

Marine Turtle Newsletter

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A female olive ridley returns to the sea in the early light of dawn after nesting in the Gulf of Fonseca, Honduras. See pages 1-4. Photo by Stephen G. Dunbar

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Marine Turtle Species of Pacific Honduras

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Understanding the distribution of marine turtles is key to the establishment of management measures that account for population size, direct conservation efforts, and increase public awareness. Without updated and accurate information on species presence at specific localities, an understanding of how species composition and relative abundances are changing may be greatly hampered.

Previous efforts have been made to describe the turtle species that inhabit the Gulf of Fonseca (GOF) along the coasts of El Salvador (Carr 1952; Hasbún & Vásquez 1999; Liles *et al.* 2011), and Nicaragua (Gaos *et al.* 2011; Gaos *et al.* 2012). However, in the country of Honduras, little information on the distribution of marine turtles has been documented in unpublished government reports, with even less in the published literature. Most of those studies have been undertaken in the Bay Islands of Honduras (Dunbar *et al.* 2008; Hayes *et al.* 2016; Baumbach *et al.* 2019) and along the north coast of the mainland (Dunbar *et al.* 2013). Efforts along the south coast of the country in the GOF have been minimal, mostly focused on the olive ridley (*Lepidochelys olivacea*) sea turtle, and mainly concentrating on tagging (Dunbar & Salinas 2008, 2013), genetics analyses of nesting turtles (Duran *et al.* 2014), and hatchery impact studies on hatchling behavior and condition (Duran & Dunbar 2015).

In this paper, we use visual observations to confirm the presence of sea turtles in the GOF along the Pacific coast of Honduras. We also discuss anecdotal reports that suggest which additional species may be found in that area, yet whose presence remains to be confirmed.

The GOF is a shallow inlet of the Eastern Pacific covering approximately 3,200 km² and surrounded by the coastal zones of El Salvador to the north, Honduras, and Nicaragua to the south (Fig. 1). Honduras presents the largest span of coastline (153 km), followed by Nicaragua (47 km) and El Salvador (29 km). Several islands are distributed throughout the Honduran portion of the Gulf, including Zacate Grande, San Carlos, and Amapala (Isla del Tigre). Coastal zones in this area consist of extensive estuaries, lagoon systems, mangrove forests, and long stretches of sand beaches.

Olive ridley (*Lepidochelys olivacea*). After visiting “Isla Ratones” (now, Punta Ratón) in the GOF, Carr (1948) was the first to report nesting by *Lepidochelys olivacea* on the beaches of Pacific Honduras. Essentially all of the turtles he observed nesting in the area were *L. olivacea*. In 1975, the Honduran government established the first ‘veda’ (prohibited period) restricting the personal collection of eggs for sale to public market vendors, and instead required all *L. olivacea* eggs collected during the first 25 days of September to be relocated into community managed hatcheries, as a means to promote conservation of the species. Cruz *et al.* (1987) visited the same area some 38 years after Carr and found this species continuing to nest on the beaches of the GOF from July to December. Several recent studies have documented regional increases in nests and nesting females (Dunbar & Salinas 2008; Dunbar *et al.* 2010, 2011, 2015), and suggested that the high degree of multiple paternity

typical of large nesting populations, but found in this small nesting group, may indicate that *L. olivacea* nesting in the GOF may actually be part of the wider Eastern Pacific population (Duran *et al.* 2014).

The olive ridley is the most abundant sea turtle species both within the waters of the GOF and on the nesting beaches of the south coast of Honduras. It is unclear whether this species is locally abundant throughout the Gulf as a foraging population, or if individuals simply pass through these waters on their way to and from other, more prominent nesting grounds. Local fishers rarely report seeing or capturing *L. olivacea* throughout the year, although the species is anecdotally reported to nest to some extent throughout much of the year, from May to February.

Olive ridleys found along the GOF are within the size range of nesting females reported elsewhere along their East Pacific geographical range. During early nesting studies of *L. olivacea* on these beaches, Dunbar & Salinas (2008) found mean CCL = 65.9 cm ±0.5 SEM while mean CCW was 70.3 cm ±0.4 SEM (range CCL: 61.4-70.5 cm; n = 30; range CCW: 66.0-75.0 cm; n = 30). These measurements agree well with Carr (1986), who also noted that curved carapace measures for *L. olivacea* were greater in width than length. Despite both the harvest of essentially every nest throughout 340 days of the year (Dunbar & Salinas 2008), and a hatchery system during the ‘veda’ period that is essentially unguided by data collection and analysis (Duran 2015), *L. olivacea* nesting persists along the Honduran coast of the GOF. Untagged (mainly new) individuals continue to appear on the beaches of the region year after year, to which Dunbar *et al.* (2010, 2011) report applying new flipper tags.

Hawksbill (*Eretmochelys imbricata*). Hawksbills were at one time reported along the Eastern Pacific coast. However, much of this historical evidence was anecdotal with few personal observations (Carr 1952; Hasbún & Vásquez 1999) leading some to conclude that hawksbills had been extirpated from the Eastern Pacific. Recently, hawksbills have been found nesting in both Costa Rica (Gaos *et al.* 2006) and El Salvador (Gaos *et al.* 2011). Some El Salvador nesters were then satellite tracked to foraging areas within mangroves in other areas of El Salvador and the GOF where the authors hypothesized these turtles feed within mangrove areas (Gaos *et al.* 2010). Corresponding evidence was previously presented by Carr (1952) who found red mangrove fruit within the digestive tract of two dissected specimens. Gaos *et al.* (2012) used satellite data to confirm that post-nesting females moved into mangrove estuaries within the GOF where they established inshore or nearshore foraging home ranges. Dunbar *et al.* (2012) and Duran *et al.* (2016) were able to confirm the movement pattern reported by Gaos *et al.* (2012) through the direct observations of both juvenile and adult hawksbills within the Honduran portion of the GOF.

We confirmed the presence of juvenile hawksbills in the GOF during July 2011 when local fishermen presented us with a dead

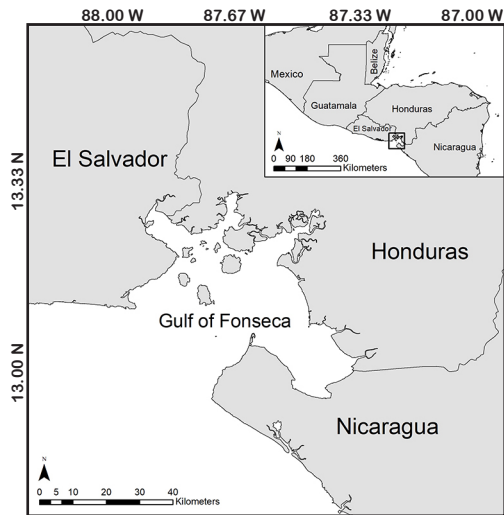


Figure 1. Map of the Gulf of Fonseca with coastal areas of El Salvador, Honduras, and Nicaragua. Inset map is of the Central America region showing the location of the Gulf of Fonseca.

turtle that was then frozen until a necropsy could be conducted, and another which was alive and in good health, with large barnacles and a layer of red algae on the carapace ($CCL_{min} = 36.2$ cm; $CCL_{max} = 38.5$ cm). We conducted surveys to determine where fishermen had seen these turtles, yet were unsuccessful in sighting any others until 9 September 2013, when local fishermen from El Venado brought us another juvenile that had been captured from the El Muerto estuary. In June 2015, seven more juveniles were collected by fishers in the San Lorenzo estuaries located in the northern part of the GOF (Duran *et al.* 2016). The following summer, fishers collected ten juveniles and one adult female. The female turtle had already been tagged on each front flipper while nesting in Estero Padre Ramos, Nicaragua. This adult female confirms the findings of Gaos *et al.* (2011) that *E. imbricata* nest in other countries, then navigate back to foraging areas within Honduran estuaries in the GOF.

Although many *E. imbricata* sightings were reported in our initial surveys, we found local fishermen readily confused large, adult *C. mydas agassizii* with *E. imbricata*. The potential for more and larger hawksbill adults in the estuaries, as found by Duran *et al.* (2016), may be the reason why fishermen confuse large *Chelonia mydas agassizii* with *E. imbricata*. In El Salvador, Hasbún & Vásquez (1999) also found fishers confused *E. imbricata* with both *L. olivacea* and the freshwater turtle, *Trachemys scripta grayii*. These observations suggest that local fishers may not represent sources of reliable information on the abundance and distribution of these marine turtle species.

Hawksbill Hybrids. Hawksbill hybrids have been previously detailed by Seminoff *et al.* (2003), although no reliable observations had been documented from the GOF. We observed two hawksbill x green turtle hybrids in 2013: one presented to us after capture by fishermen near the Nicaraguan portion of the GOF in July ($CCL_{min} = 45.5$ cm; $CCW = 37.5$ cm) and the other captured by fishers in an estuary near the town of Guapiñol in November ($CCL_{min} = 42.2$ cm; approximate $CCW = 31$ cm). We determined that these were hybrid turtles from the presence of only two prefrontal scutes and a greater number of facial scales typically characteristic of green

turtles. Seminoff *et al.* (2003) suggested that hybridization may occur because of the scarcity of hawksbill males along the Eastern Pacific, thus inducing hawksbill females to more readily accept heterospecific males during the breeding season.

Green (*Chelonia mydas*) and Black (*Chelonia mydas agassizii*). On visiting “Isla Ratonés” in the GOF in 1947, Carr was surprised to find no nesting *C. mydas*, and that all of the nesting turtles he observed were *L. olivacea* (Carr 1948). Despite the lack of nesting green turtles, Carr noted that fishermen of the Gulf caught this species between January and June, but that none of the captured female turtles he examined were found to be with eggs at any advanced state of maturity (Carr 1952). Carr (1952) further noted that many local residents in the GOF readily confused the green turtle with *L. olivacea*. Although historically there has been some confusion as to whether the species in this area is *C. mydas* or *C. m. agassizii* (Carr 1952), both Carr (1952) and Pritchard *et al.* (1983) confirm that specimens they observed were *C. m. agassizii*. While black turtles have more recently been confirmed in the El Salvador portion of the GOF (Hasbún & Vásquez 1999), Cruz *et al.* (1987) have provided the only published report confirming that *C. m. agassizii* nested in Pacific Honduras. Our observations between 2009 and 2015 at nesting beaches and in coastal and estuary waterways around both Punta Ratón and El Venado confirm that low numbers of black turtles persist in feeding habitats along Pacific Honduras, but there is no documented nesting along this coast at the present time.

