Understanding Coral Bleaching Across Four Oceans

- addressing CBD's Specific Workplan on Coral Bleaching

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This poster is linked with a separate SBSTTA8 poster addressing a GEF/World Bank Coral Reef Targeted Research project

Bleached *Acropora sp., Great Barrier Reef 2002*

1. Introduction

Coral bleaching is rapidly developing as a major problem for the health of coral reefs worldwide. Unfortunately, the level of understanding of this phenomenon is still limited.

Filling critical knowledge gaps is important if management practices are to be effective in minimising the detrimental impacts of coral bleaching as projected to occur over the next 50 years.

2. Climate change, coral bleaching and the future of reefs?

Coral bleaching implies the loss of symbiotic micro-algae living in the surface-tissue of reef-building corals, where they generate energy to sustain critical life processes.

If bleached, yet soon re-colonised by new micro-algae, most corals can recover. If not, they will start to degrade.

Different types of environmental stress can trigger bleaching. However, increased sea surface temperature of 1-2ºC above summer average is the main driver, in extreme cases causing global mass bleaching events, as seen in 1998.

Predicted increase in sea surface temperature (figure 1) suggest coral mass bleaching will become a regular phenomenon within few decades.

The physiological mechanisms and the longer-term ecological impacts of coral bleaching are still poorly understood.

A key question is: can corals adapt to rapidly increasing sea temperatures? Other unknowns relates to the rate of reef decline, the after-effects, and longer-term implications for society.

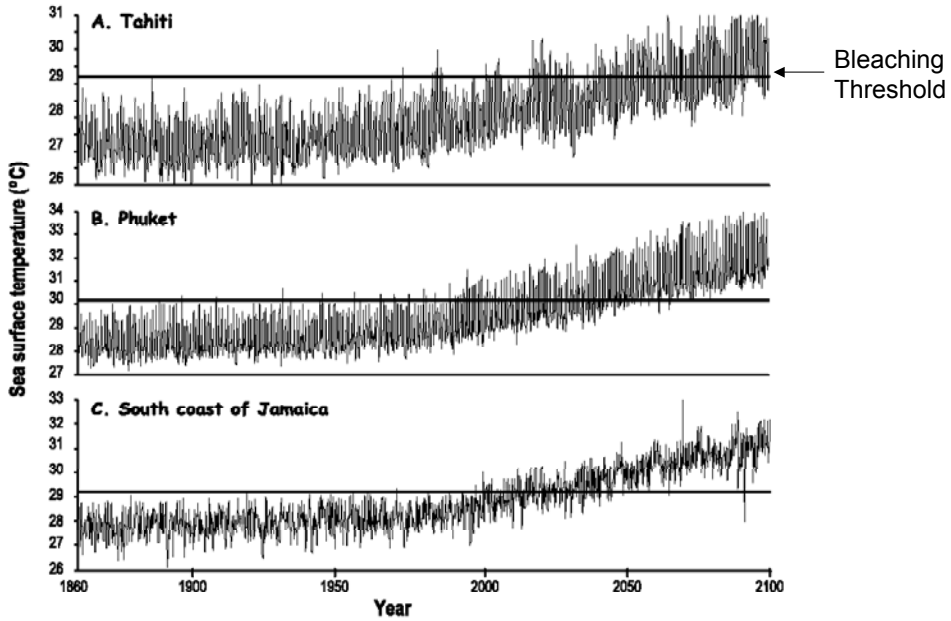


Figure 1: Sea surface temperature data generated by the global coupled atmosphere-ocean-ice model (ECHAM4/OPYC3, Roeckner *et al.* 1996)

Mass coral bleaching and mortality:

- **Induced by elevated sea temperature**
- **Exacerbated by high irradiance**
- **Six major bleaching event since 1979**
- **Thousands of square miles affected**
- **May be followed by huge mortalities**
- **Increasing frequency and severity**

3. International expert group on coral bleaching

In response to this situation, an international group of experts in the area of coral physiology and ecology was started by IOC/UNESCO in September 2000 to identify and fill critical knowledge gaps relating to:

1) tolerance limits and potential mechanisms of corals for adaptation/ acclimatization to thermal stress;
2) long-term responses of coral reefs to large-scale changes in environmental variables; and
3) development of possible molecular, cellular, physiological or community indicator tools that are reliable in their ability to detect environmental stress responses.

