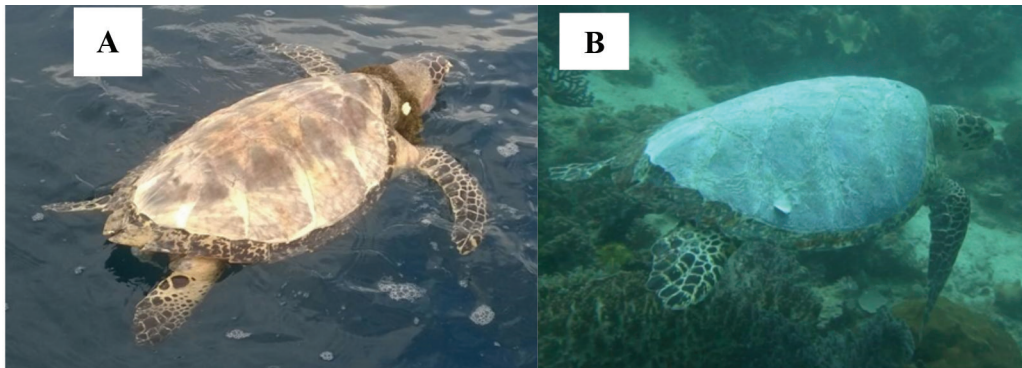


Figure 2: Two adult female hawksbill turtles found with their carapace shell carved out at Baturua Reef, Semporna - (A) floating carcass found in July 2018; (B) individual found alive in May 2019 with evidence of shell harvest

To the authors' knowledge, this is the first documentation of a free-swimming hawksbill turtle observed without its carapace scutes. While there have been previous reports of possible tortoiseshell harvest in Pulau Mantanani Kecil (South China Sea), Sabah, Malaysia, in 2012, where 3 hawksbill turtles showed similar post-harvest signs of neatly carved-out carapace scutes, leaving the circumferential marginal scutes intact, as well as having their eyes poked (Goh, 2012).

The lateral and central carapace scutes of hawksbill turtles are often targeted in the tortoiseshell trade (Miller *et al.*, 2019). A similar modus operandi has been reported in Negros Occidental, Philippines (Nelz, 2018) and Rocha, Uruguay (Fallabrino, n.d.), where individual hawksbill turtles were found dead except for 1 of the 3 in Pulau Mantanani Kecil, which was reported to have died shortly after its discovery.

The freshness of the shell harvest through the decomposition stage in the carcass from 2018, and the recent cuts and lack of biofouling in the rope around the neck of the live individual from 2019 highly suggest that the poaching events took place in close vicinity to the Baturua Reef. The fact that both turtles had ropes tied around their necks suggests that they were likely captured intentionally, possibly for the purpose of harvesting their shells. The observed modus operandi of carving out the shell from the carapace while leaving the marginal scutes intact

further supports this hypothesis. It is concerning that this activity appears to be ongoing, as evidenced by the recent encounters reported in this study.

While the encounter with a free-swimming hawksbill turtle after shell hunting is rare, no further investigation was made after the rope was removed, and the turtle swam off. It is possible that the poacher had just released the hawksbill turtle when it was found, and after a while, it may have become debilitated due to vulnerability to predators, pathogens, disease, and/or other complications. There is a possibility of carapace scute regeneration in individuals that survive the harvest (Deraniyagala, 1939; Uchida, 1980, as cited in Witzell, 1983). Roberts (1827) also recorded that hawksbill turtles, which had undergone the harvesting process, recovered with one shell piece instead of the usual 13 pieces. Additionally, the shell bone and keratin of Testudines can heal by second intention (Kuchling, 1999; McArthur & Hernandez-Divers, 2004; Boyer & Boyer, 2006).

