CORAL REEF BLEACHING: INCIDENCE, EXTENT, CAUSE, SIGNIFICANCE AND THE URGENCY IN UNDERSTANDING THIS MAJOR DISTURBANCE: ORAL TESTIMONY OF DR. ERNEST H. (BERT) WILLIAMS, JR.

Thank you for inviting me to testify before this Subcommittee today. My name is Bert Williams and I am head of the Caribbean Aquatic Animal Health Project and Professor in the Department of Marine Sciences of the University of Puerto Rico at Mayaguez. Our project has been attempting to follow and understand coral reef bleaching since 1987.

For your convenience, we have arranged for a major, worldwide coral reef bleaching event to be occurring for this Hearing. Sorry, I couldn't resist a joke. Although we predicted this major bleaching event in an article in "Nature", we are not pleased that this destructive disturbance has begun.

The first proof of global warming may well come from the bleaching of the fragile and highly sensitive coral reef system. Unfortunately we do not have sufficient data to fully evaluate this intriguing suggestion, because this gigantic series of disturbances have been understudied and virtually ignored. Unravelling the mysteries of bleaching and the many other possibly related major marine ecological disturbances (MMEDs) is a vital component in any understanding of global processes and changes. These disturbances may actually be "alarms" from the drastically changing and deteriorating marine environment.

Studying large-scale disturbances will be expensive, but we can no longer afford to ignore the consequences and implications of these problems. Our own feeble attempts in following coral reef bleaching, have disclosed a mechanism for predicting major bleaching events one year in advance. This is a sufficient interval to organize and establish sophisticated research efforts to study this enormous problem.

We have also established a tentative cause for coral reef bleaching which invites experimental proof. All that is necessary is the support for these large-scale experiments. We have laid this ground work with practically our "bare hands" alone.

What is needed is the will and support to tackle these problems. Not because we are humbled by the possibility of the massive destructive potential of major marine ecological disturbances, but because we are fascinated with the enormous potential of valuable knowledge available in understanding these fundamental processes.

Major marine ecological disturbances are modern day "sea monsters". They are far more dangerous and devastating than any of those from folk lore. But they are filled with incredible amounts of vital information on the fate of our planet for those bold enough and with sufficient vision to face them.
Coral Reef Bleaching Complexes

In 1979-80, 1982-83, 1986-88 and 1989-90 world-wide complexes of bleaching events occurred over many areas of the tropics and subtropics as you can see on the projected map.

1979-1980: Bleaching in 1979 was limited to a preceding event in Bonaire. In 1980, it occurred in 5 widely spaced Pacific and Atlantic locations. Quite possibly other sites went unreported.

1986-1988: Preceding bleaching events produced moderate bleaching in several Pacific and Atlantic locations. Major bleaching was concentrated in the Caribbean in 1987, but severe to moderate bleaching occurred in many Indo-Pacific locations. Moderate to mild bleaching also occurred in many Caribbean and Pacific locations in 1988.

1989-1990: The 1989 preceding event brought the most severe bleaching ever known in Jamaica, moderate bleaching in the Cayman Islands and the Florida Keys, and mild bleaching in many other Caribbean locations. This year, severe bleaching is occurring in Puerto Rico, Jamaica, the Cayman Islands, the Bahamas, the Florida Keys, and, apparently for the first time, in the Flower Garden Banks off Texas; many other Caribbean locations, Hawaii, Okinawa and possibly other Pacific locations are experiencing bleaching, but we do not know the extent and severity in these areas.

THE CAUSE OF BLEACHING

Our analysis of the first 3 major bleaching complexes in our article in "Atoll Research Bulletin" suggested that elevated seawater temperatures, compounded by the deterioration of the coral reef environment, caused coral reef bleaching. Preliminary information from the new bleaching complex is in agreement with our original suggestion. More limited field experimental work supports this suggestions as do recent large-scale temperature studies.