We confirmed the presence of a foraging black turtle in May 2013, when local fishers led us to an estuary opening at El Muerto where they had trapped a turtle they reported as *E. imbricata*, which we immediately recognized as *C. m. agassizii* based on its scute morphology, shell pattern, and color. Additionally, the size of the turtle ($CCL_{min} = 80.4$ cm, $CCW = 67.7$ cm) was characteristic of black turtles previously reported by Cruz *et al.* (1987) in the GOF area. On one other occasion (28 August 2013), local fishers brought us two black turtles from sites near the marine border between Honduras and Nicaragua. In both instances, fishers believed the turtles to be hawksbills. On inspection, we confirmed both were black turtles of $CCL_{min} 45.5$ cm and 81.5 cm, respectively and $CCW 37.5$ cm and 77.8 cm, respectively.

Additionally, there has been some history of confusion between the olive ridley (*L. olivacea*) and black (*C. m. agassizii*) turtles (Carr 1948, 1952). Commenting on field observations of turtles reported as *C. m. agassizii* during a 1984 nesting season on San Sabastian Island, El Salvador, just outside the GOF, Hasbún & Vásquez (1999) suggested that measurements of turtles reported as *C. m. agassizii* were more consistent with measurements of *L. olivacea*. Additionally, we have noted confusion persists among local community members on differences between *C. m. agassizii* and *E. imbricata* (Dunbar, pers. obs.).

Leatherback (*Dermochelys coriacea*). Although Hasbún & Vásquez (1993) report that sporadic nesting of leatherback turtles takes place in El Salvador between November and February, there are no published reports of leatherbacks either foraging or nesting along the south coast of Honduras. Descriptions of large, black turtles with different shells than other species of turtles have been provided by local fishers. However, a clear description of *D. coriacea* in this area has never, to our knowledge, been provided. Thus, we cannot confirm the presence or absence of leatherbacks along the south coast of Honduras at this time.

Loggerhead (*Caretta caretta*). While Benitez (1985) reports the presence and nesting of *C. caretta* in El Salvador, both Marquez (1990) and Hasbún & Vásquez (1999) are skeptical that there is good evidence to support that claim, and suggest that what Benitez reported were more likely to be olive ridley, rather than loggerhead turtles. Such misidentifications between *C. caretta* and *L. olivacea* have, according to Carr (1952) and Frazier (1985), had a long-standing history throughout the East Pacific region. Although it is possible that there is an occasional nesting event by this species along the Pacific coast of Honduras, to date, there is no historical or current evidence that *C. caretta* forages or nests in the GOF region.

Conclusion. We provide the first inventory report of sea turtle species on the south coast of Honduras along the Gulf of Fonseca. This report is of value as a benchmark for the species of turtles that have been confirmed in the area, as well as for those that have not, yet have been anecdotally reported. Additionally, we have provided substantial evidence that local fishers providing anecdotal reports have often misidentified sea turtle species, suggesting the need for ongoing capacity building in GOF communities to improve both species identification and proper conservation management. Finally, this work lends further support to the species inventories described in previous publications provided by local naturalists, as well as researchers in other countries of the GOF.

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A Juvenile Green Turtle Long Distance Migration in the Western Indian Ocean

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Juvenile sea turtles are known to undertake long migrations (Hays & Scott 2013) and undergo ontogenetic shifts in their foraging habitats (Bolten 2003; Reich *et al.* 2007; Arthur *et al.* 2008). Juveniles can remain in the same habitats for many years (Bressette *et al.* 1998; Ehrhart *et al.* 2007; Redfoot & Ehrhart 2013; Shimada *et al.* 2014), providing an opportunity for in-water studies of marked individuals. Due to the recapture of tagged turtles, a picture is emerging of the migratory patterns between Kenya and the Seychelles (Zanre 2005; von Brandis *et al.* 2017). Whereas previously described migrations have all taken place from the Seychelles to the continental African coast, the migration presented here is the first documented case of a juvenile green turtle in the opposite direction.

On 3 November 2015, a juvenile green turtle (*Chelonia mydas*) was captured in the early morning in a net by Baraka Omar, a local fisher, near Watamu, Kenya (Fig. 1). Omar notified Kenya-based NGO Local Ocean Conservation (LOC), and their Bycatch Release Program (BCRP) team met him at the landing site. LOC has been running the BCRP in collaboration with Kenya Wildlife Services since 1998 and works with hundreds of fishers, conducting nearly 1,400 rescues per year. Upon collection of the turtle, it was assessed

and found to be in good health and “generally clean,” meaning it was free of algae and epibionts. Measurements of the turtle were taken as per Bolten (1999): minimum curved carapace length (CCLmin): 38.8 cm; curved carapace width (CCW): 38.4 cm; weight: 7.4 kg. Photos of the left, right and top of the head were taken for future visual identification purposes (Fig. 2). As per LOC protocol, this juvenile turtle was tagged in the left rear flipper (KES0113; Inconel 681 tag from the National Band and Tag Company, Kentucky, USA). Since the start of the BCRP, over 8,100 turtles have been tagged by LOC, most of which have prefix KE, KES or KEL. The tagged turtle was then transported to the beach in the Watamu Marine National Park the same day and released.

Four years later, on 19 September 2019, the same turtle was captured by research staff from the Seychelles Islands Foundation (SIF) Public Trust in the lagoon of Aldabra Atoll (Fig. 1, 2), Seychelles, nearly 950 km (straight line distance) from Watamu. Aldabra Atoll is a raised coral atoll and UNESCO World Heritage Site managed by SIF, about 1,100 km from the Seychelles main island of Mahé, and is nearly 400 km from Madagascar. The atoll consists of four main coralline islands, which surround a shallow

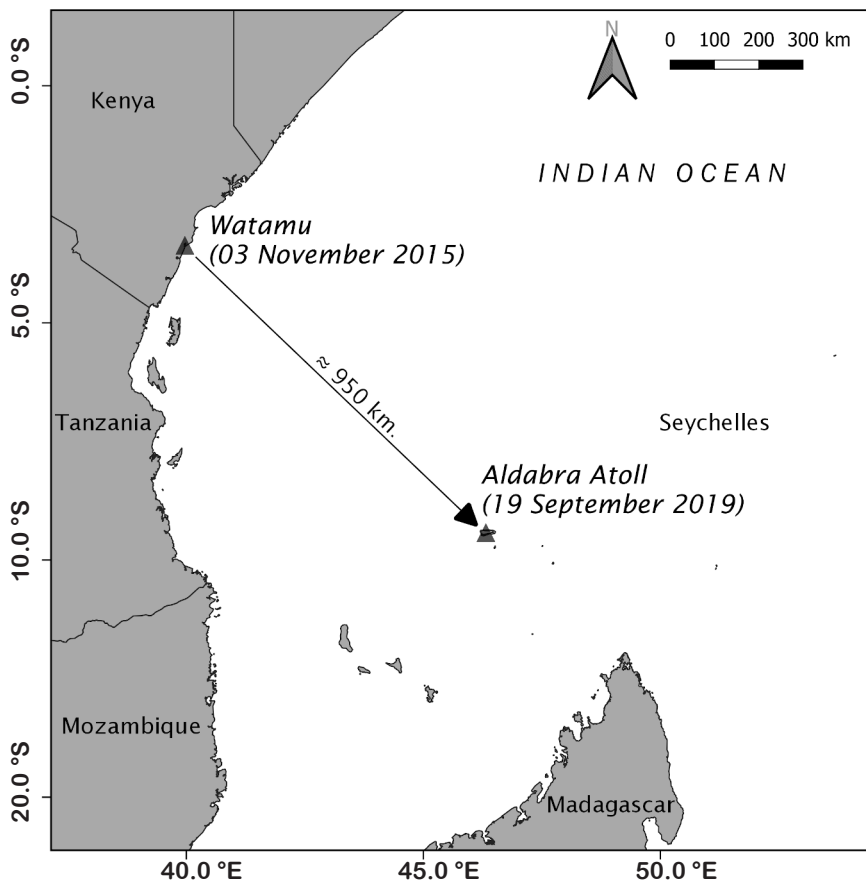


Figure 1. Map showing the original capture location of the juvenile green turtle at Watamu, (Kenya) and the recapture location of Aldabra (Seychelles) nearly four years later.



Figure 2. Juvenile green turtle KES0113 at time of capture in Watamu, Kenya (top left, right), and KES0113 recaptured on Aldabra, Seychelles (bottom) nearly four years later.

interior lagoon (226 km²). A small team (typically 10-15 people) of permanent SIF staff live at a research station at the atoll for research and conservation purposes. The Aldabra in-water turtle monitoring program began in 1986, prior to SIF management, and has been part of routine monitoring predominantly in the lagoon since 1996. The turtle was caught during one of these in-water sessions and measured (CCLmin: 54.0 cm, CCW: 52.5 cm, weight: 45.5 kg). The left rear flipper tag was recorded and the turtle was tagged in the left and right front flippers (Inconel 681 tags: E4955, E4944) based on the SIF turtle tagging protocol. In the nearly four years between captures, the turtle grew 15.2 cm in length, 14.1 cm in width, and gained 38.1 kg, a growth rate of almost 10 kg and just over 4 cm in length per year.

Although adult green turtles have previously been found to transit between the Seychelles and Kenya (Zanre 2005; SIF unpublished data), this is the first account of a juvenile green turtle carrying out this migration. It is also the first time that a juvenile turtle has

been found to swim from the continental coast to the Seychelles. A juvenile hawksbill turtle (*Eretmochelys imbricata*) carried out a similar long distance migration from the St. Joseph Atoll, Seychelles, to Kenya (von Brandis *et al.* 2017). This turtle was also captured by a fisher who reported it to LOC through the BCRP. Evidence of migrations to other continental African countries include the recovery of a tag from a green turtle which originated in the Seychelles on the Tanzanian coast (Sea Sense 2015) and a hawksbill turtle originally tagged in the Seychelles was found in Mozambique in the 1990s (J.A. Mortimer, pers. comm.). The recapture event reported here, combined with similar events in the region, highlight the connectivity of turtle populations the Western Indian Ocean (WIO) and the value of these tagging programs.

