

**THE ECOLOGY AND MICROBIOLOGY OF BLACK BAND DISEASE AND  
BROWN BAND SYNDROME ON THE GREAT BARRIER REEF**

Thesis submitted by  
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Department of Marine Biology of James Cook University

## **THESIS DEDICATION**

This thesis is dedicated to my loving parents, Buddy and Pat Boyett, for their emotional, inspirational, and financial support.

## **PUBLICATIONS ARISING FROM THIS THESIS**

Boyett HV, Bourne DG, Willis BL (2006) Effect of elevated temperatures on the progression and spread of black band disease from the Great Barrier Reef. *Marine Biology* (to be submitted)

Willis BL *et al.* (2006) The ecology and microbiology of Brown Band Syndrome on the Great Barrier Reef. *Science* (to be submitted)

## ABSTRACT

The overall objective of this study was to investigate the progression and transmission of black band disease (BBD) and brown band syndrome (BrB) on the Great Barrier Reef. Specifically, my aims were to: 1) examine variations in the natural progression and transmission of BBD and BrB between different months of the year and reef sites (Chapter 2); 2) investigate the effect of elevated temperature on the progression of BBD and BrB using experimental aquarium manipulations (Chapter 3); 3) histologically examine the microorganisms associated with BBD (Chapter 4); and 4) investigate the microorganisms associated with BrB using microbiological and molecular techniques (Chapter 5).

The *in situ* rate of progression and transmission of black band disease (BBD) on the coral *Acropora muricata* was measured and compared between seasonal field studies at Lizard Island on the Great Barrier Reef (GBR). BBD progressed along and transmitted between coral branches at a significantly faster rate during the austral summer month of January as opposed to the cooler months of July and May. The 2-3°C increase in seawater temperatures and 650  $\mu\text{E}/\text{m}^2/\text{s}$  rise in light intensities measured between the months of January and July/May suggest that elevated temperatures and light intensities are positively correlated to the progression and transmission of BBD. Temperature manipulations within closed experimental tanks were also performed to determine the effect of elevated temperatures on the rate of BBD progression. Increased rates of BBD progression within the higher temperature treatment (32°C) during summer clearly indicate that elevated temperatures near the upper thermal limits of corals promote the progression of BBD, possibly due to a combination of increased virulence of the pathogen and increased host susceptibility at these higher temperatures. However, the lack of increased progression within elevated temperature treatments (29°C and 31°C) during May trials, raise the question concerning other factors that may also be required to promote the progression of BBD.

The *in situ* rate of spread of brown band syndrome (BrB) on *Acropora muricata* branches was compared between two reefs in the northern and central sectors of the

Great Barrier Reef (GBR). The rate of spread of the syndrome was 2.3 times faster on a lagoon reef at Lizard Island (Horseshoe Reef) than on the reef flat at Davies Reef. Although a combination of parameters is most likely responsible for this variation, the most obvious difference between the two reef sites was the degree of water circulation. Experimentally elevated temperatures in aquarium experiments did not influence the progression of BrB at Lizard Island suggesting that temperature on its own does not enhance the progression of this syndrome. Future research should experimentally investigate whether or not the combination of elevated temperatures and high light intensities, commonly associated with summer months, enhance the progression of this syndrome.

The microbial consortium of BBD isolated from *Acropora elseyi*, *A. florida*, *A. muricata*, *A. nasuta*, *Pocillopora verrucosa*, and *Porites* spp. at Lizard Island consisted of five different taxa of cyanobacteria. Based on morphological characteristics, two of these cyanobacteria taxa appear to belong to the genus *Oscillatoria*, two may be in the Order *Nostocales*, and one of these taxa resembles the morphological features of *Phormidium corallyticum*. However, these predictions are based solely on histological features and further molecular identifications are required before these species can be formally classified. Morphological and molecular studies indicated that the microorganisms associated with BrB on five acroporid colonies from Davis Reef consisted of a newly identified ciliate species and an array of associated bacteria. Analysis of 18S rDNA sequence data confirmed the ciliate as a new species belonging to the Class Oligohymenophora, Subclass Scuticociliatia. Isolation of BrB bacterial species detected a potentially pathogenic strain (HB-8) which was closely affiliated by 16S rDNA comparisons with *Vibrio fortis* strains. Six out of 12 acroporid branches inoculated with this potentially pathogenic strain reached 100% mortality after 48 hours, however the macroscopic signs (brown band) of the syndrome were not observed. This indicates that there are likely two phases of BrB including a tissue necrosis phase, which may be caused by the bacterium strain HB-8, and a ciliate phase which causes the characteristic brown band of the syndrome.

