

The Disease¹

Green turtles develop fibropapilloma that are lobulated tumors on the skin of the axillary and inguinal regions, between scales and scutes, in the mouth, on the viscera, and on the conjunctiva and corners of the eyes. These lesions are initially small, local lesions that can grow to 30 cm or more in diameter. The tumors interfere with the hydrodynamic features of the afflicted turtle, making swimming more difficult. If the tumors are located around the mouth or eyes, the turtle may have difficulty eating, breathing, or seeing. It is not uncommon for the eyes to become totally occluded, resulting in blindness. As such, this disease is not only a cosmetic problem but also reduces and, in many cases, eliminates the turtle's ability to survive.

The lesions have been classified as fibropapilloma based on established morphologic criteria for tumor classification in domestic animals. The lobulated pattern observed at the gross level consists of thick, papillary (finger-like) projections above the level of the skin or mucous membrane. If these lesions

¹This section is based on a contribution by J. P. Sundberg.



Figure 3.--A canine cutaneous papilloma demonstrates the exophytic papillary pattern of proliferating epithelial cells on thin fibrovascular stalks. (Reprinted with permission from Vet. Pathol. 25:67-71.)

become traumatized, the surface will become smooth and often becomes necrotic and bloody. Histologically, these tumors consist of mild-to-marked epidermal proliferation that covers a dense mass of well-vascularized, fibrous connective tissue. The diagnostic term fibropapilloma comes from the papillary pattern of the early lesion and the predominance of fibrous connective tissue. Recently, herpes-like intranuclear inclusions have been seen within tumor epidermal cells, and electron microscopy confirmed the presence of a herpes virus. Trematode eggs are also often found within vessels in the connective tissue component. As more tumors are examined, additional primary and secondary processes likely will be observed.

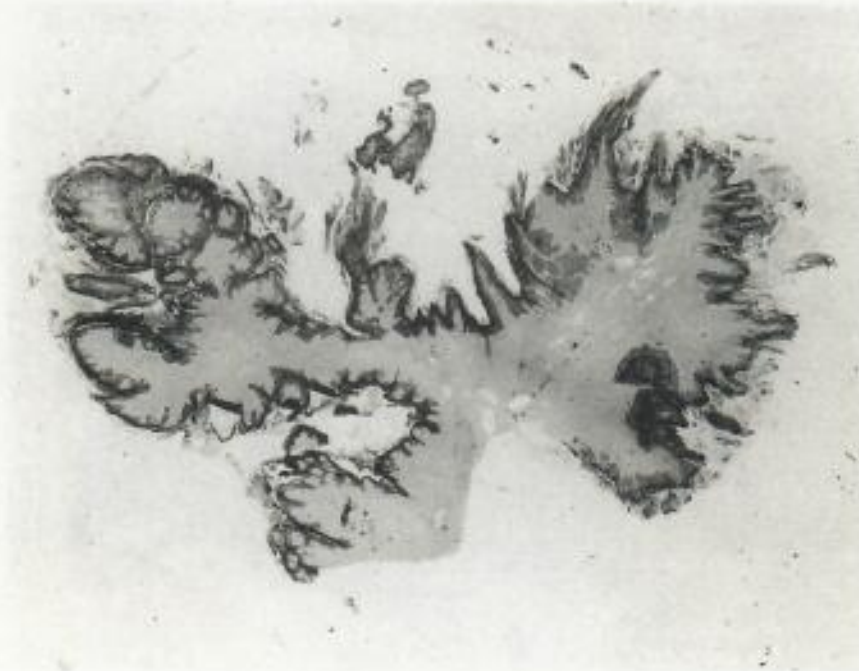


Figure 4.--A mule deer fibropapilloma has projections that are wide because of the proliferating fibroblasts in the supporting systems. (Reprinted with permission from *Virus Diseases in Laboratory and Captive Animals*, Darai, G. (editor), Matinus Nijhoff Publishers, Boston, 1988.)