The work of LOC with local fishers has enabled the tagging of the reported juvenile green turtle, as well as the tag recovery from a hawksbill turtle (von Brandis *et al.* 2017) from the Seychelles. In this case, the juvenile green turtle was successfully released

in Kenya and was then recaptured in a well-protected habitat at Aldabra. The use of both habitats, one with high human impact and the other with little human interference, highlights some of the risks and benefits these individuals may face. This recapture event underlines the wide geographic area that juvenile turtles potentially utilize and therefore the high levels of threat that they face during these migrations, such as bycatch and targeted illegal take (Bourjea *et al.* 2008). The tagging programs described here are contributing to the ability to effectively manage sea turtle populations in the WIO by providing insight into the migratory patterns of juvenile turtles. Stronger international collaboration between the various sea turtle conservation efforts in the region, exemplified by this paper, are vital to further deciphering connectivity of the turtle populations.

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Nesting activity of *Chelonia mydas* and *Eretmochelys imbricata* at Pom-Pom Island, Sabah, Malaysia

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Green (*Chelonia mydas*) and hawksbill sea turtles (*Eretmochelys imbricata*) have been of conservation concern in Sabah for decades (Pilcher & Ali 1999; Pilcher & Basintal 2000). Green turtles are listed as Endangered by the IUCN Red List and are protected from human exploitation in most countries under CITES (Seminoff 2004). Hawksbill turtles were initially listed as Endangered in 1982 and upgraded to Critically Endangered in 1996 due to human exploitation (Mortimer & Donnelly 2008).

Green turtles are widely distributed, with the largest Southeast Asian nesting populations in the Turtle Islands Heritage Protected Area (TIHPA, overlapping both Malaysia and Philippines) and the Sarawak Turtle Islands (Satang Besar, Talang-Talang Besar and Talang-Talang Kecil Islands, Sarahaizad *et al.* 2018). Other green turtle nesting beaches can be found on Redang and Perhentian Islands, Kemaman and Kerteh (Terengganu), Chendor and Cherating (Pahang), and Pantai Remis (Perak) (Sarahaizad *et al.* 2018). Nesting activity has also been reported at Semporna District, Sabah (Sipadan Island Park, Matakang Island, Pandanan Island and Pom-Pom Island, Basintal 2001; Chan 2006; Jolis & Kassem 2011; Jolis 2014; Harith & Hamid 2018). Hawksbill turtles have only a few remaining important nesting beaches in Malaysia, including Sabah's Turtle Islands Park (primarily Gulisan Island), in the state of Melaka and peninsular Malaysia (Chan *et al.* 1999). Others include Terengganu and Johor (Basintal 2001; Chan 2006) and Semporna District, with nesting occurring in Matakang Island and Pom-Pom Island (Mortimer 1991; Basintal 2001; Palaniappan 2001; Basintal 2002; Jolis & Kassem 2011; Jolis 2014; Harith & Hamid 2018).

In Sabah, both green and hawksbill turtles are fully protected legislatively under the Parks Enactment 1984 and the Wildlife Conservation Enactment 1997. Offenders risk being fined between RM (Malaysian Ringgits) 50,000-250,000 (US \$12,225-61,140, January 2020 exchange rate), and a jail term of no less than a year, to a maximum of five years, or both a fine and jail time upon conviction. However, life-history traits of sea turtles (long-lived, late maturing, migratory behavior and egg-laying) and anthropogenic impacts make them vulnerable on land and at sea. In Semporna District, green and hawksbill turtles are highly susceptible to various threats, including the trade and consumption of adult sea turtles and eggs, which removes them from the marine ecosystem (Jolis & Kassem 2011; Jolis 2014; Harith & Hamid 2018). Despite a ban on poaching in Sabah, poaching cases are still recorded (Gavin Jolis pers. comm.).

Nesting demographic parameters vary across sea turtle populations and regions. Large annual fluctuations in the number of females arriving at a nesting beach are common for some species and are apparently linked to environmental conditions on the feeding grounds (Limpus & Nicholls 1988). Information on nesting demographics and threats for the Semporna District population

of green and hawksbill turtles are limited, and are mainly based on data from Sipadan Island Park (Basintal 2001; Jolis 2014). However, the status of the other areas remain unknown and need to be determined to gain a better understanding of the status for identifying and implementing conservation interventions. In this study, focusing on Pom-Pom Island, we summarize eight years of research, and characterize the nesting ecology and threats for green and hawksbill turtles. The objectives of this research were to: (i) estimate the reproductive demographic parameters of the nesting population (clutch frequency, re-migration interval, and hatching success) and, (ii) estimate the impacts of poaching. Our study provides the first comprehensive characterization of nesting green turtle and hawksbill populations on Pom-Pom Island.

Pom-Pom Island is located at the southeast corner of Semporna District (Fig. 1). The island is 2.3 km in circumference at the high tide line with a fringing coral reef 4 km long. The island is flat sand with a maximum elevation <2 m above the high tide line. The reef flat is 50-75 m wide to the west and several hundred meters wide around most of the island. The beach is mostly comprised of fine-grained sand and coral rubble supporting halophytic vegetation (Jolis & Kassem 2011). The island has a wet season or the northeast monsoon from December to January, while the southeast monsoon is during June and July. The transition periods bring variable wind patterns and rainfall (Wood 1994). Tidal fluctuations are semi-diurnal and range between 1.2-2 m (Wood 1987).

The Pom-Pom Island Conservation Department, in collaboration with the Sabah Wildlife Department and WWF-Malaysia started a sea turtle conservation programme in 2009 with the aim of protecting sea turtle eggs from poaching and studying the nesting population. Pom Pom Island Resort built two hatcheries (Fig. 2) and started a long-term turtle patrol program. Each hatchery measures 7 m x 5 m and each is divided in squares of 1 m x 1 m with a capacity of 35 nests (Fig. 2). Every year, the sand in the hatchery is completely replaced with new sand collected from the nesting beaches, to avoid the formation of roots and to prevent an increase in the bacteria/parasite population. The hatcheries have a natural shaded area provided by Pandanus trees (*Pandanus tectorius*).

Pom-Pom Island nesting beaches are divided into sectors, labeled in alphabetic order, starting from "A" at the beginning on the south side and running clockwise around the western side to the north and east (Fig. 1). The surveys were conducted from 01 January 2011 to 31 December 2018, on foot by two patrollers lead by the resident marine biologist. The surveys were conducted every night from 7:00 pm to 5:30 am. Occasionally, volunteers from the local conservation center would patrol the island from 11:30 pm to 12:30 am. Species and crawl identification followed Pritchard & Mortimer (1999) and the Sea Turtle Identification Key (www.seaturtle.org).



Figure 1. Map of Pom Pom Island with sector representation of the nesting beaches, Sabah, Malaysia.

All turtle crawls were recorded; nesting and non-nesting emergences of adult females were visually differentiated by direct observation of the nester (during patrol) or by examining crawl signs (presence/absence of escarpment, primary/secondary body pits and thrown sand) and by verifying the presence of eggs.

When a nester was found during patrol, oviposition was observed from a safe distance of 5 m to minimize stress to the turtle. Following oviposition, the nester was measured, tagged and photographed, eggs were counted and relocated to the turtle hatchery, and the relocated nest was labelled. Curved carapace length (CCL) and curved carapace width (CCW) were measured at the widest point. Metal Monel enumerated tags, with the prefix of BJ were attached proximally and adjacent to the second large scale on the trailing edge of each front flipper.

Nesting season length and peak were estimated. Dates of the first and last nests were recorded. The season peak was calculated using the mean number of nests laid per month across all years. Nesting periodicity was estimated at inter- and intra-annual scales. Re-migration interval, the number of years between nesting seasons, was calculated for recaptured turtles. The inter-nesting interval was estimated as the number of days between one successful nesting event and the start of the next nesting attempt within a season, even if the next landing was a non-nesting emergence (Alvarado & Murphy 1999). Clutch frequency (number of nests per female within a season) was estimated. Females included in this calculation were physically encountered at least twice in the season to confirm their emergence schedule and ensure particular nests were attributed correctly to specific individuals (Alvarado & Murphy 1999). Turtles that were eventually poached prior to their final nesting attempt were not included in this calculation.

Eggs from natural nests were counted and gently transferred into a rigid bucket with a sand layer on the bottom, transported to

Pom-Pom Hatchery by foot and relocated in a new egg chamber. The chamber was covered with sand; a net was applied on the top of the chamber with a wooden tag describing the species, number of eggs, date, patroller name and approximate date of hatching. The distance between the center of nests in the hatchery was a minimum of 1 m. Upon emergence, hatchlings were counted, transferred into a rigid bucket with a sand layer at the bottom and released, usually during high tide, on the beach 5-10 m away.

Nests were excavated 3 days after the first evidence of emergence was observed. When no emergence was evident, nests were inventoried on the 70th day after the original observation date. Incubation periods were estimated as the number of days between oviposition and the date that the primary emergence was observed.

We examined and categorized the contents of each nest following Miller (1999). Categories included: E = emerged hatchlings (departed/departing from nest); S = shells (empty shells counted if >50% intact); L = live hatchlings; D = dead hatchlings; UD = undeveloped eggs; UH = unhatched eggs (with obvious embryo); UHT = unhatched term eggs (fully developed in egg shell or pipped); P = depredated eggs (open, nearly complete shell with egg residue). Reproductive output metrics were calculated as:

$$\text{Total clutch size} = E+L+D+UD+UH+UHT+P$$

$$E = S-(L+D)$$

$$\text{Hatching success} = [S/(S+UD+UH+UHT+P)] \times 100$$

$$\text{Emergence success} = [(S-(L+D))/(S+UD+UH+UHT+P)] \times 100$$

Threats were assessed during surveys by quantifying: (1) nesters and nests poached (or nearly poached) and (2) human disturbance activities. We counted turtles as poached if at least one of the following lines of evidence were present: (a) crawl tracks emerging from the water but not returning, (b) human activity at the nest, such as digging and foot prints (c) emergence tracks wiped away by humans, presumably to disguise a poaching event, typically

	2011	2012	2013	2014	2015	2016	2017	2018	Total
<u>Green turtles</u>									
Diurnal survey	365	375	384	412	396	400	435	423	3190
Nocturnal survey	410	433	423	476	455	423	443	465	3528
Nests	36	62	76	24	21	72	57	81	429
NNEs	22	66	33	30	28	39	46	51	315
Poached nesters	0	0	0	0	0	0	0	0	0
Poached nests	0	13	0	0	0	0	1	7	21
Nesters	36	62	76	24	21	72	57	81	429
New nesters	36	57	74	22	21	72	55	79	416
% untagged nesters	100	91.9	97.4	91.7	100	100	96.5	97.5	96.9
<u>Hawksbill turtles</u>									
Diurnal survey	365	375	384	412	396	400	435	423	3190
Nocturnal survey	410	433	423	476	455	423	443	465	3528
Nests	4	6	2	7	6	7	5	21	58
NNEs	0	3	2	3	5	7	8	9	37
Poached nesters	0	0	0	0	0	0	0	0	0
Poached nests	0	0	0	0	0	0	0	0	0
Nesters	4	6	2	7	6	7	5	21	58
New nesters	4	6	2	7	6	7	5	21	58
% untagged nesters	100	100	100	100	100	100	100	100	100

Table 1. Summary of annual green and hawksbill turtle nesting activity on Pom Pom Island, 2011-2018. Diurnal and nocturnal survey effort is summarized for context. NNEs (non-nesting emergences) including false crawls, body pits and abandoned egg chambers. New nesters, untagged turtles, % of untagged nesters, and percentage of annual nesters that were untagged are displayed.

in conjunction with missing return tracks and cessation of future nesting by a female that was expected to have additional nesting events in the season. Nests were considered poached if they were confirmed to be present and had evidence of human removal of eggs (*e.g.*, digging and broken shells).