In summary, the rate of progression and spread of BBD and BrB on the Great Barrier Reef appear to be dependent on the response of both the coral host and the disease

pathogen to changing environmental conditions. The higher *in situ* rates of BBD progression and transmission during the summer month of January and the higher rates of BBD progression within temperature treatments experimentally elevated to near the upper thermal limits of corals likely reflect that environmental conditions detrimental to the coral host may simultaneously increase the virulence of the coral pathogen while reducing the coral's immunity. However, it is important to note that the mechanisms causing mortality (i.e. ingestion of tissue versus tissue necrosis) may also have an influence on disease progression. Consequently, in order to fully understand the mechanisms and parameters involved in the progression and transmission of coral diseases, coral disease research should continue to investigate these diseases using an ecological and microbiological approach.

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## TABLE OF CONTENTS

Title.....	i
Thesis Dedication.....	ii
Publications arising from this thesis .....	iii
Abstract.....	iv-vi
Statement of Access.....	vii
Declaration.....	viii-ix
Acknowledgements.....	x
Table of Contents.....	xi-xiii
List of Tables .....	xiv-xv
List of Figures.....	xvi-xix
<b>Chapter 1.0. General introduction .....</b>	<b>1-8</b>
1.1. Prevalence of coral disease .....	1
1.2. Coral disease terminology.....	2
1.3. Potential causes of coral disease .....	2-4
1.4. Pathogens and vectors.....	4-5
1.5. Justification of study species .....	5-6
1.6. Specific objectives .....	6-8
<b>Chapter 2.0. Progression and spread of black band disease and brown band syndrome on the Great Barrier Reef .....</b>	<b>9-35</b>
2.1. Abstract.....	9
2.2. Introduction.....	10-12
2.3. Materials and methods .....	13-18
2.3.1. Study site description .....	13
2.3.2. Sampling design.....	13-16
2.3.3. Rate of progression .....	17
2.3.4. Rate of transmission.....	17-18
2.3.5. Statistical analyses .....	18
2.4. Results.....	19-28
2.4.1. Progression and transmission of black band disease.....	19-23

2.4.2. Progression and transmission of brown band syndrome.....	23-26
2.4.3. Black band disease versus brown band syndrome .....	26-28
2.5. Discussion .....	29-34

**Chapter 3.0. Effect of increasing temperatures on the progression of black band disease and brown band syndrome .....35-57**

3.1. Abstract.....	35
3.2. Introduction.....	36-38
3.3. Materials and methods .....	39-45
3.3.1. Study site.....	39
3.3.2. Field control sampling design .....	39-40
3.3.3. Aquarium setup – black band disease .....	40-42
3.3.4. Aquarium setup – brown band syndrome .....	43-44
3.3.5. Rate of progression .....	44
3.3.6. Statistical analyses .....	44-45
3.4. Results.....	46-52
3.4.1. Effect of temperature on the progression of BBD in January 2004.....	46-47
3.4.2. Effect of temperature on the progression of BBD in May 2004 .....	48-49
3.4.3. Effect of temperature on the progression of BrB in May 2004.....	50-52
3.5. Discussion.....	53-57

**Chapter 4.0. Histopathological examination of the cyanobacterial consortium associated with black band disease on the Great Barrier Reef .....58-75**

4.1. Abstract.....	58
4.2. Introduction.....	59-61
4.3. Materials and methods .....	62-63
4.4. Results.....	64-71
4.4.1. Description of observed cyanobacteria .....	64-70
4.4.2. Description of additional microorganisms within the consortium .....	70-71
4.5. Discussion .....	72-75

**Chapter 5.0. Investigation of the microorganisms associated with brown band syndrome for determination of the causative agent(s) .....76-99**