The fibropapilloma of the skin and conjunctiva have a benign appearance based on criteria used for mammalian tumors. There is no evidence of vascular invasion or high mitotic activity. Yet a number of animals with superficial lesions have been found to have multiple visceral (internal) lesions when complete necropsies have been performed. Whether the visceral lesions are truly related to the external disease, or are an independent process, has yet to be determined.

Morphologically, and presumably biologically, similar lesions are found on terrestrial mammals (Figs. 3-5). Variation

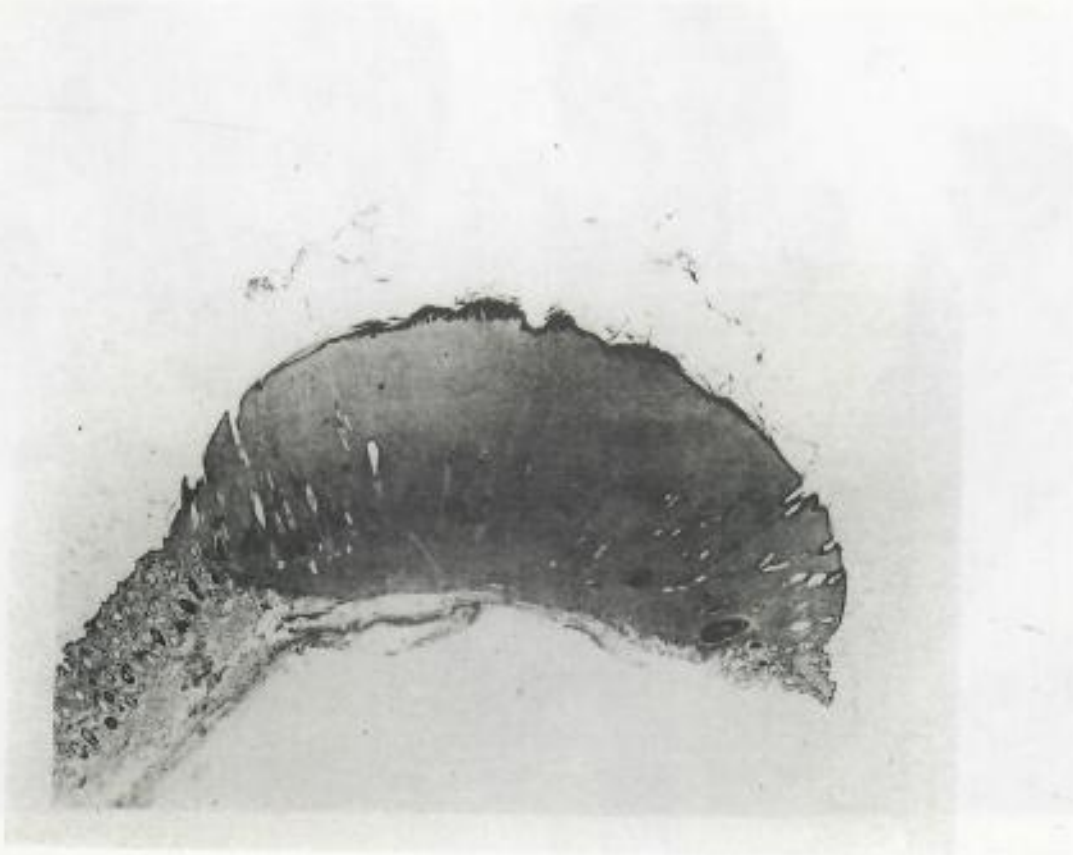


Figure 5.--A white-tailed deer fibroma has mild epidermal proliferation covering fibrous connective tissue proliferation. (Reprinted with permission from *Virus Diseases in Laboratory and Captive Animals*, Darai, G. (editor), Martinus Nijhoff Publishers, Boston, 1988.)