Data on annual nesting activity, annual sector distribution of nests, annual nest parameters are presented as means \pm standard deviation (SD). For annual nesting activity and annual sector distribution of nests, a two-way ANOVA ($P < 0.05$), with Bonferroni post hoc tests to determine how these parameters were affected by time and sector. Annual nest parameters were analyzed with one-way ANOVA ($P < 0.05$) with Tukey's Multiple Comparison Test. Significance level was set at $P < 0.05$. Statistical analysis and graphics were created with GraphPad Prism 8.0 (GraphPad Software, San Diego, CA, USA).

Green turtles nest and hatchlings emerge year-round at Pom-Pom Island. The majority of green turtle nests and NNEs (non-nesting emergences) occurred in sector B, followed by sectors C and D (Fig. 3a). In 2012-2013, the highest abundance was in sector D, followed by sector B (Fig. 3a). Peak season occurred between May and September with 68% of all nests (Fig. 3a). On Pom-Pom Island there were 429 total nests (mean = 61.3 ± 23.5 nests/year; range = 21-81; Table 1). A total of 315 NNEs was observed (45 NNEs/year ± 14.4 ; range = 22-66; Table 1). Over the 8-year study, emergences occurred between 7:30-11:30 pm with a few exceptions.

Hawksbill turtles nest from January to October at Pom-Pom Island with a peak season (61% of total nests) laid between May and August (Fig. 3b). A total of 58 nests (8.4 ± 5.8 nests/year; range = 2-21 nests/year; Table 1), and 37 NNEs (5.2 ± 2.7 NNEs/year; range = 2-9; Table 1), were recorded during the study period. All nests and NNEs were found between 22:00-05:00. For hawksbill turtles, most of the nests occurred in sector B, followed by sectors A and

C (Fig. 3b). Rocky substrate and roots impacted some nesters by impeding the excavation of an egg chamber. During the study period, 202 nesting attempts by green turtles and 24 attempts by hawksbills were unsuccessful due to the presence of roots. An increase of abandoned egg chambers was recorded through the years, with the most affected sectors being sectors C and D.

We measured and tagged 71 green and 7 hawksbill turtles on Pom-Pom Island. Green turtle mean CCL was 101.7 ± 10.2 cm, and mean CCW was 92.2 ± 13.3 cm. Among tagged sea turtles, nine green turtle nesters visited the island twice within one year. Inter-nesting interval was 14.5 ± 5.2 days. No data are available on the re-migration interval, because none of the tagged turtles were observed on the island in the following years. However, a green turtle measuring 84.0 cm CCL and 79.0 cm CCW tagged with PHY1609G was found attempting to nest on Pom-Pom Island on 20 July 2012. WWF-Malaysia investigated and contacted the key agencies from the Philippines. The green turtle was first encountered on 22 March 2012 and again on 23 May 2012, at Baguan Island, the Philippines Turtle Islands Park, 300 km north of Semporna, where she was tagged (Gavin Jolis, pers. comm.). Hawksbill turtle mean CCL was 80.6 ± 5.5 cm, and mean CCW was 77.8 ± 7.6 cm. Of the 7 tagged hawksbills, none of them were reported visiting the island a second time.

During the study period, 416 untagged green and 58 untagged hawksbill turtles were recorded. Poachers removed 21 green turtle nests over the years (Table 1). No egg poaching was reported for hawksbill turtles (Table 1). No poaching of nesters on land was observed for either green or hawksbill turtles (Table 1). However, during the study period, 38 adult female green turtles were found dead at Pom-Pom Island. The carcasses had no plastron indicating that these turtles were poached for their meat and parts. It is not clear



Figure 2. Pom Pom Island Resort sea turtle hatchery, Pom Pom Island, Sabah, Malaysia.

if the poaching occurred at Pom-Pom Island. However, these cases strongly suggest that poaching is still occurring in Semporna District.

Overall, 429 green turtle nests from 142 different individuals were recorded for a total number of 37,946 eggs. Clutch size was 68.5 ± 6.7 and no significant difference ($P < 0.05$) was found among the years. Mean incubation duration was 53.6 ± 3.9 days. Hatching success was $87.9 \pm 4.9\%$. A significant increase ($P < 0.05$) in hatching success was found in 2013 (96.9%). Emergence success was $76.4 \pm 16.1\%$. Nest excavations revealed a low level of egg predation. Ants impacted 2% of nests. No other predators were reported for the hatchery. Egg poaching accounted for the loss or partial loss of 4.9% of nests. Hatchlings were directly released to the sea; $<1\%$ of the hatchlings showed abnormalities. One of the nests (70 eggs, 56 hatchlings), on 23 September 2016, produced 4 albino hatchlings. No direct hatchling collection or poaching was reported for either species.

Fifty-eight hawksbill turtle nests, with 6,768 eggs, were recorded. Clutch size was 95.8 ± 20.3 eggs; no significant differences ($P < 0.05$) were found among the years. Mean incubation duration was 57.1 ± 6.2 days. Hatching success was $86.1 \pm 11.4\%$, whereas emergence success was $72.2 \pm 16.1\%$. No significant differences ($P < 0.05$) in either parameter were found among the years. Similar to green turtles, nest excavations revealed little egg predation in hawksbill

	Pom Pom Island, Sabah, Malaysia	Malaysia	Turtle Island, Philippines	Ogasawara, Japan
Source	This study	Pilcher & Basintal 2000	Trono 1991; Burton 2012	Abe <i>et al.</i> 2003; Suganuma <i>et al.</i> 2006
<u>Green turtles</u>				
CCL (cm)	101.7 ± 10.2	NR	NR	95.2 ± 4.5
CCW (cm)	92.2 ± 13.3	98.5 ± 6.0	99.5	NR
Nests	61.3 ± 23.5	NR	NR	NR
Observed clutch freq	2.8 ± 1.0	2.7 ± 0.8	5	4.1
Inter-nesting interval (days)	14.5 ± 6.0	15.5 ± 6.2	15.5	13.40
Incubation (days)	53.6 ± 3.8	53.1 ± 4.2	54.3	NR
Clutch size (eggs)	68.5 ± 6.7	87.3 ± 21.9	95.6	102
Hatching success (%)	87.9 ± 4.9	NR	87.1	NR
Emergence success (%)	76.4 ± 16.1	NR	85.7	NR
	Pom Pom Island, Sabah, Malaysia	Melaka, Malaysia	Melaka, Malaysia	Turtle Island Park, Sabah, Malaysia
Source	This study	Sarahaizad <i>et al.</i> 2017	Sarahaizad <i>et al.</i> 2017	Chan <i>et al.</i> 1999
<u>Hawksbill turtles</u>				
CCL (cm)	80.6 ± 5.5	NR	NR	76.3 ± 5.1
CCW (cm)	77.8 ± 7.6	NR	NR	65.7 ± 5.0
Nests	8.4 ± 5.8	481	463	69
Observed clutch freq	1.0	NR	NR	1.4 ± 0.7
Inter-nesting interval (days)	unknown	NR	NR	17.2
Incubation (days)	57.2 ± 6.2	NR	NR	53.6 ± 2.5
Clutch size (eggs)	95.8 ± 20.3	123.5 ± 32.3	118.5 ± 39.7	120.4 ± 27.4
Hatching success (%)	86.2 ± 11.5	NR	NR	NR
Emergence success (%)	72.2 ± 16.2	NR	NR	NR

Table 2. Reproductive parameters for green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) nesting at Pom Pom Island, relative to other populations in the region.

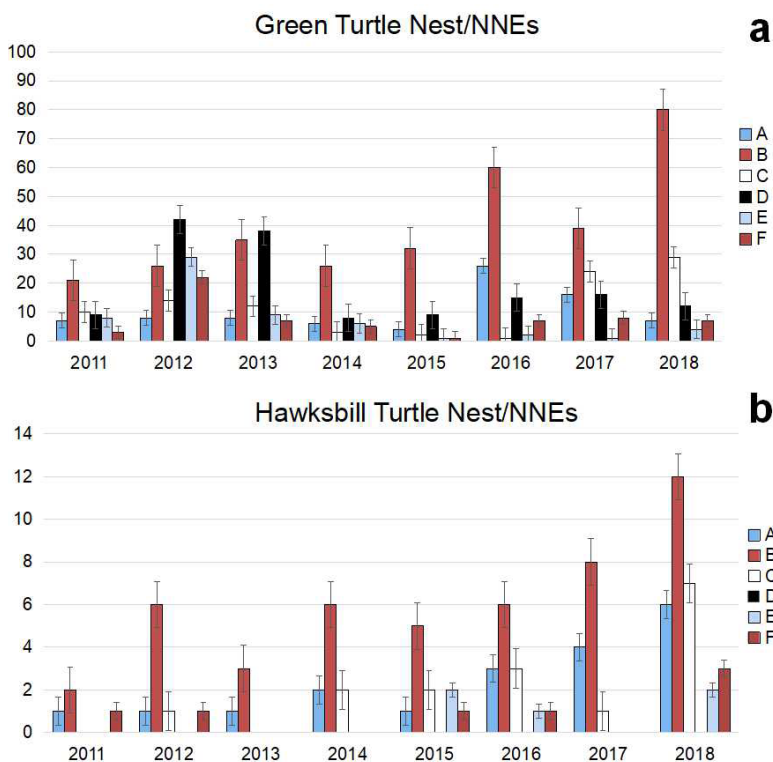


Figure 3. Average number of green turtle (a) and hawksbill turtle (b) nests and NNEs per sector, 2011-2018. Error bars = SD.

turtle nests. Ants impacted 1% of nests. No direct egg poaching or hatchling collection was reported for hawksbill turtles.

