Evidence of initial coral community recovery at Discovery Bay on Jamaica's North Coast

M. James C. Crabbe[1,2]

1. Institute for Biomedical and Environmental Science and Technology, Faculty of Creative Arts, Technologies and Science, University of Bedfordshire, Park Square, Luton, LU1 3JU, UK; james.crabbe@beds.ac.uk
2. Department of Zoology, University of Oxford, The Tinbergen Building, South Parks Rd, Oxford OX1 3PS, UK; james.crabbe@wolfson.ox.ac.uk

Received 01-VIII-2013 Corrected 04-II-2014 Accepted 24-III-2014

Abstract: Current challenges to coral reef sustainability include overfishing, destructive fishing practices, bleaching, acidification, sea-level rise, starfish, algae, agricultural run-off, coastal and resort development, pollution, diseases, invasive species and hurricanes. We used SCUBA belt transects to record coral cover and digital image analysis in the Dairy Bull Reef off the north coast of Jamaica and found that it is a positive example of how reefs can recover after major environmental disturbance. Live coral cover increased from 13±5% in 2006 to 31±7% in 2008, while live *Acropora cervicornis* increased from 2±2% in 2006 to 22±7% in 2008. Coral cover levels were maintained until 2012. Rev. Biol. Trop. 62 (Suppl. 3): 137-140. Epub 2014 September 01.

Key words: hurricanes, bleaching, MPAs, climate change, global warming, Belize, Jamaica.

Current challenges to coral-reef sustainability, include overfishing, destructive fishing practices, coral bleaching, ocean acidification, sea-level rise, algal blooms, agricultural run-off, coastal and resort development, marine pollution, increasing coral diseases, invasive species, hurricane/cyclone damage, and, in Indo-Pacific regions, crown-of-thorns starfish outbreaks. The fringing reefs around Discovery Bay in Jamaica have seen a number of climate-related challenges in recent years, notably several hurricanes as well as a mass bleaching event in the Caribbean in 2005 (Jones et al., 2008). Diary Bull reef has for several years been the fringing reef with the most coral cover, with a benthic community similar to that of the 1970s (Huston, 1985), and it was the subject of the study which suggested a rapid phase-shift reversal (Idjadi et al., 2006). After the 2005 bleaching event there was a major loss of live coral cover, particularly of *A. cervicornis* (Quinn & Kojis, 2008). Here, we investigate coral cover at Dairy Bull reef over a ten year period, from 2002-2012.

MATERIALS AND METHODS

Jamaican sites and sampling: Four randomly located transects, which were not continuous, each 15m long and separated by at least 5m, were laid at between 5-8.5m depth at Dairy Bull reef (18°28.083'N; 77°23.302'W) near Discovery Bay, Jamaica. GPS coordinates were determined using a hand-held GPS receiver (Garmin Ltd.). The belt transect method using SCUBA was used to record coral cover (English, Wilkinson & Baker, 1997) after photography and then by digital image analysis using UTHSCSA (University of Texas Health Science Center, San Antonio, Texas) Image Tool image analysis software. Corals 2 m either side of the transect lines were photographed for archive information. Percentage cover was determined for total live coral, and

the dominant species *Acropora cervicornis*, *Porites astreoides*, and *Acropora palmate* as well as for *Diploria strigosa, Sidastrea siderea* and *Acropora palmata*.

This work was conducted at Discovery Bay during March 26-April 19 in 2002, March 18-April 10 in 2003, July 23-August 21 in 2004, July 18-August 13 in 2005, April 11-18 in 2006, December 30 in 2006-January 6 in 2007, and July 30-August 16 in 2008, July 27-August 8 in 2009, April 14-16 in 2010 and July 30-August 2 in 2012. Surveys were made at the same locations at the same sites each year. One or two-factor ANOVA was used to compare coral data among sites; ± error values represent standard errors of the data.

RESULTS

Dairy Bull reef: Figure 1 shows mean percentage cover +1 S.E. of total live coral, and dominant species *Acropora cervicornis*, *Porites astreoides*, and *Acropora palmata* at Dairy Bull reef from 2002 to 2012. Table 1 shows mean percentage cover +1 S.E. for *Acropora cervicornis*, *Porites astreoides*, *Diploria strigosa, Sidastrea siderea and Acropora palmata*.