in the diagnostic terms refers to the relative degree of the epidermal component of the tumor versus the dermal or fibrotic component. Many mammals develop papillomas. These tumors consist of proliferation of stratified squamous epithelium in a papillary pattern on thin fibrovascular stalks to support the epithelium. When the fibrovascular stalks become thickened with the proliferating fibroblasts, the tumor is termed a fibropapilloma. If no papillary pattern is present and the tumor consists almost entirely of connective tissue, it is termed a fibroma. Malignancies of the squamous epithelium are called squamous cell carcinomas. Fibrosarcomas are malignancies of the



Figure 6.--The green turtle fibropapilloma resembles fibropapillomas or fibromas of terrestrial species. (Reprinted with permission from J. Comp. Pathol. 101:39-52.)

fibroblasts. Green turtle tumors most closely resemble fibropapilloma (Figs. 6 and 7). Whether these tumors are true neoplasms or hyperplastic responses will be one of the objectives of future research projects.

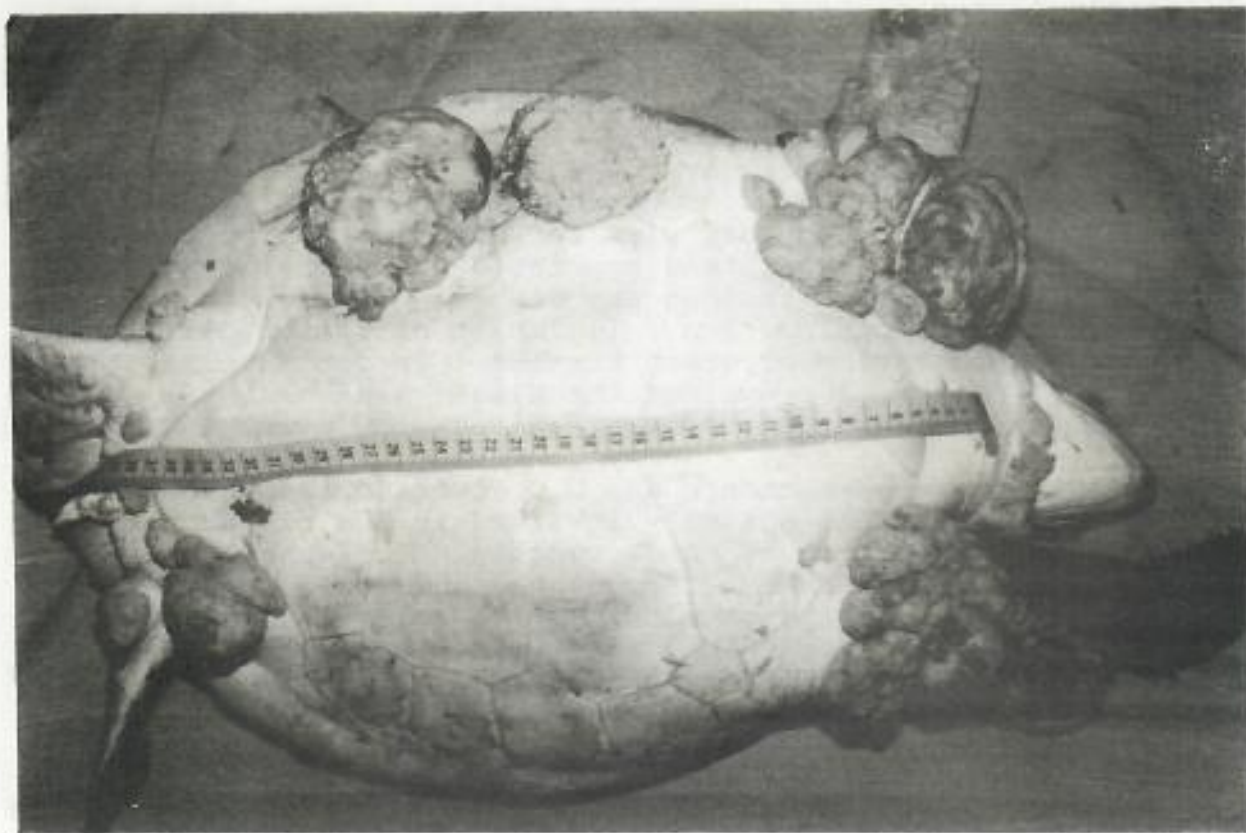


Figure 7.--The green turtle fibropapilloma resembles fibropapillomas or fibromas of terrestrial species. (Reprinted with permission from J. Comp. Pathol. 101:39-52.)

