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Marine Turtle Fibropapillomatosis: Hope Floats in a Sea of Ignorance

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It has been 60 years since the occurrence of fibropapillomatosis (FP) in marine turtles was first reported in the scientific literature (see Herbst 1994) and yet only in the past 10 years, as FP has become recognized as a growing threat to these endangered animals, has significant effort been focused on trying to understand the nature of this disease. Yet in this relatively short period of time a tremendous amount of progress has been made toward understanding the cause of this condition, and it is my hope that such progress can continue. Much more, however, remains to be learned about this disease before practical and effective management strategies can be developed and each answer unleashes a cascade of new questions that must be addressed. This presentation reviews what has been learned about FP from observation and experimental studies in order to establish a foundation upon which to frame future studies and management plans.

Most of what we can say conclusively about FP has been gained from a series of experimental transmission studies in green turtles (*Chelonia mydas*). We know from these controlled experiments that FP is a transmissible disease and that tumors contain an infectious agent that can be transmitted to other turtles through skin injection or scratch inoculation (Herbst *et al.* 1995). We know that this agent is very small, is found in the cell free (filterable) fraction of tumor tissue homogenate and that it is inactivated by organic solvents, which strongly suggest that the causative agent is an enveloped virus (Herbst *et al.* 1996b). We also have observed in two cases, spontaneous horizontal transmission from tumor-bearing turtles to naive turtles following co-housing involving extensive physical contact.

These transmission experiments also have implicated a novel tumor-associated herpesvirus in the disease, since herpesvirus replication and shedding was detected in tumors of donor animals and in experimentally induced tumors (Herbst 1994, Herbst *et al.* 1999). In addition, all turtles that developed experimentally induced tumors also developed anti-herpesvirus antibodies (seroconversion) (Herbst *et al.* 1998). The association of this herpesvirus with FP has been confirmed by PCR in a number of studies (see Herbst *et al.* 1999). This herpesvirus remains the main candidate for the etiology of FP and since my first reports of these findings and preliminary genetic analyses of this herpesvirus (Herbst *et al.* 1996a) a number of independent laboratories have focused their efforts on trying to isolate and characterize this virus further. Transmission of FP with purified virus remains the only one of Koch's postulates that must be fulfilled to prove that this virus is the etiologic agent of this disease.

It is evident from experiments that apparently healthy individuals are susceptible to infection and that they need not be debilitated or immune suppressed to develop tumors. It is my opinion that a virus, perhaps the FP-associated herpesvirus, is necessary and sufficient to cause FP in marine turtles. This conceptual model, however, does not preclude the involvement of a variety of cofactors in modulating the severity of the disease and affecting whether or not individuals recover or succumb to it (Herbst and Klein 1995).

If this model of FP as a viral infectious disease is accepted, then the questions that become important in developing practical management strategies to limit the impact of this disease relate to understanding the ecology of this virus. For example, whether or not the virus is shed continuously or intermittently from infected turtles or their tumors, whether or not virus can remain infectious for long periods in the environment outside the host, and whether or not there is an environmental or biological reservoir other than turtles, have tremendous implications for the success of control strategies that rely on isolation or removal of turtles with FP. Ultimately, it may be found that there is no practical way to manage this disease in wild populations short of widespread vaccination.

The prospect that it is impractical to control this disease in wild populations or that the opportunity to bring it under control has been lost, now that it is pandemic (Herbst 1994), must lead us to ponder the long term impact of this pandemic on marine turtles species. Here again, we lack sufficient epizootiologic data, information about the behavior of this disease in populations to generate predictive models. We know that this disease kills some turtles outright and we also know that some turtles recover. We also know that the disease course is prolonged and that, while they are affected with FP, turtles are more susceptible to other mortality factors such as predation, entanglement, and starvation. The long term effect of this pandemic on these endangered populations will depend upon the relative balance between the increment in mortality rate caused by FP and the recruitment rate of individuals to the breeding population, and may not become apparent for several more decades. While this prolonged wait may be discouraging, there is reason to hope that in this time we will continue to learn and eventually gain sufficient understanding of the pathogenesis and epizootiology of this disease to take effective action if required and that it will not be too late.

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Incidence of Fibropapillomas in the Green Turtle (*Chelonia mydas*) in Cuban Waters

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The incidence of fibropapillomas in green turtles in the Cuban shelf quantified between 1983 and 1996. Of the 3390 turtles sampled from the fishery, 20 (0.6%) had visible tumours. Fibropapillomas were mainly found on the neck, eyes and flippers. Affected animals were detected each of the four Cuban fishery zones (northeast, northwest, southeast, southwest). Turtles from 55 to 102 cm SCL were recorded with tumours. A high proportion of affected animals were females, reflecting the sex ratio in the population as a whole.

Introduction

Fibropapillomas in green turtles (*Chelonia mydas*) has been reported from different parts of the world (e.g. Balazs, 1991; Ehrhart, 1991; Limpus and Miller, 1994; Lagueux *et al.*, 1998; Sola *et al.* 1998). In Cuba, fibropapilloma has been noted on green turtles since the mid-1980s, and were called "tumours" or "warts" by fishermen. In this paper, we present data on the frequency of fibropapilloma in green turtles in the Cuban shelf, which will serve to broaden our knowledge on the geographical distribution of the disease.

Materials and Methods

The presence of fibropapilloma on green turtles taken in the turtle fishery at 14 sites throughout the Cuban shelf was recorded, between 1984 and 1996. The location of the fibropapilloma on the body was recorded, along with straight carapace length (SCL), straight carapace width (SCW) data, bodyweight and sex of the animals. A total of 3390 green turtles were examined over the 13 year period. Location and date of capture of turtles were also recorded.

Results and Discussion

A relatively low incidence of fibropapilloma was recorded, with only 20 turtles (0.6% of turtles examined) showing visible external signs of the disease. The first case was recorded in 1985. Ten (50%) of the cases were recorded in 1985 and the remaining cases were from 1986 (4), 1987 (1), 1988 (2), 1990 (1), 1992 (1) and 1994 (1).

Affected animals were recorded in each of the four Cuban fisheries zones, from transit zones (northeast coast), nesting [e.g. Doce Leguas Keys (southeast), Cayo Largo del Sur (southwest)] and foraging grounds (southeast).

Of the 20 affected turtles, 12 (60%) had lesions on only one region of the body, 7 (35%) on two regions and 1 (5%) on three regions. The highest incidence of fibropapilloma was found on the neck (N= 10; 50% of turtles), eyes (N= 8; 40%) and flippers (N= 7; 35%). Other affected areas included the tail, axillary and groin regions (5% each respectively). The exact region of the body for one lesion was not recorded. Tumors were measured in 7 cases, and ranged between 3 and 22 cm in size.

The smallest turtle with tumours was 55 cm SCL, and the largest was 102 cm SCL (**Fig. 1**). Sampling did not include turtles less than 50 cm SCL, and was directed towards larger individuals. Due to the limited number of affected turtles, it is not possible to draw conclusions on the relationship between incidence of tumours and turtle size. However, fishermen have reported seeing small individuals with tumours in lagoons west of Doce Leguas, and so it is reasonable to assume that turtles of even small size classes can be affected. With regard to sex, 18 (90%) of the affected

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