The effort has joined forces with the developing GEF/World Bank Coral Reef Targeted Research effort to engage in a series of cooperative investigations. These will generate new insight as well as management tools to help mitigate the impacts of coral bleaching and other threats to the sustainability of coral reefs (see separate SBSTTA 8 poster).

4. CBD's Specific Workplan on Coral Bleaching

Developed under the programme of work on Marine and Coastal Biological Diversity, in consultation with an international liaison group of experts, and adopted by COP 6 (Decision VI/3, April 2002), the workplan supports efforts to:

- *gather and assimilate information on;*
- *build capacity to mitigate the effects of; and*
- *promote policy development and implementation strategies*

- addressing the impacts of coral bleaching and related mortality on coral-reef ecosystems and the human communities which depend upon coral reef services.

The IOC/UNESCO Coral Bleaching Working Group addresses the following key objectives of the CBD workplan:

5. Information gathering

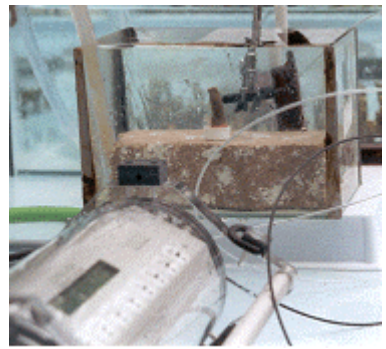
Through reviewing and testing specific hypotheses in joint investigations, the Coral Bleaching working group is addressing the overall questions:

- *Are coral reefs resilient in the face of projected climate change over the next 100 years?*
- *How is the primary factor temperature affected by other secondary factors?*
- *Why are some corals more immune than others?*
- *How fast will change occur within coral reefs' ecosystems?*
- *What factors influence the ability of reefs to recover?*
- *Is a phase shift permanent?*
- *What will the final state of the coral ecosystem be like if coral abundance decreases dramatically?*

Targeted research

Core to the Targeted Research project will be a new global collaborative research network, allowing key hypotheses be tested through replicate experiments in different geographic areas of the World; - integrating field and lab work, scientific seminars and discussions among international researchers and local students.

Collaborative thermal stress-simulation experiments provide new knowledge on molecular and cellular mechanisms causing coral bleaching



Linked with ecological surveys this provide new insight into the longer-term impacts for reef ecosystems

Two pilot research workshops has been held to develop and test the targeted research concept:

1. Heron Island, Southern Great Barrier Reef, 25 Feb-18 March 2002, 42 participants, Univ. Queensland

2. Puerto Morelos, Mexican Caribbean, 9-22 Sept 2002, 25 participants, National Univ. Mexico (UNAM)

6. Mitigating responses

Spanning molecular, cellular and ecological types of investigations, the program will generate tools and techniques applicable to a wide range of problems facing both developed and developing nations.

Indicator tools

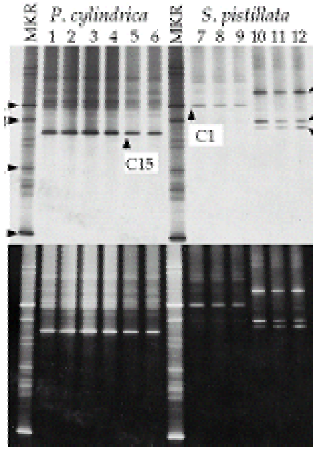
A major output is a series of indicator tools such as:

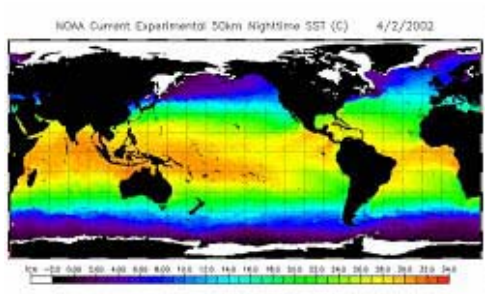
Molecular markers that will rapidly and easily distinguish heat stress from other types of stresses (e.g. sedimentation, metal contamination, nutrient stress) on coral reefs.

Cellular markers that will enable users to accurately anticipate and monitor the advent of coral bleaching or recovery.

Genetic markers that will enable insight into the tolerance and resilience of communities of reef-building corals.

Ecological markers that will enable users to monitor impacts of coral bleaching and to project how the changes are likely to impact on local ecosystem function.





