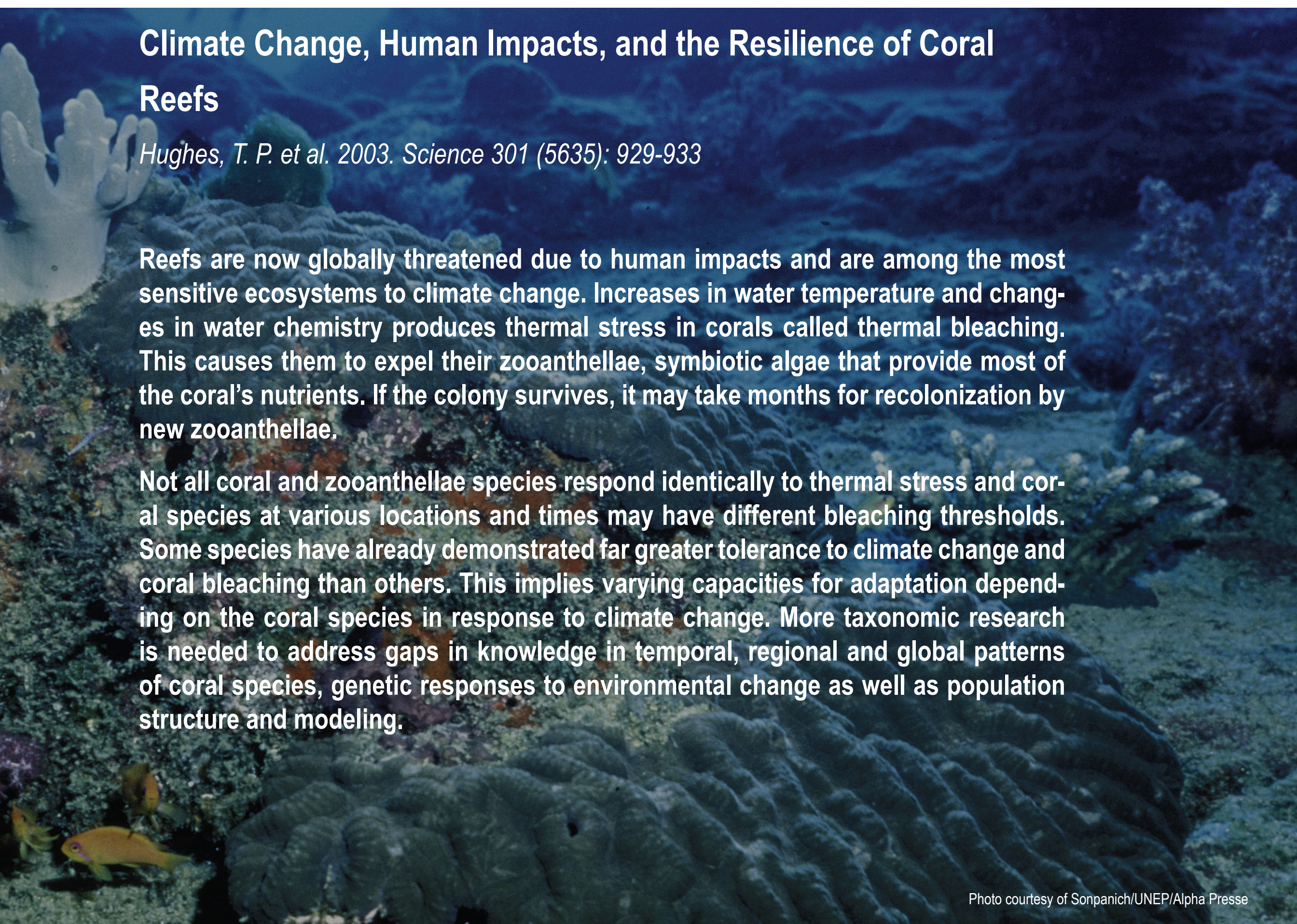
# Understanding Adaptations of Biodiversity to Climate Change using Taxonomy

Global distributions of species and their community composition are expected to shift as a consequence of climate change. When taxonomists collect a specimen, they note the specific latitudinal and longitudinal coordinates and habitat where it was found. For many ecologically important but lesser known taxa, spatial distribution data is insufficient for analysis, which is a major taxonomic constraint when assessing effects of climate change on biodiversity. The following case studies demonstrate the need for increased taxonomic research in this area.