Poachers use various methods to catch sea turtles, including flipping them on their backs on a beach at night and netting or spearing them during the day at coral reefs (Hughes, 1973; Webster *et al.*, 2016; Gomez & Krishnasamy, 2019). In this report, it was unclear how the sea turtles were caught, except for the presence of ropes attached around their necks, which were presumably used to hold them during the

harvesting process. Unlike green turtles, the meat and organs of hawksbill turtles were not harvested, possibly due to toxicity, as previously reported in mass poisoning events known as chelonitoxism (Silas & Fernando, 1984; Aguirre *et al.*, 2006; Fussy *et al.*, 2007; Diamond *et al.*, 2012; Pavlin *et al.*, 2015). The discovery of these discarded carcasses is valuable in the investigation of tortoiseshell harvest. Unlike other coastal communities where sea turtles are caught for subsistence (Mancini & Koch, 2009), in Sabah, sea turtles are hunted because of foreign demand, as noted by the Sabah Wildlife Department and WWF-Malaysia (as cited in Gomez & Krishnasamy, 2019), which is supported by previous local market surveys that did not observe live sea turtles or tortoiseshell products (Gomez & Krishnasamy, 2019). However, ongoing commercial and foreign demand poses a serious threat to sea turtle populations (Webster *et al.*, 2016).

Between 2018 and 2021, we found a total of six hawksbill turtle carcasses washed ashore on Pom Pom Island (Supplementary Data). We could not visually determine the cause(s) of death of all six individuals. However, none of them had their carapace scutes removed. The hawksbill carcasses consist of 2 adults and 4 juveniles with SCL greater and less than 70 cm, respectively. It is common to find carcasses of sea turtles washed ashore on beaches around Semporna, especially the green turtles, as these areas serve as important rookeries and foraging habitats for turtles (Jolis, 2014; Nishizawa *et al.*, 2018; Joseph *et al.*, 2021).

Sea turtles are vulnerable to a range of threats, including boat strikes (e.g., Phu & Palaniappan, 2019), pollution and marine debris (Domenech *et al.*, 2019), and infectious diseases such as fibropapillomatosis (Loganathan *et al.*, 2021). However, the intentional killing of turtles has also been reported such as in Terengganu where green turtles were slaughtered by cutting their throats, and sometimes the plastron was cut open to retrieve unlaidd eggs (Tolen & Rusli, 2020). Similarly, numerous carcasses of fresh-slaughtered green turtles have been reported in

Semporna, where the turtles are killed for their meat, fat, and body parts such as plastron and marginal scutes (The Star, 4 October 2021). Despite being protected under Section 41(1) of the Wildlife Conservation Enactment 1997 (Joseph *et al.*, 2021), which imposes a fine of up to RM50,000 or a prison sentence of up to 5 years, or both, on anyone convicted of killing or harvesting shell, meat, or eggs of sea turtles, the illegal harvesting of turtles continues in Sabah.

Morphometric Analysis of Hawksbill Turtle Scutes

In June 2021, a complete set of hawksbill turtle carapace scutes, weighing 324.52 g and comprising a total of 13 pieces was found sealed in a plastic bag at north Pom Pom Island (Figure 3). There was a lack of visible biofouling on the plastic bag, indicating that it was not in the water for long. We suspected that the culprit(s) was nearby and had discarded the tortoiseshell scutes to avoid the authorities. We were able to estimate the size of the harvested individual using the SCL, extrapolated as 48.1 cm using the equation $Y=4.077X (0.871)$ developed by Kobayashi (2004), which indicates that the individual was a juvenile turtle. Additionally, the total straight length of the five central scutes that were reconstructed was 44.3 cm, confirming the individual as a juvenile turtle. The width of the first right costal carapace scute at its 2 furthest points measured 17.0 cm.

The discovery of raw tortoiseshell scutes at Pom Pom Island indicates that the illegal harvesting of turtles is an ongoing and active issue in Semporna. However, we doubt that the harvest occurred at Pom Pom Island itself, as it has resorts and enforcement agencies that would deter poachers, and a curfew from 1800 to 0600 would limit access to the island by poachers. The total weight of the carapace scutes found here was relatively heavy for their size when compared to the global hawksbill turtle population size and weight correlation by Miller *et al.* (2019). Heavier scutes tend to fetch a higher price (Lam *et al.*, 2011) and may potentially influence the tortoiseshell harvest.