The mechanism we suggested for these complexes or cycles of bleaching events is shown on the projection. It suggests that slowly rising seawater temperatures combined with short-term warming periods and normal seasonal high temperatures force the overall temperatures to levels sufficiently elevated to cause
bleaching. Deterioration of the marine environment may also be lowering the threshold temperatures required for bleaching to occur. Preceding events are at the beginning of a short-term warming period and are thus less damaging. Major events occur at the height of a short-term warming period and are thus more serious.

WHAT IS NEEDED

1) Large-Scale Monitoring and Experimental Research Effort on coral reef bleaching and other major marine ecological disturbances. Ray Hayes and Tom Goreau will discuss this need.

2) Alert and Communication Center to follow, compile information about, and coordinate efforts in understanding major marine ecological disturbances. This is the cheapest component of an MMED effort, but is absolutely essential for any hope of understanding these complex events.

3) Reaction Team to examine and analyze outbreaks of major marine ecological disturbances in cooperation with other specialists. It must be in place before each crisis. Most of the mystery in MMEDs is due to a lack of preparation. Both the specialists and the local field biologists would welcome the aid of and cooperate with such a team.

ACKNOWLEDGMENTS

Thank you for inviting this testimony and for your interest in this serious problem. We thank Wallop Breau Funds, Sea Grant, the Caribbean Marine Research Center, and the World Resource Institute for partial support of our efforts.

CORAL REEF BLEACHING PUBLICATIONS


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THE DISTRIBUTION AND TIMING OF MAJOR CORAL REEF BLEACHING, POTENTIAL CAUSES, INDICATORS, AND THE BLEACHING CYCLE

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MAJOR CORAL REEF BLEACHING

Spectacular coral reef bleaching occurred in the Caribbean in 1987, as we detailed in popular articles in OCEANUS (1987), SEA FRONTIERS (1988), and NATURAL HISTORY (1990); and scientific articles in SCIENCE (1987), NATURE (1990), ATOLL RES. BULL. (1990), and others (list available). We received reports of world-wide bleaching for 1979-80, 1982-83 and 1986-88 (maps available). Bleaching also occurred in much of the Caribbean in 1989.

POTENTIAL CAUSES AND INDICATORS OF GLOBAL CHANGES

We have suggested that increasing temperatures of the 1980s, short-term warming events, and seasonal highs, force seawater temperatures to the point of causing major coral reef bleaching events. Deterioration of coral reefs may have also reduced reef organism's resilience or resistance to the bleaching process. Coral reef organisms live in waters that are almost as hot as they can withstand. Even slight changes can be important in this tropical environment. Coral reefs may be highly sensitive indicators of global changes.

THE CORAL REEF BLEACHING CYCLE


POSSIBLY RELATED MAJOR MARINE ECOLOGICAL DISTURBANCES (MMED)

Regional-wide mass mortalities of marine fishes occurred in 1980, black long-spined sea urchins in 1983-84, acroporid corals and recurring mortalities of herrings throughout the 1980s. Many other MMEDs have similarly occurred in other regions in the 1980s. These problems may be interrelated, may share causes, and may be additional indicators of global changes.

ASSOCIATION OF MARINE LABORATORIES OF THE CARIBBEAN SERVICES

The Executive Board of the AMLC approved the following statement during their 19 June 1990 meeting: "The Association of Marine Laboratories of the Caribbean (AMLC) recognizes the necessity to develop long-term monitoring of marine environmental variables implicated as possible causes of mass coral reef bleachings and offers its resources and expertise to such a regional effort in the Caribbean Basin in cooperation with other international organizations in the region." The Association's goals include the initiation and coordination of its 27 Institutional Member Marine Laboratories in the Greater Caribbean Region in cooperative research efforts. The AMLC hopes to be a useful and positive forum and structure for the process of examining and understanding this problem. As Executive Director of the Association, I would like to welcome the use of the Association, member laboratories, and our individual scientists, to serve in the resolution of this problem.


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