The major Caribbean-wide bleaching event was in 2005 (Eakin et al., 2010). Live coral cover increased from 13±5% in 2006 to 31±7% in 2008, while live *Acropora cervicornis* increased from 2±2% in 2006 to 22±7% in 2008. Coral cover levels were maintained until 2012. Statistical analysis of the recovery showed that only *Sidastrea siderea* and *Diploria strigosa* had coral cover in 2012 that was statistically significantly similar to coral cover in 2002 and 2005 before bleaching.

DISCUSSION

Diary Bull reef has for several years been the fringing reef around Discovery Bay, Jamaica, with high rugosity, the most coral cover,

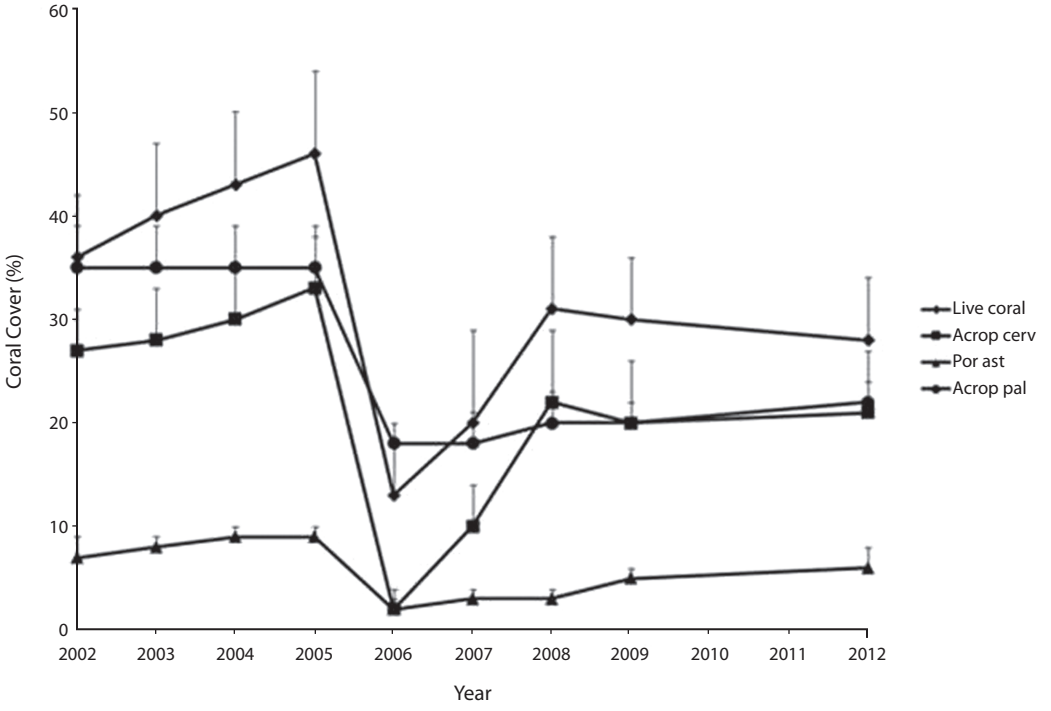

Fig 1. Coral cover at the Dairy Bull reef site from 2002-2012, for: live coral (♦); *Acropora cervicornis* (■, Acrop cerv); *Porites astreoides* (▲, Por ast); *Acropora palmata* (●, Acrop pal). Values are shown + 1 S.E.

TABLE 1
Mean percentage coral cover of live coral, *Acropora cervicornis*, *Porites astreoides*, *Diploria strigosa, Sidastrea siderea and Acropora palmata* species along transects at Dairy Bull, from 2002-2005 (pre-bleaching), 2006-2009, and 2012

