

Continued degradation of Tobago's coral reefs linked to the prevalence of coral disease following the 2005 mass coral bleaching event.

S. Harding¹, J-W van Bochove¹, O. Day², K. Gibson¹ and P. Raines¹

1) Coral Cay Conservation, Elizabeth House, 39 York Road, London, SE1 7NQ, U.K.

2) Buccoo Reef Trust, Cowie's Building, Carnbee Junction, Auchenskeoch Road, Carnbee, Tobago, West Indies

Abstract. In the summer of 2005, the Caribbean region experienced a widespread coral bleaching event. In order to determine the extent and effect of this event on the reefs of Tobago, the Buccoo Reef Trust (BRT) and Coral Cay Conservation (CCC) conducted a targeted coral reef survey programme around the island between October and November 2005 as the first part of a two-phase campaign. In Phase I the reefs were assessed to establish their current status. In Phase II, a long-term monitoring programme was installed to record subsequent degradation or recovery of the reefs from the bleaching event. Results from Phase I found overall mean bleaching of hard corals to be 66%. Although most sites had greater than 85% bleaching, some local reefs on the northeast of Tobago had less than 20% bleaching, perhaps indicating localised tolerance. Bleaching was also found to be highly variable, both between and within species. Notably, *Acropora palmata* stands all appeared to be unbleached. No significant coral diseases were observed during Phase 1 surveys. Results from Phase 2 indicate a high prevalence of coral disease at many sites throughout the area. Yellow Band Disease was commonly seen on *Montastrea* species. There were also high levels of White Plague Disease and *Aspergillois*. Initial findings suggest that disease were generally prevalent on reefs adjacent to areas of high coastal development and/or agricultural land use and prevalence was inversely related to depth.

Keywords: Coral, disease, bleaching, reef status, Tobago

Introduction

The coral reefs of Tobago, like many of those throughout the Caribbean region, are severely threatened (Gardner et al. 2003) and the overriding cause is thought to be human activity (Mora 2008). Threats to reef health include overfishing, habitat degradation, land-based pollution stresses and climate change induced events. The prevalence and types of coral disease in the Caribbean have been well documented (Antonius 1981; Goreau et al. 1998; Green and Bruckner 2000; Smith et al. 1996; Sutherland et al. 2004). Tobago has been no exception with serious disease outbreaks in the past e.g. Laydoo (1983).

The large-scale bleaching event of 2005 is an example of a major climate change induced event that significantly affected Tobago's coral reefs (see Wilkinson and Souter 2008). In order to determine the extent and effect of this event on the reefs of Tobago, the Buccoo Reef Trust (BRT) and Coral Cay Conservation (CCC) conducted a targeted coral reef survey programme at 22 sites around the island between October and November 2005.

A two-phase campaign was launched. In Phase I the reefs were assessed to establish their current status. In Phase II, a long-term monitoring programme was installed in order to monitor the reefs to record subsequent degradation or recovery from the event.

Results from Phase 1 found overall mean bleaching of hard corals to be 66% (O'Farrell and Day 2005). Bleaching levels in Tobago were found to be consistent with regional results, with most Tobagonian sites exhibiting greater than 85% bleaching. However, some local reefs on the northeast of Tobago had less than 20% bleaching, perhaps indicating localised tolerance. Bleaching was also found to be highly variable, both between and within species. Notably, *Acropora palmata* stands all appeared to be unbleached. No significant coral diseases were observed during Phase 1 surveys although a few diseased coral colonies were observed in north-west Tobago in 2003 including White Band, Yellow Band (Blotch) and Black Band Disease (Lapointe 2003).

Following the successful partnership in 2005 CCC and the BRT established a programme of

study in collaboration with the Tobago House of Assembly and with the support of the United Nations Development Programme Global Environment Fund (UNDP-GEF). Part of this study, the Tobago Coastal Ecosystem Mapping Project (TCEMP), began in March 2007 in north-west Tobago (Fig. 1) with the three main objectives to:

1. Provide baseline data on the status of Tobago's coral reef, mangrove and seagrass ecosystems;
2. Increase awareness about Tobago's marine resources through educational programmes;
3. Build in-country capacity through scholarship programmes.

The data collected during the TCEMP will be used by the Integrated Watershed and Coastal Area Management (IWCAM) Caribbean programme to provide relevant information to the Government of Trinidad and Tobago in order to enable effective coastal zone management.