The green turtle reproductive demographic parameters estimated in this study are within the ranges established for other green turtle nesting populations in the area (Table 2). The curved carapace length (CCL) range was 85.3-120.0 cm. Within one season, nesters laid a high number of nests, deposited a low number of eggs in each nest, and spent approximately the same period of time in the water between nesting events, compared to nearby populations (Table 2). An inter-nesting interval of 14.5 ± 5.2 days is similar with other studies, such as Ogasawara, Japan (Abe *et al.* 2003). Clutch size is similar to other parts of Malaysia (Pilcher & Basintal 2000), and slightly smaller than those reported in other locations (Table 2).

On Pom-Pom Island, the hawksbill turtle population appears to be significantly smaller compared to other nearby locations (see Table 2). In this study we report a lower number of nesters ($n = 58$), nests ($n = 58$) and NNEs ($n = 37$) compared to other locations such as Pulau Gulisaan (Chan *et al.* 1999) and Melaka (Sarahezad *et al.* 2018). Pom-Pom Island hawksbill nesters appear to be similar in size to those reported in other studies (see Table 2). Clutch size is slightly smaller than values reported in other locations (see Table 2). Over the study period, a slight increase in annual hawksbill turtle nests was recorded. Indeed, in 2018, 21 nests were recorded, accounting for almost 50% of the nests recorded from 2011-2018.

Green turtle nests at Pom-Pom Island incubated relatively quickly and have higher hatching and emergence success relative to other locations. The incubation period is similar to numbers observed in the warm climates of the Philippines and Malaysia (Trono 1991; Pilcher & Basintal 2000), and shorter than those in the cooler climates such as Hawaii and Australia (Limpus 2008; Balazs *et al.* 2015; see Table 2). Hatching success and emergence success

are slightly higher compared to the published values for the region (Trono 1991; Limpus *et al.* 2003; Balazs *et al.* 2015).

Hawksbill turtle nests had longer incubation periods than other locations. The incubation period is slightly higher than nests observed in other warm climates such as Pulau Gulisaan (Chan *et al.* 1999) and Melaka (Sarahezad *et al.* 2018; Table 2). Hatching and emergence success were higher than other locations (Pazira *et al.* 2016). This resulted in more hatchlings being released, giving hope for the sea turtle population of Semporna because newly mature adults can continuously recruit into the breeding population. However, future long-term monitoring programs will be necessary to confirm the positive effects of conservation programs.

The nesting data on green and hawksbill turtles may reflect a benefit of sea turtle conservation efforts and a small increase in the nesting population. Observing a high percentage of new nesters recorded for the first time for both green and hawksbill turtles is expected at the start of any study when new individuals are tagged and/or photo identified. Possible explanations for our lack of observing tagged turtles include: i) newly mature adults continue to recruit into the breeding population; ii) re-migration is regional and not island-specific, as nesters move between several islands (*e.g.*, Matakang, Pandanan or Timba Timba Islands); iii) long re-migration intervals. Given the re-migration intervals known for other sea turtle populations, extreme nesting site fidelity, local knowledge and monitoring of nesting activity

on Pom-Pom Island, and a 20-40 year age at first reproduction, we find the regional re-migration hypothesis most plausible. However, further long-term monitoring studies, extended to neighbor islands are required to analyze in details these aspects. Poaching is currently the greatest threat to these nesting populations. The 3% harvest rate potentially may have been higher without patrol efforts. Hence, on-the-ground monitoring and patrolling with adequate manpower and skills are needed and important to reduce egg poaching.

Information on nesting ecology, population abundance, trends and conservation efforts are critical for conducting population status assessments and to improve direct conservation efforts not only locally, but also regionally. Our 8-year study provides a comprehensive characterization of green and hawksbill turtle nesting populations, filling in those major data gaps in demographic parameters and providing evidence of local conservation efforts, as well as reporting the current impact of poaching. The data reported in this study are promising in light of the previous exploitation of nesting and feeding turtles throughout Semporna District, highlighting the importance of local conservation programs conducted by various stakeholders such as Sabah Wildlife Department and WWF-Malaysia, together with resort operators. Currently, a management body on marine turtle management in Semporna was established in 2014 and information from this study should be shared to create conservation interventions on that island such as management of coastal reclamation and egg poaching.

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First Report of *Herpestes ichneumon* Predation on *Chelonia mydas* Hatchlings in Turkey

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Linnaeus first described *Herpestes ichneumon* (the Egyptian mongoose) on the banks of the River Nile in 1758. The mongoose was subsequently found to be an uncommon inhabitant of cultivated areas of the Nile Valley and Delta, usually near water (Kasperek 1993). In Turkey, the family Herpestidae has only one member, *H. ichneumon* (Kryštufek & Vohralík 2001), currently listed as Least Concern by the IUCN Red List (Do Linh San *et al.* 2016). Researchers have previously reported on *H. ichneumon* from different parts of Turkey (Danford & Alston 1877; Betchold 1940; Alkan 1965; Gülen 1953, 1971; Huş 1967; Kumerloeve 1955, 1965, 1975, 1978; Corbet 1978; Turan 1984; Bosman & Van Den Berg 1988; Doğramacı 1989; Özkurt *et al.* 1998; Gaubert *et al.* 2011; Atay & Yeşiloğlu 2012; Özkurt 2015). The recent occurrence of the species was reported from Hatay, Osmaniye, Adana, and Mersin, in the area between Hatay and Silifke, but the species was not reported between Silifke and Tarsus in Mersin (Özkurt 2015). In Osmaniye, between 2009 and 2011 this mongoose was seen only once, on the move in the morning, by one of the authors (A.H.U.), in the wayside of the exit of Adana-Osmaniye highway. In Turkey, there has been a decrease in the wild population of Egyptian mongoose (Özkurt 2015), and there is a need for tracking programs to protect this animal.

The small Indian mongoose, *Herpestes auropunctatus* (Hodgson 1836), formerly known as *Herpestes javanicus* (E. Geoffroy Saint-

Hilaire 1818; see Veron *et al.* 2007 and Patou *et al.* 2009), is reported to be predator of sea turtles. In the Caribbean, *H. auropunctatus* predation on eggs and hatchlings has been documented on hawksbill sea turtles (*Eretmochelys imbricata*; Small 1982; Nellis & Small 1983; Coblenz & Coblenz 1985; Kontos 1985, 1987, 1988; Leighton *et al.* 2008, 2009, 2010), leatherback sea turtles (*Dermochelys coriacea*; unpubl. study, stated by Eckert & Eckert 1983; Nellis & Small 1983; McDonald-Dutton *et al.* 2000) and green turtles (*Chelonia mydas*; Seaman & Randall 1962). Sea turtle nesting in Turkey has been recorded since 1972 on beaches from Kuşadası to Samandağ (Fig. 1) and surveys of sea turtle nesting within the region have increased since 1988 (Hathaway 1972; Baran & Kasperek 1989; Türkozan & Kaska 2010; Ergene *et al.* 2016a). Mongoose predation on sea turtle eggs and hatchlings had never been reported from any of the nesting beaches of Turkey, until now.

Mongoose are opportunistic foragers (Nellis & Everard 1983) and a review by Leighton (2009) noted that mongooses are best classified as dietary generalists capable of taking advantage of whatever food is locally available, from rodents, arthropods and toads, to garbage and fallen fruit. Nellis & Everard (1983) reported that mongooses are a potential pest to agricultural crops. Mongooses are strictly diurnal and they hunt primarily by sight but they also have a good sense of smell (Hinton & Dunn 1967) and they dig for prey in sand or leaf litter with their clawed forepaws (Nellis & Everard

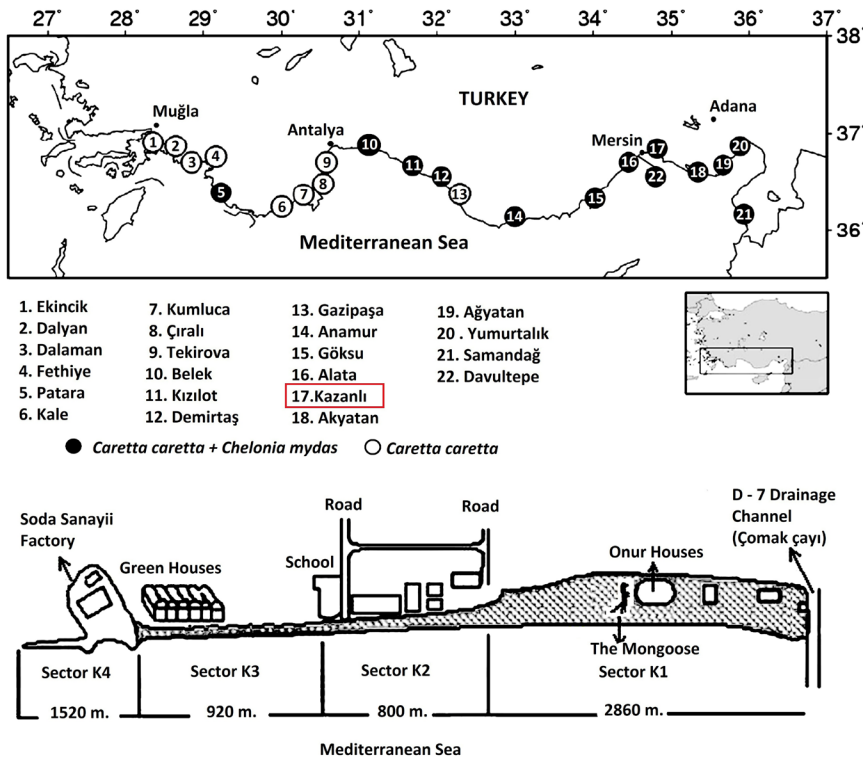


Figure 1. The important nesting beaches for marine turtles in Turkey (modified from Türkozan & Kaska 2010). The bottom panel shows a general view of Kazanlı Beach with its sectors and the back structure (modified from Elmaz & Kalay 2006, not to scale).



