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NOTE

Evidence of regression of fibropapillomas in juvenile green turtles *Chelonia mydas* caught in Niterói, southeast Brazil

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ABSTRACT: Fibropapillomatosis is a disease characterized by cutaneous tumors affecting all marine turtle species, but mostly *Chelonia mydas*. The disease was first reported in 1938, and since then, the number of sightings has been increasing over the years. This disease can cause many complications in the affected animal and can lead to death, and is thus included in the many threats to marine turtle populations. It is still not known for certain what causes this disease, although many studies indicate a herpesvirus as the main etiologic agent. The incidence of fibropapillomatosis is rarely reported in adults, leading to speculations that there may be a cure for the disease or that the animals die before reaching adulthood. In this paper, 2 cases of fibropapillomatosis regression are reported from juvenile *C. mydas* caught between July 2008 and July 2010 in the coastal zone of Itaipu, Niterói, Rio de Janeiro, Brazil. These individuals were identified photographically upon recapture. One individual had a total regression (disappearance) of external papilloma within 164 d between first capture and recapture, and the other individual had a partial regression (decrease in size) observed within 13 to 188 d of recapture. The mechanism that triggers the regression is still unknown but is likely to be an immune system response or removal of the tumor promoter. There are few reported cases of regression in the world, and constant monitoring through mark–recapture is necessary to assess whether the marine turtles affected by this disease have real chances of survival.

KEY WORDS: Sea turtle · Disease · Reptiles · Tumor · Photo-identification · Conservation · Pollution

INTRODUCTION

Fibropapillomatosis is a disease characterized by the development of single or multiple skin tumors, with varied size, shape, and color, occurring externally or internally in the animal (Balazs & Pooley 1991, Herbst & Klein 1995). The tumors can become large enough to interfere with locomotion, occlude vision, impair other vital functions when they afflict internal organs, and, consequently, contribute to the death of the animal (Aguirre 1991, Herbst 1994).

Fibropapillomatosis was first reported in 1936 in a green turtle from an aquarium in Florida, USA (Smith & Coates 1938). Since then, reports of this disease have been increasing, reaching present prevalence rates of 92% in some populations of this species (Herbst 1994). Furthermore, the occurrence of fibropapillomatosis has been recorded in all marine turtle

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species, but at lower frequency (Harshbarger 1991, Aguirre et al. 1999, D'Amato & Moraes-Neto 2000, Huerta et al. 2000).

Although studies in the last 20 yr are not conclusive, several researchers (e.g. Jacobson et al. 1991, Greenblatt et al. 2005) have suggested that the herpesvirus group is the most likely etiological agent of fibropapillomatosis (Lu et al. 2000, Stacy et al. 2008), whereas others did not find papillomaviruses associated with the fibropapillomas (Brown et al. 1999). Even so, other secondary causes may contribute to the development of the disease, such as parasites, genetic predisposition, stress, immunosuppression, increased exposure to ultraviolet radiation, exposure to carcinogenic chemicals, or bacterial agents (Aguirre 1991, Romero et al. 2008).

Most cases of fibropapillomatosis in marine turtles were recorded in areas close to large urban centers, indicating that there may be a positive relationship between the prevalence of this disease and human activity (Herbst 1994, Aguirre & Lutz 2004). Some comparative studies found a higher prevalence of the disease in coastal and estuarine areas in relation to oceanic regions (Hirama & Ehrhart 2007).

Fibropapilloma regression cases have been reported since the 1990s (Herbst 1994, Hirama & Ehrhart 2007), but records are limited, as such observations stem from the continuous work of capture and recapture of sick specimens. The biological mechanism that triggers the regression is still unknown. However, as fibropapillomatosis is caused by an infectious agent, a natural response by the marine turtles immune system has been identified as the putative cause of the regression (Lin et al. 1993, Aguirre et al. 2000, Herbst 2000).