## Climate Change, Human Impacts, and the Resilience of Coral Reefs

*Hughes, T. P. et al. 2003. Science 301 (5635): 929-933*

**Reefs are now globally threatened due to human impacts and are among the most sensitive ecosystems to climate change. Increases in water temperature and changes in water chemistry produces thermal stress in corals called thermal bleaching. This causes them to expel their zooanthellae, symbiotic algae that provide most of the coral's nutrients. If the colony survives, it may take months for recolonization by new zooanthellae.**

**Not all coral and zooanthellae species respond identically to thermal stress and coral species at various locations and times may have different bleaching thresholds. Some species have already demonstrated far greater tolerance to climate change and coral bleaching than others. This implies varying capacities for adaptation depending on the coral species in response to climate change. More taxonomic research is needed to address gaps in knowledge in temporal, regional and global patterns of coral species, genetic responses to environmental change as well as population structure and modeling.**

Photo courtesy of Sonpanich/UNEP/Alpha Presse

## Butterfly Species Richness Patterns in Canada: Energy, Heterogeneity, and the Potential Consequences of Climate Change

*Kerr, J.T. 2001. Conservation Ecology 5(1):10*

Pollinator species provide important ecosystem services, including pollinating a large percentage of our food crops. As is the case with most invertebrates, their spatial patterns have been poorly documented and many are threatened by human activities including climate change. Regional changes of species distributions have already been documented in Europe and North America for a variety of species and groups of organisms, with northward expansions. In Canada, butterflies are the only relatively complete pollinator taxon where enough data exists for analysis of spatial distribution based on climate history.

The analysis was conducted using butterfly and skipper specimens from the Canadian National Collection Database collected throughout the 1900s in Canada. It was found that butterfly diversity increases with high climatic energy and land cover variation, and that these factors explain 50-80% of butterfly species richness. Therefore, climate change is likely to have significant effects on species distributions on a regional scale, through heat-related and habitat diversity changes. It was found that butterfly spatial patterns were extremely similar to other organisms such as birds and mammals, suggesting that the same factors control the distribution of many different organisms.

***Papilio glaucus*** **- Eastern Tiger Swallowtail Butterfly &** ***Danaus plexippus*** **- Monarch Butterfly on thistle**

# Case Studies

## Impacts of Climate Change on Range Expansion by the Mountain Pine Beetle

*Carrol, A.L., et al. 2006. Mountain Pine Beetle Initiative Working Paper. Canadian Forest Service*

Insect life-cycles are extremely dependant on temperature and are expected to respond rapidly to climate change by shifting their geographic distributions to take advantage of new niches that become available. Since the mid-1990's, mountain pine beetle (MPB) (Dendroctonus ponderosae (Hopkins) populations have erupted in British Columbia (BC) into the largest outbreak ever recorded, causing massive damage to lodgepole pine forests, although other pine species can be attacked. Hot summers have facilitated beetle reproduction and mild winters have allowed greater survival of offspring in recent decades.

Under normal conditions, native bark beetles, such as MPB, attack dead or dying wood and provide vital ecosystem services such as nesting habitat for birds, food sources for predators and nutrient cycling. Under global warming, many habitats that were uninhabitable to MPB due to climate are now hospitable. MPB is most common in south-central BC and the north-western US but has recently expanded its range to breach the Rocky Mountain geo-climatic barrier and is now established in north-eastern BC and Alberta. The number of infestations since 1970 in formerly inhospitable environments shows expansion of populations into new areas at an increasing rate. It is predicted that most of the boreal forest will be available for infestation by MPB and a continued eastern expansion is probable. Taxonomic research has been essential for identifying, mapping and predicting the impacts of the MPB and linking its expansion to climate change.

Photo courtesy of Kenneth Erfurth