Figure 2. In K1 Sector; a general view of the beach toward the D-7 drainage channel (Çomakçayı) in the east.



Figure 3. In K1 Sector; a general view of the beach toward Onur Site in the west.



Figure 4. In K1 Sector; a general view to the west of Onur Site where the mongoose attacked green turtle hatchlings on the sand surface.

1983; Leighton 2005). Nellis & Small (1983) stated that mongooses were seen early in the morning on sea turtle nesting beaches, and even if the hatchling emergence occurred at night, the late emergents and weak stragglers on their way to the sea in daylight would attract mongooses. Predation frequently occurs early in development (Stancyk *et al.* 1980) or close to when hatchlings emerge (Fowler 1979). Olfactory cues from emerging sea turtle hatchlings may attract predators (Carr & Hirth 1961) such as mongooses (Nellis & Small 1983) prior to emergence. Mongooses excavate turtle nests in a limited way and they consume pre-emergent hatchlings near the surface of the sand (Nellis & Small 1983). In the US Virgin Islands, mongooses have been observed attempting to excavate a green turtle nest (Seaman & Randall 1962) and digging at hawksbill sea turtle nests (Small 1982; Nellis & Small 1983). Nellis & Small (1983) stated that mongooses are persistent in their predatory activities when they discover a nest and they can burrow through the openings of mesh wire used to inhibit dog predation. Leighton *et al.* (2008) stated that the predation risk for hawksbill sea turtle nests closely reflected the edge response of small Indian mongooses, with predation being low for nests on the open beach and increasing sharply for nests located within vegetation in the Caribbean. Leighton *et al.* (2008) reported that mongoose predation affected nests laid from 3.4 m within vegetation to 1.5 m onto the open beach.

In Turkey, at Kazanlı Beach, the sea turtle population has been investigated by different research teams since 1988. We started monitoring and conservation studies on sea turtles in 2006 during the nesting season (Ergene *et al.* 2013). These studies continued for eight nesting seasons between 2009 and 2016 (Ergene *et al.* 2015; Ergene *et al.* 2016b; Uçar *et al.* 2018). Egyptian mongoose predation was not recorded on sea turtle nests, eggs or hatchlings in any of the nesting seasons at Kazanlı Beach until the 2013 nesting season. At Kazanlı Beach during the 1993 breeding season, however, 18 green turtle hatchlings were found dead in the K3 Sector; all had been decapitated. Although the mongoose was suspected, the actual predator was not identified. Local people claimed that mongoose existed in Kazanlı (S.H. Durmuş, pers. comm.), but no definite conclusion was ever made. This study reports on the evidence of *H. ichneumon* preying on the hatchlings of *C. mydas* in Turkey for the first time, and fills a gap that existed in the distribution range of this mongoose species.

Kazanlı Beach, designated as a Nature Site area, is one of the most important nesting sites for *C. mydas* in Turkey. A few *C. caretta* also nest in Mersin, along the southeast coast of Turkey (Türkozan & Kaska 2010; Fig. 1). Kazanlı Beach is approximately 12 km from the center of Mersin. At the most eastern end of the beach is the D-7 drainage channel (Çomak, 36.8073 °N, 34.7914 °E) and the



Figure 5. The Egyptian mongoose, *H. ichneumon*, photographed at Kazanlı Beach, Mersin. Date: 02 August 2013 at 06:01 am.

Soda-Chrome Factory (36.8116° N, 34.7289 °E) is at the western end of the beach. The beach is a total of 6.1 km in length (Fig. 1). The suitable part of the beach for sea turtle nesting is 4.7 km long. In previous studies on sea turtle nesting (Coley & Smart 1992; Yerli & Demirayak 1996), Kazanlı Beach was divided into four different sectors (K1, K2, K3 and K4) according to its prominent physical features (Türkozan & Kaska 2010). We used the same sector divisions in the present study (Figs. 1-3). Field surveys were conducted from 26 May to 9 October, in the 2013 sea turtle nesting season at Kazanlı Beach.

On the first day of hatchling emergence at Kazanlı Beach (22 July 2013), seven fresh dead green turtle hatchlings were found during the morning survey, approximately between 07:30-08:00 am. All of them had signs of predation, including bite marks (particularly on their heads), dismemberment and fatal wounds. However, it is possible that the predator consumed whole hatchlings, so the exact number of hatchlings predated was unknown. Additionally, the predator did not appear to have dug up the nest at all. Tracks from a small mammal were found next to the dead hatchlings. A small mammal was spotted about 50 m away from the dead hatchlings, going in the direction of Onur Site before it disappeared (Fig. 4). Although the vegetation was close to this nest, the animal did not run straight away into the vegetation. Instead, it ran diagonally toward the vegetation to the west of Onur Site as the possible escape route. In the following days, this small mammal was seen several more times after dawn in the area in front of the balcony of the research station at Onur Site. All observations were likely of the same animal. Afterward, we tried to photograph the animal on 02 August at 06:01 am, from the balcony. We also photographed this small mammal at a point behind the beach in the vegetation close to the escape point (Fig. 4). We were able to confirm that the animal that escaped the vegetation and the animal in the balcony photograph were the same and that it was in fact an Egyptian mongoose, *H. ichneumon* (Fig. 5).

At Kazanlı Beach, all observed nests are protected with wire-mesh cages to prevent predation by domestic dogs (*Canis familiaris*), which are the main nest predator. Because the predated nest had not previously been documented, it had not been protected by mesh wire during incubation. The nest had not been disturbed by this mongoose

digging either during or after incubation. The location of the nest was recorded as 36.8101 °N, 34.7669 °E. The distance from the nest to the sea was 19.70 m and it was 1.4 m inward from the edge of the vegetation line. Four days after the dead hatchlings were found, we inventoried the nest. The nest contained one live hatchling, one dead hatchling, 82 empty shells (representing hatchlings presumed to have reached the sea) and 19 unhatched eggs (of which 12 were developed). The depth of the nest was 61 cm.

In Kazanlı, the food opportunities for this mongoose include various small animals (*e.g.*, rats) and anthropogenic kitchen waste, which is sometimes discarded in the vegetation to the west of Onur Site by the residents. As a result, mongooses might have been attracted to the area by the discarded food or by the rats attracted to the food waste. Also, in Kazanlı, activities such as planting vegetables in greenhouses are constantly carried out, so these animals might have been attracted by the greenhouse crops. The mongoose attack on hatchlings in Kazanlı Beach has been observed only once during sea turtle monitoring research since 1988. We think that this mongoose does not yet associate sea turtles as a regular source of food. Therefore, we conclude that the mongoose is not currently a threat to sea turtles, and no action needs to be taken to control the mongoose.

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High Number of Healthy Albino Green Turtles from Africa's Largest Population

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Albinism and leucism are two types of color mutations involving color loss producing different phenotypes. There are different definitions of leucism, with some authors referring to it as partial albinism (Rodríguez-Pinilla & Gómez-Martínez 2011; da Costa *et al.* 2013; Erickson & Kaefer 2015). However, true albinos are easily differentiated, because they lack pigmentation and feature red or pinkish eyes, while leucistic animals have reduced/absent coloration but with normal eye pigmentation (Krecksak 2008; Turner 2011).

These mutations are a relatively rare phenomenon but have been reported for many different animal groups (birds: Sage 1962; mammals: Fertl & Rosel 2009; amphibians: Eagleson *et al.* 2010; reptiles: da Costa *et al.* 2013). Reports of albino and leucistic marine turtles refer mostly to hatchlings found in nests during monitoring campaigns. Most of the accounts are of a few individuals per nest, usually associated with other physical abnormalities such as supernumerary scutes or skull deformities (Türkozan & Durmuş 2001; Ibarra & Gasca 2009; Bárcenas-Ibarra *et al.* 2015).

For green turtles (*Chelonia mydas*), these accounts are uncommon but widespread throughout their distribution range (Table 1). The largest number of albino hatchlings reported from a single clutch was of 29 (including dead embryos and dead-in-shell hatchlings), from Juno Beach, Florida (Perrault & Copenrath 2019).

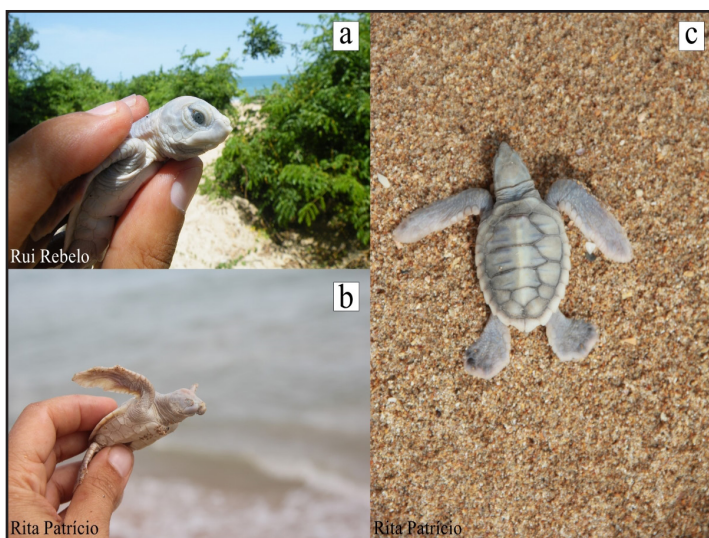


Figure 1. a) Healthy leucistic hatchling found 30 September 2009. Its pigmented eyes and grey body indicate the presence of melanine; b) Malformed leucistic hatchling found 9 October 2014. With a highly deformed skull, this hatchling had a low chance of survival; c) Malformed leucistic hatchling found 3 September 2014 with supernumerary scutes.

Here we report all cases of albino and leucistic hatchling green turtles recorded at Poilão Island, Bijagós Archipelago, Guinea-Bissau. The green turtle population nesting on the Bijagós Archipelago is among the six largest in the world, with 90% of the nesting occurring at Poilão Island, where ca. 29 000 clutches are estimated to be laid annually (Catry *et al.* 2009). This island is protected by traditional taboos and, since 2000, by the João Vieira and Poilão Marine National Park (PNMJVP), a 495 km² protected area that is also part of a Biosphere Reserve and a Ramsar site.

Poilão has been target of annual monitoring campaigns since 2004, organized by the “Instituto da Biodiversidade e das Áreas Protegidas” (IBAP), the governmental institution managing protected areas and nature conservation in Guinea-Bissau. Annually, about 100 randomly selected nests are monitored to obtain estimates of nesting success. These are followed throughout the incubation process until hatchling emergence, and the nest cavity is opened afterwards, or after 60 days in the case of no recorded emergence, to evaluate nest contents.