Year	Live coral	*A. cervicornis*	*S. siderea*	*D. strigosa*	*P. astreoides*	*A. palmata*
2002	36±6	27±4	6±2	2±0.3	7±2	35±4
2003	40±8	28±5	7±2	2±0.3	8±1	35±4
2004	43±9	30±5	7±2	3±0.3	9±1	35±4
2005	46±8	33±5	6±2	2±0.3	9±1	35±4
2006	13±5	2±2	2±1	0±0	2±1	18±2
2007	20±9	10±4	3±1	1±0.2	3±1	18±3
2008	31±7	22±7	4±1	1±0.3	3±1	20±3
2009	30±6	20±6	5±1	2±0.3	5±1	20±2
2012	28±6	21±6	5±2	2±0.3	6±2	22±2

* Values are ± standard errors.

with a benthic community similar to that of the 1970s (Huston, 1985), and it was the subject of the study which suggested a rapid phase-shift reversal (Idjadi et al., 2006). Cover of live corals for 2005 and 2006 determined here are similar to figures reported by Quinn and Kojis (2008). It is encouraging that coral cover and the rapidly growing *A. cervicornis* colonies have returned to the reef at levels approaching pre-bleaching values. This site shows relatively high rugosity (Crabbe, 2010) and the influence of *M. annularis* colonies on the reef, acting as structural refugia (Idjadi et al., 2006) and maintenance of biological legacies and reasonably fast growth (Diaz-Pulido et al., 2010) may have facilitated this recovery. Coral resilience has also been noted on the reefs of Bonaire (Bruckner, 2012). Interestingly, we found a variety of clades of zooxanthellae, including clade C, in corals at Dairy Bull reef (Crabbe & Carlin, 2007), and that may also be a factor in their recovery (Stat, Loh, Hoegh-Guldberg & Carter, 2008).

It may be that under conditions of low coral cover, low reef rugosity and low biodiversity, a major disturbance such as the 2005 bleaching event crosses a 'threshold' which then induces a cascade to induce the crossing of other thresholds, leading to a stable but less desirable alternative state (Kinzig & Pacala, 2001). An example where this has happened may be the reefs of Tobago (Mallela & Crabbe, 2009). On the reefs of North Jamaica, there is a variable response and resilience, strongest in the case of Dairy Bull reef, which exhibits relatively high rugosity, coral cover and biodiversity with no significant macrogal cover (Crabbe, 2009). What our work suggests is that marine park managers may need to assist coral recruitment and settlement in years where there are severe acute disturbances, including hurricanes and bleaching events, by setting up coral nurseries and/or natural or artificial high rugosity substrate on the reef. In addition, where the insults to coral reef are of a long term human-induced chronic nature, such as overfishing and land development (Mumby, Hasting & Edwards, 2007), engagement with fisherfolk and land developers is vital to minimise the human-induced threats which are so damaging to coral reefs. Unfortunately, previously successful efforts to engage the local fisherman in controlling catches around Discovery Bay (Sary et al., 1997) have not been maintained, and it may be that the development of a sustainable Discovery Bay Marine Protected Area is the only solution.

ACKNOWLEDGMENTS

I thank the Earthwatch Institute for funding in Jamaica, Mr. Peter Gayle, Mr. Anthony

Downes, and the staff of the Discovery Bay Marine Laboratory for their invaluable help and assistance, and volunteers for their help underwater during this project.

RESUMEN

Evidencia de la recuperación inicial de la comunidad coral en Bahía Discovery, Costa norte de Jamaica. Los retos actuales para la sostenibilidad del arrecife de coral incluyen la sobrepesca, prácticas pesqueras destructivas, decoloración de corales, acidificación del océano, aumento del nivel del mar, brotes de estrellas de mar, floraciones algales, escorrentías agrícolas, el desarrollo costero y hotelero, contaminación, enfermedades, especies invasoras y huracanes. Utilizamos transectos de cinturón SCUBA para registrar la cobertura de coral y analizar imágenes digitales en el arrecife Dairy Bull, en la costa norte de Jamaica en el Caribe, y encontramos que constituye un ejemplo positivo de cómo los arrecifes pueden recuperarse después de una perturbación ambiental importante. La cobertura de coral vivo aumentó de 13±5% en 2006 a 31±7% en 2008, mientras que *Acropora cervicornis* aumentó de 2±2% en 2006 a 22±7% en 2008. Los niveles de cobertura de coral se mantuvieron hasta el 2012.

Palabras clave: huracanes, blanqueo, amp, el cambio climático global warming, Belice, Jamaica.

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