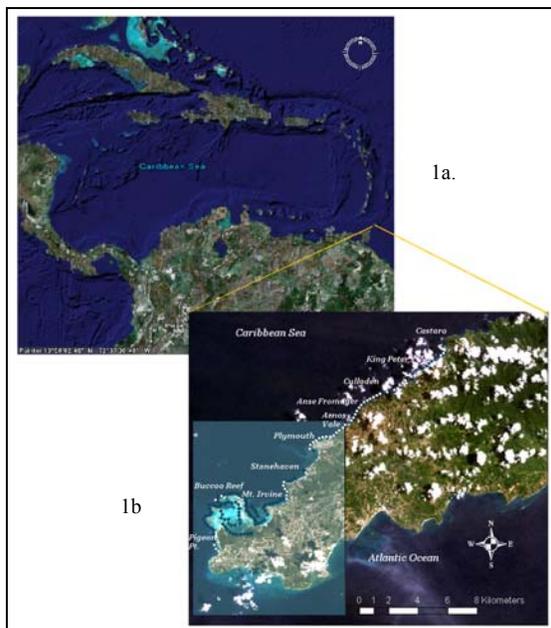


Figure 1. Map of the Caribbean (1a) and western half of Tobago (1b) indicating the area of study

Methodology

Coral Disease Studies

Anecdotal observations suggested that coral disease prevalence had become a more serious contributor to coral reef degradation in Tobago following the 2005 bleaching event. To document this phenomenon, monitoring of the prevalence and severity of common and easily identifiable coral diseases was initiated in 2007. Here we present some initial trends for diseases recorded during

CCC baseline surveys. Monitoring stations of tagged coral colonies were also set up in order to collect quantitative data on the rate of coral disease infestation. Full details of the survey methods used are provided in the report by van Bochove et al. (2008).

Results

All data presented was collected on CCC baseline surveys between May 2007 and June 2008 along the north-western coast of Tobago between the Buccoo Reef complex and Castara (Fig. 1). Four coral diseases, Yellow Blotch Disease (YBD), White Plague (WPL), Dark Spot Syndrome (DSS) and Aspergillus (ASP), were recorded most often on surveys conducted at 7, 12 and 16 metres depth (Table 1). Other coral diseases that were recorded occasionally were Black Band Disease (BBD), White Band Disease (WBD), White Pox (WPD) and Patchy Necrosis but data for these diseases are not presented here.

Table 1. Coral species affected by four main diseases in north-west Tobago.

Species	Disease: Yellow Blotch	White Plague	Dark Spot	Asper- gillus
<i>Colpophyllia natans</i>		M, D		
<i>Dichocoenia stokesii</i>			M	
<i>Diploria strigosa</i>	S, D	S, M		
<i>Gorgonia ventalina</i>				S, M, D
<i>Millepora sp.</i>	D			
<i>Montastraea spp.</i>	S, M, D	M, D	M	
<i>M. faveolata</i>	S, M, D	S, M, D		
<i>M. franksi</i>	S, M, D	S, M	D	
<i>M. cavernosa</i>	S, M, D	S, M	D	
<i>Porites asteroides</i>		S, M, D		
<i>Siderastrea radians</i>			S	
<i>Siderastrea siderea</i>		M, D	S, M, D	
<i>Solenastrea hyades</i>	D			

Where: S = Shallow (7 m), M = Medium (12 m), D = Deep (16 m).

Ten species of hard corals, one hydrozoan and one gorgonian were affected by the four main coral diseases (Table 1). A number of genera were infected by more than one disease at a range of depths (e.g. *Montastraea* and *Siderastrea*). Others were only affected by one disease type such as *Porites asteroides* (WPD) and *Gorgonia ventalina* (ASP).

Coral disease prevalence for the four main diseases is presented in Figure 2 for three depth bands (7, 12 and 16 metres) as a mean percentage value for all the coral types affected. The proportion of coral colonies affected by YBD,

WPL and DSS appear to be inversely related to depth, with the highest levels recorded at the shallowest depth band surveyed (7 m).

This decrease with increasing depth is most obvious for DSS where disease prevalence decreases from 67% to 23%. The highest levels of disease prevalence were recorded for common sea fans with *Aspergillosus* (72%) Infestation levels were all greater than 60% of coral colonies at the shallow depth band (7 m).

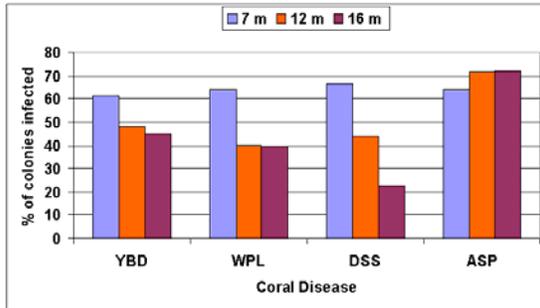


Figure 2: Coral disease prevalence in all coral types at three depth bands in north-west Tobago

Looking at two hard coral genera in detail, coral disease data for *Montastraea* and *Siderastrea* indicates that each genus is mainly affected by two types of disease (Figs. 3 & 4).