Like on other sea turtle breeding sites, we have documented unusual colorations among hatchlings during nest excavations. Throughout the years, there have been regular but isolated accounts of leucistic and albino individuals. The first is from 30

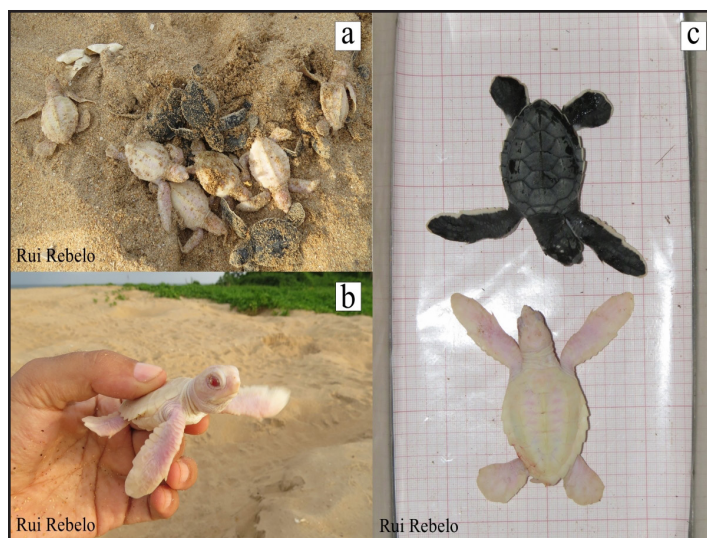


Figure 2. a) Excavation of the nest with 30 healthy albino hatchlings; b) Healthy albino hatchling from the same clutch. The red eyes and pinkish skin indicate the absence of melanin; c) Comparison between an albino and a normal colored green turtle hatchling.

September 2009, when a single leucistic hatchling, with no visible malformations, was found in a clutch of 105 eggs (Fig. 1). The next two accounts were in 2014 (3 September and 9 October), each of a single leucistic malformed hatchling in each clutch. The first presented supernumerary scutes, while the second had a deformed mandible and skull, lacking eyes (Fig. 1).

On 5 October 2018, 30 healthy albino green turtle hatchlings were found in a single nest (Fig. 2). The nest was excavated after 60 days without emergence, having been laid on 5 August 2018, by a 99.5 cm (curved carapace length), 97.5 cm (curved carapace width) normally pigmented female. The female was tagged with two flipper tags (10209 on left front flipper and 10210 on right front flipper) and a PIT tag (977200009430435) in the left shoulder. This female was observed nesting again on the same beach on 18 August and 3 September 2018.

During nest excavation, at 68 cm depth we found 115 live hatchlings and 8 undeveloped eggs with no embryos, comprising a clutch of 123 eggs. This is near the average clutch size at this breeding site (120.3 ± 30.2 eggs, n=98, Patricio *et al.*, 2017). All hatchlings looked healthy and had no visible malformations or scute anomalies, apart from the lack of pigment in the 30 albino turtles (Fig. 2).

We collected all 30 albino hatchlings and a random sample of 30 normally pigmented hatchlings, and used calipers to collect

the following morphometric data, to the nearest 0.1mm: straight carapace length (SCL), straight carapace width (SCW) and shell height (SH) (Table 2). After measurements, a small tissue sample (ca. 5mm x 1mm) from the edge of the carapace was taken from each hatchling for future genetic analysis. All hatchlings were processed <30 min and, afterwards were kept in the shade, inside buckets with moist sand from their nest, and released on the sand near the nest after dark, simulating natural conditions.

The only difference in size was that the albino turtles were significantly wider (larger SCW, $t_{29} = 3.622$, p -value < 0.001, Table 2). Sonmez & Ozdilek (2011) reported that albino hatchlings were bigger than normal hatchlings. This suggests that, in green turtles, albinism may be associated with bigger overall size in hatchlings.

The complete absence of visible malformations on the albinos of such a large clutch makes this report unusual, and the first of its kind for green turtles. Perrault & Coppentrath (2019), who reported a similar case of 23 live green turtle albino hatchlings found in a single nest laid on Juno beach, Florida, found that some albino hatchlings had scute abnormalities (Table 1). The only other published case of a single clutch having a large number of albino hatchlings with no malformations comes from Marcovaldi *et al.* (1995) who reported 22 live albino loggerheads (*Caretta caretta*) from a nest laid in Brazil.

In the context of the Brazilian loggerhead albinos, Godfrey & Mrosovsky (1995) suggested that “if (...) albinism is caused by

Location	Quantity	Mutation	Malformations / Mortality	Date	Reference
Sarawak, Malasia	3	Albinism	All died	1963	Harrisson 1963, cited in Türkozan & Durmuş 2001
Tortuguero, Costa Rica	5 from 14,272 eggs	Albinism	NS	1977	Fowler 1979
North Carolina, USA	1 from 819 eggs	Leucism	NS	1980	Schwartz & Peterson 1984
Florida, USA	1 adult (captive)	Albinism	NS	1980	Joseph <i>et al.</i> 1985
Sri Lanka	9 from 9 different nest	Albinism	7 with abnormal jaws or eyes	1989	Hewavisenthi 1990
Turkey	3 from 3 nests (298 eggs total); 2 found on beach	Albinism	Brain outside skull and double head	1994	Türkozan & Durmuş 2001
Cyprus and Turkey	22 from 1169 eggs	Albinism	Dead in shell; Head and scute abnormalities	2000	Kaska <i>et al.</i> 2000
Poilão, Guinea-Bissau	3 from 3 clutches	Leucism	Abnormal number of scutes and deformed skull and mandible	2009 & 2014	This study
Samandağ, Turkey	2 from a 165 egg clutch	Albinism	Abnormal number of scutes	2010	Sönmez <i>et al.</i> 2011
Yucatan, Mexico	8 from 17,690 eggs	Leucism	NS	2010 & 2012	Bárcenas-Ibarra <i>et al.</i> 2015
Fernando de Noronha, Brazil	2	Leucism	NS	2015	https://tinyurl.com/u8sju6l
Vamizi, Mozambique	4 from one nest	Albinism	2 died	2015	Trindade 2015
Queensland, Australia	1 from one nest	Albinism	NS	2016	https://tinyurl.com/v3pqgsd
Poilão, Guinea-Bissau	30 from 122 eggs	Albinism	None	2018	This study
Florida, USA	23 from 115 eggs	Albinism	Some with scute abnormalities	2019	Perrault & Coppentrath 2019

Table 1. Reported cases of albinism and leucism in green turtle hatchlings, *Chelonia mydas*. NS = non specified.

	Albino (n = 30)		Normal (n=30)	
SCL	49.94 ±0.98	(46.8-52.2)	50.09 ±1.26	(46.2-52.0)
SCW***	42.57 ±0.79	(40.4-44.3)	41.63 ±1.24	(38.0-43.8)
SH	20.14 ±0.61	(18.6-21.2)	20.21 ±0.57	(19.1-22.2)

Table 2. Morphometric measurements (mm) of all measured hatchlings from the clutch reported in this study. Values are presented as mean ±SD (range). SCL = rectilinear carapace length; SCW = rectilinear carapace width and SH = shell height. *** indicates significant difference between groups (see text)

a single locus homozygous recessive allele, a cross between two heterozygous parents would result in 25 % of the offspring having an albino phenotype.” This implies that a clutch with ~25% of albino hatchlings would probably belong to a single father, and possibly to two related parents, and may describe the parental contributions in the two cases of large numbers of green sea turtle albino hatchlings, from Florida (25% albinos, Perrault & Coppenrath 2019) and Poilão Island (24% albinos, this study). Multiple paternity is common in green turtles (Chassin-Noria *et al.*, 2017; Lee *et al.* 2018), and its incidence tends to be highest in rookeries with higher numbers of nests (Lee *et al.*, 2018). The possible occurrence of a single paternity event in a nesting population as numerous as the one in Poilão is not necessarily unexpected, and the frequency of such cases in this population is still unknown. Multiple paternity studies will help to clarify if single paternity is common at this site or a rare event much like albinism.

Apart from the embryo/hatchling stages, albino and leucistic marine turtles are rarely seen in the wild (Fletemeyer 1977, cited in Türkozan & Durmuş 2001; Limpus *et al.* 1979; Restrepo & Valverde 2019). This could be because of the usually associated malformations, or because albino and leucistic individuals are easier to detect by predators (Childs 1953; Krecsak 2008) or unable to survive for long without protective coloration (Wood *et al.* 1999). Still, in 2018 two apparently healthy leucistic adult green turtles nested successfully at Tortuguero National Park in Costa Rica, indicating that it is possible for some of these individuals to reach adulthood (Restrepo & Valverde 2019). Some authors have pointed out that the lack of pigmentation in the retina could hamper the vision and/or seafinding ability of albino individuals (Guillery 1986; Godfrey & Mrosovsky 1995; Perrault & Coppenrath 2019). We did not test this specifically, but when returning them to the sea, we noticed no difference between the albino hatchlings and their normally pigmented siblings: all went straight to the sea.

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Hawksbill Turtle (*Eretmochelys imbricata*) Tagged as a Juvenile in Cuba Observed Nesting in Barbados 14 Years Later

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A hawksbill turtle (*Eretmochelys imbricata*) originally tagged in its juvenile phase in 2005 in Cuba, was observed nesting in Barbados almost fourteen years later (Fig. 1). The turtle was tagged in the right front flipper (R3) with a titanium tag (CB136) by the Fisheries Research Center (CIP-Cuba) Tagging Program, which has been tagging sea turtles on nesting beaches, in hatcheries, and in foraging habitats throughout the Cuban archipelago since 1989 (Moncada 1993). The minimum distance travelled (straight-line distance between tagging and re-capture sites via an at-sea route) by this turtle is greater than previously reported for hawksbills (Meylan 1999; Bjorndal *et al.* 2008; Ordoñez *et al.* 2010), with the exception of the distance travelled by another Barbados nesting hawksbill, who was tagged as a juvenile in Atol das Rocas, Brazil (Santos *et al.* 2019).