EXECUTIVE SUMMARY

Problem

Green turtles, *Chelonia mydas*, develop lobulated tumors (fibropapilloma) on their skin, scales, scutes, eyes and surrounding tissues, oral cavities, and viscera. The cause of this disease is unknown, but it has increased to epidemic proportions in the past few years in areas as far apart as Florida and Hawaii. The disease represents a significant threat to the survival of this protected marine turtle species and is cited as the top priority research issue in the draft *Hawaiian Sea Turtle Recovery Plan*.

Objective

The overall objective of this research plan is to determine the cause of fibropapilloma, thereby ultimately leading to solutions and effective strategies for containment. The urgent need to solve this problem arises from the unanimous belief among the workshop participants that this disease will continue to affect populations of turtles locally and worldwide, adding further to their survival difficulties.

Planning Framework

The Marine Turtle Fibropapilloma Disease Workshop in December 1990 was sponsored by the Honolulu Laboratory, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA. Scientists from across the country met to discuss their research and to propose activities that could identify a solution to the disease. With an interactive planning methodology, this research plan was prepared as a first step in developing a comprehensive research strategy on marine turtle fibropapilloma. No formal organization of these researchers exists, but individual researchers and their agencies may use this research plan as a framework for research coordination.

Recommendations

The research plan recommends a 5-year schedule of activities to make substantial progress toward finding the cause of marine turtle fibropapilloma. The estimated cost of this research program is US\$2.7 million with \$510,000 in the first year. Implementing any resulting solutions would require additional funding.

The most promising avenues of investigation are the isolation and identification of either a virus or parasite in association with the disease. Most of the research to date has been on incriminating a virus by using some of the latest technology in attempting to identify the etiologic agent. Additional research

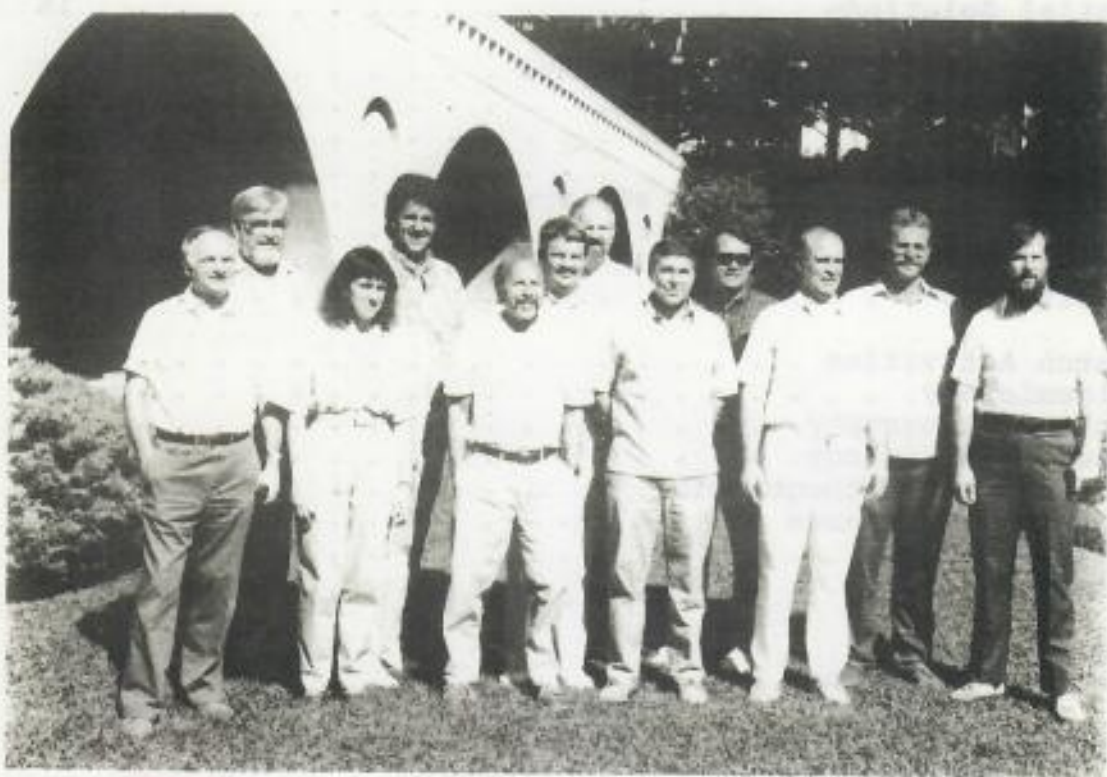
has occurred on the impact of trematode parasites. Some other possible causes are pollutants, changes in natural environments or habitats, and weakened immune systems. A full epidemiological investigation of the disease also is required. However, work on studying the transmission mechanisms is extremely difficult because so little is known of the complete life cycle of marine turtles and because experimental work on threatened and endangered species has been extremely limited.