Molecular biomarkers and sea-surface temperature maps are some of the tools being developed and integrated to assist predict and manage bleaching impacts on reef ecosystems

Predictive models and scenario-building

A more complete *model* of the mechanisms that trigger mass coral bleaching will be developed to enable better projections of the potential impact of climate change on coral reefs, and allow better forecasting of the potential impacts on human communities relying upon them for their livelihoods.

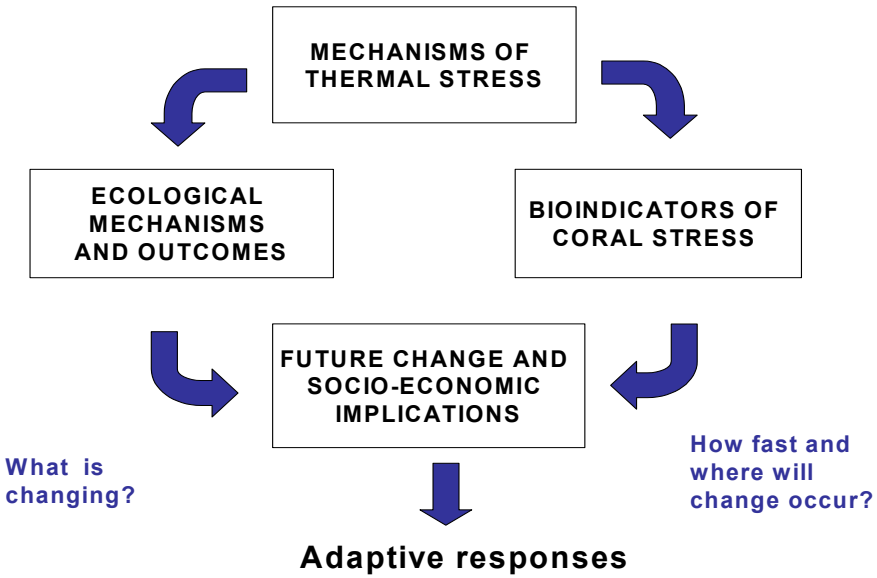
Rapid response capability

Ultimately the network, the new tools and standard field procedures will provide a rapid response capability to document coral bleaching and mortality, as well as an infrastructure to monitor longer-term effects.

7. Capacity Building

Global collaborative research in four main areas will build research expertise and management capacity at institutions in developing countries.

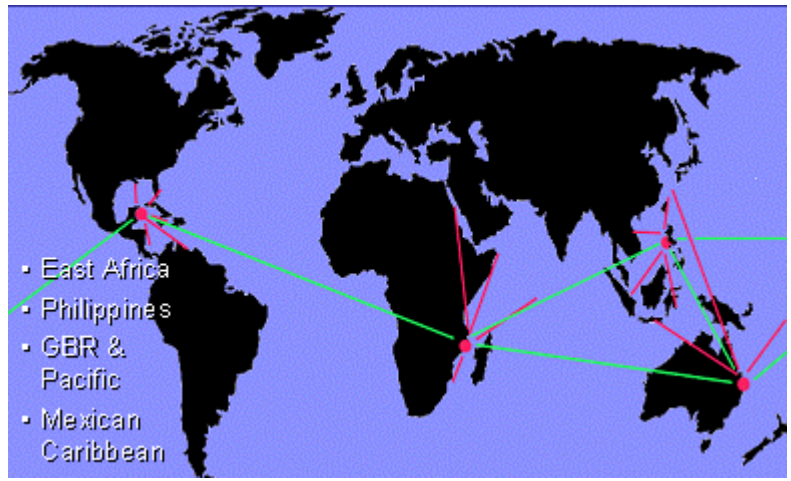
Four main research areas



The project aims to strengthen the links between researchers and students at institutions in both developed and developing nations through joint experiments and learning opportunities.

This program will provide:

- Training-through-research opportunities
- Grants for developing country scientists to visit foreign laboratories
- Seminars and training courses to spread new knowledge and techniques
- Career opportunities for young researchers in coral physiology, taxonomy, and ecology
- Strengthened national research capacities with new expertise, technologies and management skills



Joint field sites are being established at universities and research institutions at representative ocean areas covering sites in Mexican Caribbean, East Africa, Philippines, Palau and Southern Great Barrier Reef.