CB136 was tagged on 21 January 2005 at Boca de Guano, Cayo Grande (20.9773 °N, 79.1834 °W) in the Jardines de la Reina

Archipelago Reserve (Fig. 1). The turtle measured 37.0 cm CCLn-t (Bolten 1999) or 34.9 cm SCL when first tagged (conversions to SCL based on Bjorndal *et al.* 2016). One year later, on 31 January 2006, the turtle was recaptured at nearly the same location and measured 43.2 cm CCL n-t (40.7 cm SCL). It had grown 5.8 cm in SCL over one year, a rate comparable to that seen in similar sized hawksbills at Monito Cliff Wall in Puerto Rico (Diez & Van Dam 2002). Growth rates for hawksbills in the Atlantic have been found to peak at about 35 cm SCLn-t (Diez & Van Dam 2002; Bjorndal *et al.* 2016), and slow thereafter, with a trend of decreasing growth rate from northern to southern locations in the Caribbean, especially after 1997 (Bjorndal *et al.* 2016).

The Jardines de la Reina Archipelago (Fig. 1) is an important foraging habitat for juvenile and adult hawksbills, and is the primary area of distribution of this species in the Cuban archipelago

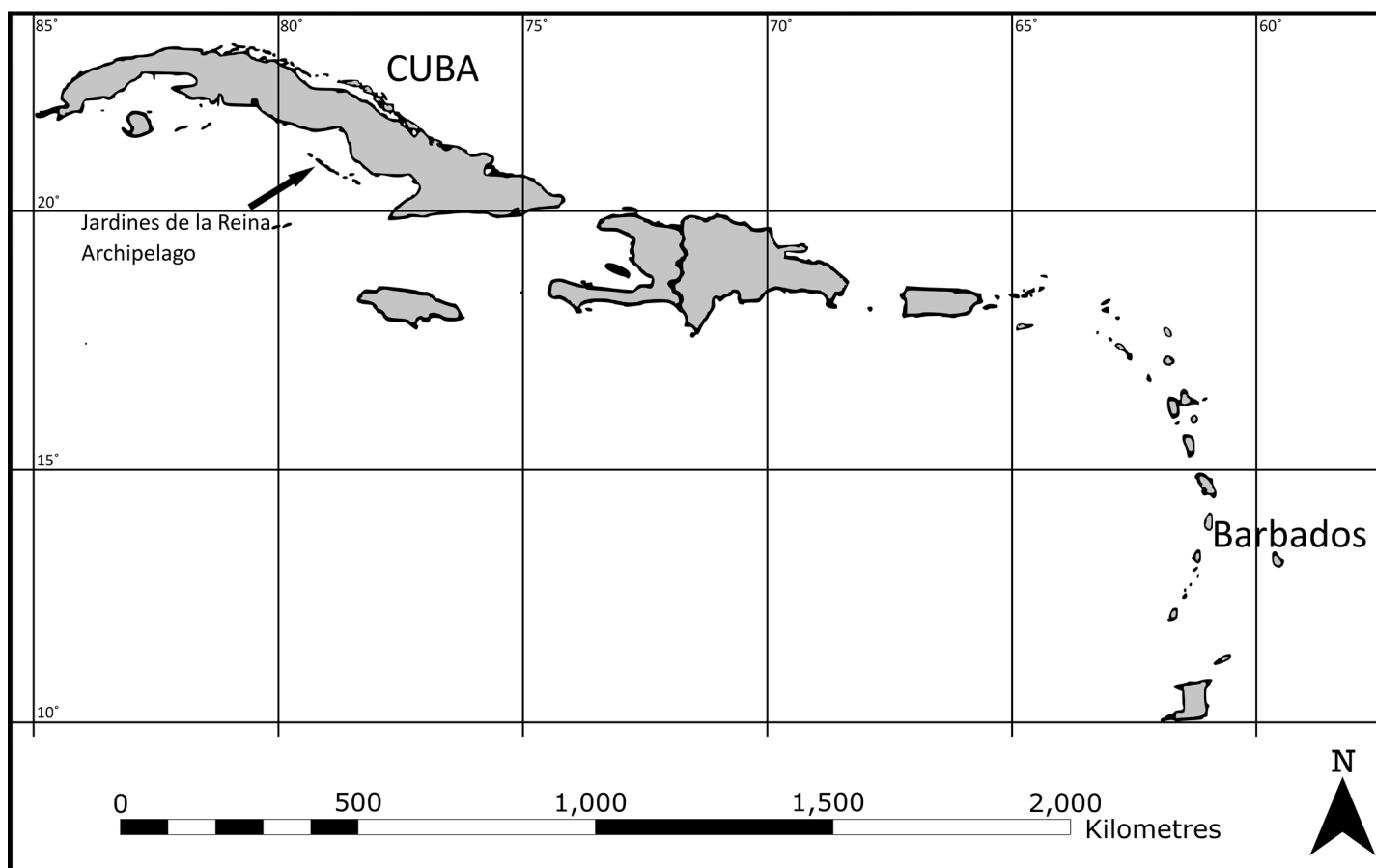


Figure 1. Geographic location of Jardines de la Reina Archipelago, Cuba in the Greater Antilles and Barbados in the Lesser Antilles.

(Moncada *et al.* 1999; Moncada *et al.* 2012a). It is located approximately 50 km off the south-west coast of Cuba (21.1253 °N, 79.4533 °W; 20.5227 °N, 78.3296 °W; Fig. 1). The majority of the islands in the archipelago have sandy beaches, interior lagoons, and abundant coral reefs and form the Doce Leguas Cays and Labyrinth. The reserve harbors important and well-developed fringing reefs mainly in the south of the cays, offering suitable foraging habitat for juvenile and adult hawksbills. Furthermore, the beaches of the cays are important nesting areas for the species (Moncada *et al.* 2010).

CB136 was observed in Barbados following nesting on 20 August 2019 at Drill Hall Beach (13.0774 °N, 59.6082 °W) on the south-west coast of Barbados (Fig. 1), where more than 150 hawksbills nest each year (Beggs *et al.* 2007). This 1.3 km coral sand beach is the national hawksbill index beach and all-night (8 pm-4 am) surveys are conducted by the Barbados Sea Turtle Project between 01 June and 30 September each year (Beggs *et al.* 2007). CB136 returned to the same beach and attempted to nest on 02 September 2019 (13.07723 °N, 59.60784 °W), but was unsuccessful. She returned the following night and nested (13.0772 °N, 59.6077 °W), after digging four body pits. She was also seen nesting a few hundred meters east of Drill Hall at Palm Beach on 29 September 2019 (13.07567 °N, 59.60385 °W) and 12 October 2019 (13.07565 °N, 59.60318 °W). The latter nest was her fifth for the season, assuming that the one in mid-September was not observed.

The time interval between the second date of observation in the Jardines de la Reina Archipelago and her first emergence to nest in Barbados was 13.6 years. The turtle measured 91.5 cm CCLn-t (85.8 cm SCL) in Barbados, indicating a growth of 50.9 cm SCL since her initial observation in Cuba in 2005, and 45.1 cm SCL since the subsequent observation in 2006. Using the 2006 measurement, this suggests a growth rate of about 3.3 cm/yr prior to her nesting in Barbados. CB136 made several body pits before nesting on the first occasion and left the beach at least once before making the second observed nest. New recruits on the nesting beach often take longer to lay their eggs, making multiple body pits and nest cavities. Her marginal scutes were described as sharply serrated, a characteristic often seen in untagged nesting females emerging on the index beach for the first time (Beggs *et al.* 2007). Two additional tags were placed on the turtle, WX 0300 (L1) and WX 0301 (R1).

Hawksbill turtles tagged as juveniles in the Jardines de la Reina Archipelago have previously been recaptured at sea in Nicaragua and Colombia (Moncada *et al.* 2012b). No hawksbill tagged in Cuba as a juvenile has subsequently been observed as a nesting adult prior to this report, so this record represents an important event that corroborates hypotheses about the biology of this species in the Caribbean region. Genetic studies by Browne *et al.* (2009) showed that both the windward and leeward Barbados hawksbill rookeries contributed to developmental aggregations at foraging grounds around the Caribbean, including Cuba. Furthermore, two adult females tagged while nesting in Barbados were recaptured in Cuban waters; one south of Isla de la Juventud and one south of Santiago de Cuba (Moncada *et al.* 2012b). Not only are hawksbills from Barbados found on foraging grounds in Cuba, but genetic analysis of juvenile hawksbills on Barbados foraging grounds indicates contributions from the Cuban rookery (Abreu-Grobois *et al.* 2006). This report of a juvenile female tagged during its development on the Cuban shelf and later nesting in Barbados, further supports the connectivity between the hawksbills of Cuba and Barbados.

This record also provides information relevant to sexual maturation in this species. The hawksbill grew to sexual maturity 13.6 years after being tagged as a 40.7 cm SCL juvenile in Cuba. A juvenile hawksbill tagged in the Bahamas at 45.1 cm SCL was observed nesting in Tobago 9.4 years later (Bjorndal *et al.* 2008), and a 26.1 cm SCL juvenile tagged in Puerto Rico nested in Panama 14.9 year later (Ordoñez *et al.* 2010). In the absence of data on growth rates during the epipelagic phase and prior to the first time each of these animals was first tagged, it is impossible to confirm age at maturity, but together the data suggest that females may take a minimum of 20 years to mature (Meylan & Donnelly 1999; Van Dam & Diez 2002), or perhaps less, but confirmation of the latter requires a more complete understanding of growth rates in different habitats and the length of the epipelagic stage in this species.

This first report of a hawksbill turtle tagged in its juvenile phase in Cuba and observed as a nesting adult in Barbados, confirms the connectivity between nesting beaches and foraging grounds in the Caribbean, and underscores the significance of regional collaborative efforts to manage and conserve this species in the Wider Caribbean.

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ANNOUNCEMENT

Tribute Celebration for Dr. Peter C.H. Pritchard (6.26.1943 - 2.25.2020)

Our sea turtle community was saddened to learn of the passing on 25 February of one of our great mentors and sea turtle scholars, Dr. Peter C.H. Pritchard. A tribute celebration of Peter will be held on Earth Day, 22 April 2020 at 4 pm at the Dr. Phillips Center for the Performing Arts, 445 South Magnolia Ave, Orlando, FL 32801. Friends, colleagues and the public are welcome to attend this special event to honor Peter. Further details will be posted to the CTURTLE listserv in the coming weeks.



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Emma and Carrie Dlutkowski practice taking curved carapace width measurement on a leatherback snow sculpture. Photo by Susan Dlutkowski.

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