MATERIALS AND METHODS

The regression cases described in the present study were identified in incidentally captured marine turtles during weekly monitoring of the beach seine fisheries on the coastal region of Itaipu, situated in the city of Niterói, Rio de Janeiro state, Brazil (22° 53′ 14″ S, 43° 22′ 48″ W), during the period between July 2008 and July 2010.

We examined all captured turtles and recorded lesions or injuries, visible fibropapillomas, and anomalies, measured size and weight, and then tagged and promptly released the animals back to the sea. In addition, each individual's head, carapace, and plastron were photographed, to compile an image database for photographic identification of captured turtles. This method has been validated, and due to its reliability it is recommended and has been regularly used for individual identification (Reisser et al. 2008, Schofield et al. 2008). We used the parietal and interparietal scales of the head to perform the identification, producing similar results. The photos were compared between the same individuals captured and recaptured to check the new occurrence of fibropapillomas or increase in their size and presence of regression.

RESULTS

In total, 131 marine turtles were captured during the study period, all identified as *Chelonia mydas* juveniles (Sanches & Bellini 1999) with a mean ± SD curved carapace length of 44.8 ± 13.2 cm. Adult individuals are larger than 75 cm (Bjorndal & Bolten 1988). Forty specimens had visible fibropapillomas, resulting in a prevalence rate of about 31% of affected marine turtles at the Itaipu study area.

Of these total captured turtles, 28 individuals (21.4%) were recaptured within a minimum of 13 and maximum of 283 d between capture and recapture. Of these recaptures, 8 (28.65%) had fibropapillomatosis and 5, with no visible fibropapillomas on their first capture, showed signs of developing the disease on the second, as external tumors were found that had not been registered before.

Later, through the analysis of the database and photographs, it was possible to demonstrate that 2/8 individuals (25%) with fibropapillomatosis at first capture showed signs of tumor regression upon recapture. Both individuals had tumors in the soft tissue on the back of the neck. The second turtle also possessed tumors located inguinally and ventrally on its posterior flippers. The first turtle showed total regression (disappearance) of the papilloma 164 d after being recaptured (Fig. 1), whereas the other showed considerable partial regression (decrease in size) of papilloma at intervals of 13 and 188 d (Fig. 2).

DISCUSSION

The use of a photographic catalog in this study enabled us to record 2 cases of fibropapillomatosis regression in juvenile marine turtle specimens. This procedure is very useful in identifying these regression cases, since the main technique used to identify regressions involves subsequent measurements of the tumors of recaptured individuals and establish-

Fig. 1. *Chelonia mydas.* Individual with total regression of a tumor situated on the dorsal region of the neck. White circles show the fibropapilloma on 3 occasions: A1: first capture; A2: first recapture (after 22 d); A3: second recapture (after 164 d) demonstrating total regression of the tumor