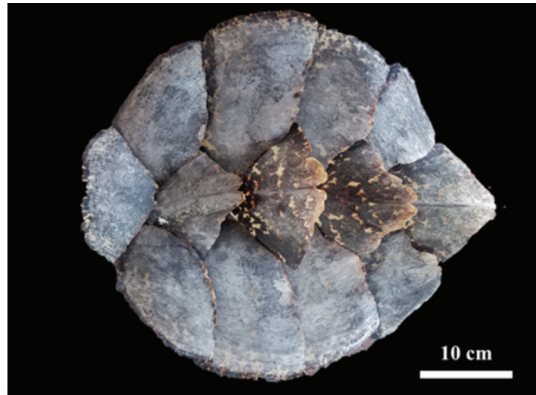


Figure 3: One complete set (13 pieces) of raw reconstructed hawksbill turtle (*Eretmochelys imbricata*) carapace scutes found at Pom Pom Island

However, the range of hawksbill turtle sizes reported here indicates that both juvenile and adult sea turtles are threatened by the harvest.

Interview Surveys

Despite sharing habitats with sea turtles and living by the sea, only a relatively small number of Bajau Laut (20%) shared knowledge about tortoiseshell harvesting, according to informal interviews conducted between 2014 and 2019. This could suggest that either the practice is not widespread within the community or that they are reluctant to divulge incriminating information. Those who did provide information claimed that they caught sea turtles either at night on nesting beaches or during the daytime near coral reefs. Green turtles were targeted for their meat, and any eggs found were collected. Captured hawksbill turtles were kept in nets until buyers were found. If no buyers were found, the Bajau Laut would proceed to remove the hawksbill's carapace scutes, a process that took approximately 2 hours and rarely resulted in the death of the turtle. Once the carapace scutes were removed, the hawksbill turtles, whether dead or alive were thrown back into the sea as the Bajau Laut claimed that hawksbill meat is not edible due to its toxicity. The head of the Bajau Laut sold the live or processed green turtle meat, plastron and marginal scutes, and tortoiseshell to middlemen, who in turn sold them to counterparts in Palawan, Philippines.

These counterparts were agents for Vietnamese and Chinese traders. Informants also provided prices for poached sea turtles, as shown in Table 1.

The low number of respondents who knew about the removal of hawksbill turtle scutes from interviews with coastal communities and Bajau Laut in the region indicates that this illegal activity is not widely known or discussed. While this is the first-ever evidence of the practice, more systematic and rigorous monitoring and enforcement efforts are needed to combat the threat to the local hawksbill turtle population. Further investigation is needed to confirm the occurrence of the illegal activity and determine its extent.

Additional anecdotal information from the local community near Baturua Reef confirmed that the incidents of the 2 hawksbill turtles were tortoiseshell poaching by the Bajau Laut. While it is known by the locals that the Bajau Laut harvests sea turtles and other marine organisms for wildlife trade such activities have never been officially documented except for cases where they have been caught and featured in newspapers. Fishing is the Bajau Laut's primary source of income. The Bajau Laut are sea nomads found mainly in Malaysia, the Philippines, and Indonesia. As stateless people, they are mobile and spend most of their time on a houseboat referred to as *lepa-lepa*. The Bajau Laut seldom come ashore and have been roving

Table 1: Price of poached sea turtles in MYR (Ringgit Malaysia) based on the interviews conducted in 2019

	Offered Price (MYR) to the Sea Turtle Hunters	Wholesale Price (MYR) to the Middlemen in Palawan (Agents for Vietnamese and Chinese Traders)
Green turtle		
Live juvenile	100/animal	300
Live adult	300/animal	600
Fresh meat	15/kg	100/kg
Dried meat	5/kg	50/kg
Dried shell	20/kg	200/kg
Hawksbill turtle		
Live juvenile	50/animal	200
Live adult	150/animal	600
Dried shell	100/kg	600/kg
Carapace scute	60/kg	600/kg

freely in the borderless Sulu Zone, including northeastern Borneo and southern Philippines (Chia, 2016). Table 1 shows the current value of the turtle trade market, specifically in relation to poached sea turtles. Interestingly, while hawksbill turtles are highly coveted for their valuable tortoiseshell, they actually fetch a lower wholesale price when sold live compared to green turtles. This could be because only the hawksbill scute is in demand, while the rest of the turtle has little to no market value. Therefore, the costs of transporting live hawksbill turtles outweigh their benefits, making it not worth smuggling them alive. Poachers instead prefer to smuggle live green turtles since they are more lucrative due to their meat and decorative uses, which command a higher market price.