Intermediate management programs may be initiated before the exact causal mechanism is discovered: rehabilitation of afflicted turtles through removal of tumors, vaccination of turtles, treatment of turtles with anthelmintics, or removal of afflicted turtles from their populations. Treatment of wild populations is presently difficult, but progress on practical inoculation schemes is under way.

At present, most research on marine turtle fibropapilloma is bootstrapped onto other research topics. This plan identifies the research activities and funding requirements necessary to make substantial progress toward finding the cause of this disease. Sources of funding are not identified in this research plan. This research plan lays out the logical map and conceptual roadwork for success, but efforts must begin immediately to develop the required funding sources.

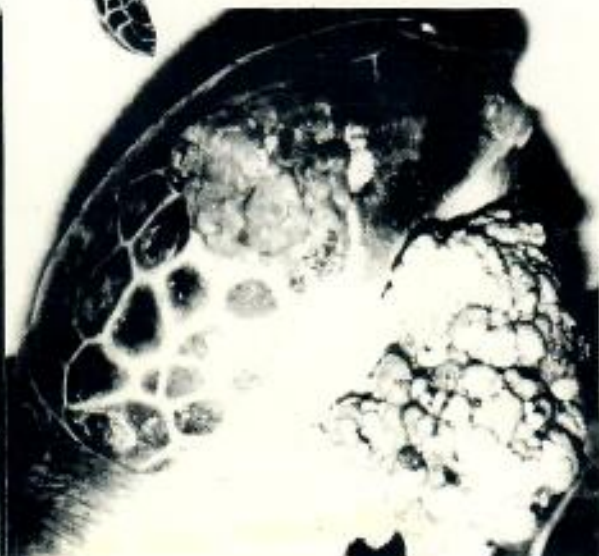
ACKNOWLEDGMENTS

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Participants at the Marine Turtle Fibropapilloma Disease Workshop held in Honolulu, Hawaii, on 4-6 December 1990. Front row (from left to right): John C. Harshbarger, National Museum of Natural History, Smithsonian Institution; Wendy Teas, NMFS Miami Laboratory; Elliott Jacobson, University of Florida; Murray D. Dailey, California State University; Alvin W. Smith, Oregon State University; and John Sundberg, The Jackson Laboratory. Back row (from left to right): Jim Swensen, Samuel G. Pooley, and George H. Balazs, Honolulu Laboratory; Sidney Simpson, University of Illinois; Lew Ehrhart, University of Central Florida; and George W. Boehlert, Honolulu Laboratory.

RESEARCH PLAN FOR MARINE TURTLE FIBROPAPILLOMA



NOAA-TM-NMFS-SWFSC-156

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center