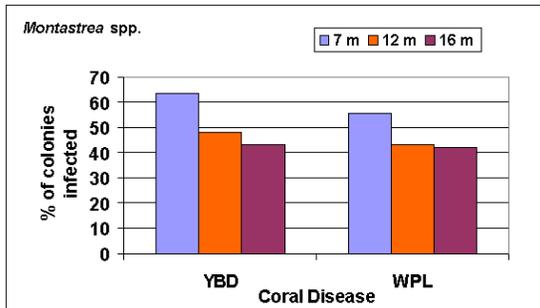


Figure 3: Coral disease prevalence in *Montastraea* spp. at three depth bands in north-west Tobago

Coral disease prevalence was generally higher in more shallow waters. More than 60% of *Montastraea* colonies were infected with YBD in shallow waters (7 m) with prevalence decreasing to 43% (16 m). Similarly prevalence of DSS in *Siderastrea* was high (67%) at 7 m. depth but dropped off markedly to 24% at 16 m (Figure 4)

Statistical comparison of disease prevalence for *Montastraea* and *Siderastrea* colonies over the three depth bands and for three diseases (Table 2) revealed significantly higher percentages of colonies infected in shallower waters for YBD in *Montastraea* and DSS in *Siderastrea* (One-way

ANOVA and Two-tailed T-Test on arcsine transformed data).

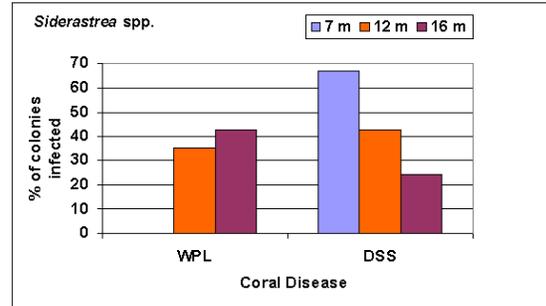


Figure 4: Coral disease prevalence in *Siderastrea* spp. at three depth bands in northwest Tobago

Table 2. Statistical comparison of coral disease prevalence for two coral genera and three diseases over three depth bands

2a – One-way ANOVA

Genus	Disease	P value
<i>Montastraea</i>	YBD	< 0.001
<i>Montastraea</i>	WPL	n.s.
<i>Siderastrea</i>	DSS	< 0.001

2b – Two-tailed T-Test

Genus	Disease	Depth Comparison		
		7 vs. 12	7 vs. 16	12 vs. 16
<i>Montastraea</i>	YBD	++	+	n.s.
<i>Siderastrea</i>	DSS	++	+++	++

Where: n.s. = not significant; + = $p < 0.05$; ++ = $p < 0.01$; +++ = $p < 0.001$

Summary and Conclusion

Coral disease is certainly a serious issue for the fringing reefs of north-western Tobago and is likely to cause a further reduction in live hard coral cover for a region that is already suffering from high coral mortality, particularly after the 2005 bleaching event. Indeed the increase in coral disease prevalence since the bleaching event may be directly linked to the thermal stress experienced during 2005 in that climate-mediated, physiological stresses may compromise host resistance and increase frequency of opportunistic diseases (Harvell et al. 1999).

This study has indicated that coral disease prevalence for YBD and DSS appears to be related to depth with the percentage of coral colonies infected decreasing with increasing depth for *Montastraea* and *Siderastrea* respectively. At the shallow depth band (7 m) at least 60% of coral

colonies were infected by one or more disease for the coral species recorded. The positive relationship between depth and disease prevalence for certain combinations of genera and disease types may well be linked variation in water quality and land-based pollution (Bruno et al. 2003). Alternatively deeper corals are likely to have experienced less bleaching in 2005 and may therefore be less susceptible to infection.

Four main coral diseases (YBD, WPL, DSS and ASP) were recorded along Tobago's northern coastline. However, insufficient data was available at the time of writing to accurately compare coral disease prevalence on a spatial scale between reef sectors along the coast. There is also a need to conduct a temporal analysis of the data to determine whether disease prevalence is changing over time, especially since the last mass coral bleaching event. Further analyses will be undertaken as the TCEMP progresses and the dataset becomes more robust. An interesting future comparison will be to look at the level of coral disease prevalence between the north-west and north-east coasts of Tobago as the two areas differ in terms of population density and coastal development. The north-east coast was also less severely bleached than the north-west in 2005, which may also influence coral disease prevalence.

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