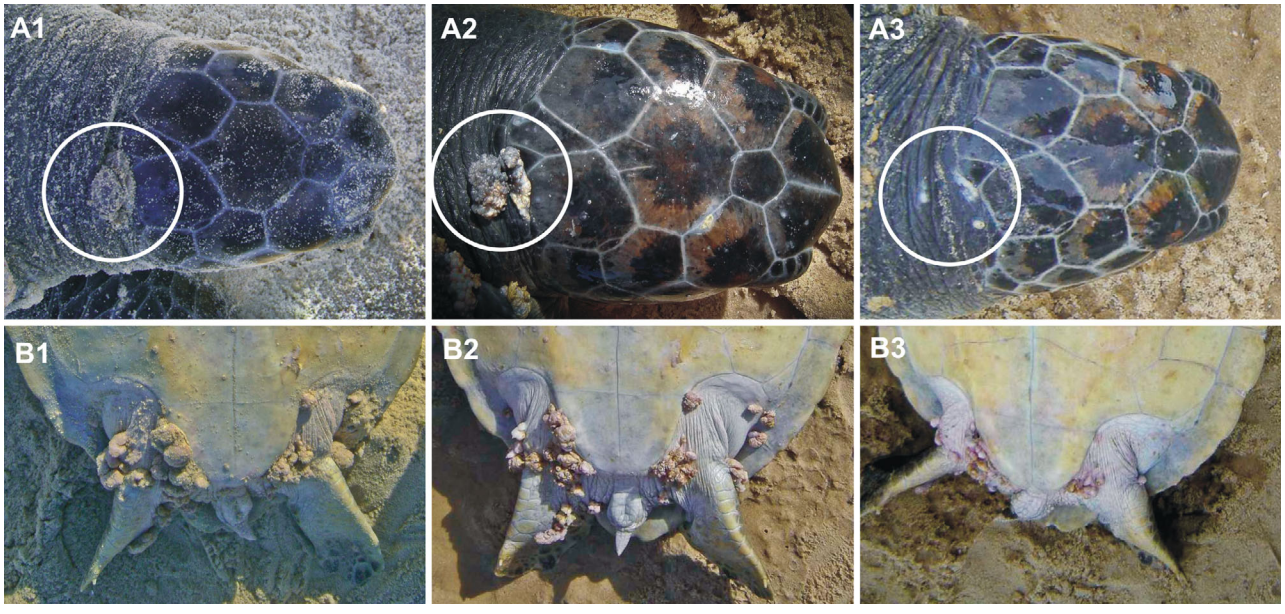

Fig. 2. *Chelonia mydas.* Individual demonstrating (A) the total regression of a tumor on the neck and (B) partial regression of tumors in the inguinal and ventral region of the posterior flippers. White circles show the fibropapillomas in 3 stages: A1 and B1: capture; A2 and B2: first recapture (after 13 d); A3 and B3: second recapture (after 188 d)

ing a score classification by comparison (Bennett et al. 1999, Hirama & Ehrhart 2007, Torezani et al. 2010). This procedure combined with photography creates a valuable tool in the detection of these cases and greater accuracy in evaluating the degree of development or regression of tumors in relation to the lifespan of marine turtles.

As the cause of disease is still uncertain and the chance of cure has not yet been evaluated for marine turtles, many speculations are made based on previous studies. Two main hypotheses have been proposed for fibropapilloma development: (1) the infection phase occurs after the recruitment of individuals when they migrate to neritic habitats, or (2) the infection is uniform among marine turtles, but the development of the disease depends on environmental factors (Herbst 1994, Herbst & Klein 1995, Ene et al. 2005). The mechanism that causes the regression is also unknown, but has been verified by the removal of the tumor promoter, since the development of the disease is primarily caused by an initiating agent, such as herpesvirus, in the presence of a natural promoter. Recently it was shown that the cyanobacterium *Lyngbya majuscula* is a potential tumor promoter; this bacterium is associated with foraging habitats of marine turtles, especially *Chelonia mydas*, the species most affected by the disease (Arthur et al. 2008).

Fibropapillomatosis associated with a herpesvirus is commonly found in various reptiles such as snakes, lizards, freshwater turtles, and tortoises from desert environments, in which all turtle species are considered more susceptible to severe infection (Wellehan & Johnson 2005, Schumacher 2006). The presence of fibropapilloma may not be necessarily linked to herpesvirus but also to other types of viruses such as those found in pigs, horses, cows, humans, and other mammals (Nishiyama et al. 2011).

Adult turtles are likely less affected by fibropapillomatosis, as most reports have been made for juveniles (Raidal 1996, Foley et al. 2005). The absence of fibropapillomas in adults could be determined by a combination of the following: a debilitation of the function of the disease, mortality of the specimens before they reach adulthood, and/or the regression of fibropapillomas (Ehrhart 1991). A case of regression reported in Hawaii showed that a majority of adult individuals were mildly affected, which may indicate that the disease mostly affects juveniles, causing them to die before reaching adulthood (Bennett et al. 1999). In our study, regression was observed in juveniles, which leads us to conclude that regression occurs in both phases of development, although it is still not known in which developmental stage the disease was contracted.

Continuous captures and recaptures in all maturing stages are extremely important for monitoring the life status of the sea turtles. Further studies are needed to determine whether sea turtles affected by this disease can survive and what measurable degree of survival is possible.

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