According to various studies (Stiles, 2009; Chu & Nguyen, 2015; Gomez & Krishnasamy, 2019), raw hawksbill carapace scutes harvested in Malaysia have been traced to Vietnam and are believed to be further sold to China. As of 1993, the price of raw scutes in Ha Tien, Vietnam was valued at USD150 to 350 per kg (Duc & Broad, 1995). In 2008, the price was reportedly USD150 per kg (Stiles, 2009). This corresponds with our information that they are sold to agents at around MYR600 per kg (about USD150). However, it is important to consider market

dynamics such as the location and involvement of middlemen that can affect the price. The hawksbill turtle population in Southeast Asia has dwindled in the past three decades, and the supply of illegally harvested hawksbill scutes is expected to dwindle too. Because of the rarity, the market price should increase. When it does not, as the data presented here where the market price remained more or less the same, it implies one of two things - either demand is lower, or supply is higher.

There is a large disparity between prices offered to sea turtle hunters and the middlemen in Palawan. Taking the weight of total carapace scutes of an average adult hawksbill turtle in Asia at 0.75 kg (Milliken & Tokunaga, 1987), local poachers at the beginning of the supply chain only make about MYR45 per adult, which is lucrative enough for the stateless Bajau Laut, who cannot formally work in Sabah.

The Coral Triangle of Southeast Asia - mainly the Philippines, Malaysia, and Indonesia - is a well-known target region for poaching sea turtles, placing significant pressure on their populations. Evidence from current seizure records and market surveys highlights a consistent illegal trade route to mainland China (Lam *et al.*, 2011). According

to the Sabah Wildlife Department and WWF-Malaysia (as cited in Gomez & Krishnasamy, 2019), local communities are involved in supplying foreign harvesters with tortoiseshell, which contributes to the illicit trade in Sabah. The exploitation of sea turtles, particularly hawksbill turtles is alarming given that there are only around 1,000 nests annually in Malaysia (Syed Kadir, 2016). However, poaching sea turtles can provide an additional source of income for impoverished coastal communities, especially in places like Semporna, where a large proportion of the population is stateless (Chia, 2016). Exploiting sea turtles at foraging grounds potentially impacts the conservation of several nesting populations in Southeast Asia as various rookeries are known to contribute to these foraging populations (Bowen *et al.*, 1996; Nishizawa *et al.*, 2016; 2018; Joseph *et al.*, 2016; 2019). The harvest of hawksbill turtles in foraging grounds will impact nesting populations in the region (León & Diez, 1999; Nishizawa *et al.*, 2016; Joseph *et al.*, 2019).

Conclusion

The illegal exploitation of sea turtles in Southeast Asia poses a significant threat to their populations, and addressing this issue requires a combination of outreach, enforcement, and research efforts. To prevent further decline in sea turtle populations, we recommend further investigation to understand the extent of the threat, particularly across reefs such as Baturua Reef, which is at the start of the supply chain. These findings underscore the need for conservation strategies that benefit local communities and sea turtles, while also increasing livelihoods.

The confirmation of illegal tortoiseshell harvesting in Semporna is an example of the ongoing exploitation of hawksbill turtles in Southeast Asia. While our study may only represent a small fraction of the actual tortoiseshell harvest, it provides a foundation for future research and conservation efforts

focused on addressing the illegal exploitation of sea turtles in the region. To combat this trade, long-term monitoring and research should be implemented, along with an extensive sampling of rookeries for genetic data to be used as a reference baseline database. Mitochondrial DNA profiling can then be done to combat the illegal trade, especially in tortoiseshell products. Moreover, marine outreach and awareness programs are crucial to enhance the knowledge and understanding of sea turtles and other marine animals among local communities. Enforcement efforts must also be strengthened in these areas. By gaining insights into the threats posed by tortoiseshell harvesting to sea turtle species, we can better define population viability concerns for resource managers and identify poaching hotspots for the trade. Ultimately, a multi-faceted approach is necessary to address illegal sea turtle exploitation and protect these marine animals. The government should prioritize conservation efforts to ensure their survival.

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