5.1. Abstract.....	76
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5.2. Introduction.....	77-79
5.3. Materials and methods .....	80-86
5.3.1. Study site and field collections .....	80
5.3.2. Microscopic characterization of ciliates.....	80
5.3.3. Culture-based bacterial plating and isolation.....	80-81
5.3.4. Culture of BrB ciliate .....	81
5.3.5. Extraction and purification of ciliate DNA.....	81-82
5.3.6. Extraction and purification of bacterial DNA.....	82
5.3.7. PCR amplification of 18S rDNA and 16S rDNA .....	82-83
5.3.8. Restriction enzyme analysis of 18S rDNA clone libraries .....	83
5.3.9. Sequencing of 18S rDNA plasmid DNA .....	84
5.3.10. Sequencing of bacterial isolates 16S rDNA.....	84
5.3.11. Sequence alignments and phylogenetic analyses.....	84
5.3.12. Preliminary infection trial .....	85
5.3.13. Infection trials .....	85-86
5.4. Results.....	87-96
5.4.1. Ciliate identification.....	87-88
5.4.2. Clone library construction and ciliate clone identification .....	89
5.4.3. 18S rDNA sequence alignment and phylogenetic analyses.....	90-92
5.4.4. Isolation of bacteria associated with BrB corals.....	92
5.4.5. Preliminary infection trials.....	92
5.4.6. Phylogenetic identification of bacterial strain HB-8.....	93-94
5.4.7. Infection trials .....	95-96
5.5. Discussion.....	97-99
<b>Chapter 6.0. General discussion .....</b>	<b>100-105</b>
6.1. Overall summary.....	100-101
6.2. Host vs. pathogen influences on progression and spread of coral disease....	101-105
6.2.1. Progression and spread of disease from the perspective of coral host..	102-103
6.2.2. Progression and spread of disease from the perspective of pathogen...	103-105
6.3. Conclusions.....	105

## LIST OF TABLES

**TABLE 2.1.** Statistical results for the rate of progression, surface area of tissue loss, and band width of black band disease between months (July, January, and May). A general linear model nested repeated measure test (RM) was used to compare the rate of progression of BBD between months and colonies nested within months.

**TABLE 2.2.** Statistical results for time to infection between months (January and May) and the rate of progression along in situ black band diseased branches used to induce the infection of healthy branches (experimental transmission pairings) and single in situ diseased branches (controls). A one-way analysis of variance test (ANOVA) was used to compare the time to infection between months and a general linear model nested univariate analysis of variance (NANOVA) was used to compare differences in the rate of progression between branches and branches nested within colonies.

**TABLE 2.3.** Statistical results for the rate of progression and band width of brown band syndrome between reef sites (Davies and Horseshoe Reef). A general linear model nested repeated measure test (RM) was used to compare the rate of progression of BrB between sites and colonies nested within sites. A general linear model nested univariate analysis of variance test (ANOVA) was used to compare the band width of BrB between sites and colonies nested within sites.

**TABLE 2.4.** Statistical results for the progression of brown band syndrome along in situ diseased branches used to induce the infection of healthy branches (experimental transmission pairings) and single in situ diseased branches (controls). NANOVA stands for the general linear model nested univariate analysis of variance.

**TABLE 2.5.** Comparative statistical results for the rate of progression and band width of black band disease and brown band syndrome during May 2004. A general linear model nested repeated measures (RM) was used to compare the rate of progression between diseases and colonies nested within diseases. A general linear model nested univariate analysis of variance (ANOVA) was used to detect differences in the width of disease bands between diseases and colonies nested within diseases.

**TABLE 3.1.** Statistical results for the rate of progression and band width of black band disease at two experimental temperature treatments (30°C and 32°C) and a field control during January 2004. A nested repeated measures test (RM) was used to compare the progression of BBD and band width between treatments and tanks nested within treatments.

**TABLE 3.2.** Statistical results for the rate of progression and band width of black band disease at three experimental temperature treatments (27°C, 29°C, and 31°C) and a field control during January 2004. A nested repeated measures test (RM) was used to compare the progression of BBD and band width between treatments and tanks nested within treatments.

**TABLE 3.3.** Statistical results for the rate of progression of brown band syndrome at three experimental temperature treatments (27°C, 28.5°C, and 30.5°C) and a field control during May 2004. A general linear model nested repeated measure test (RM) was used to compare the rate of progression of BrB between temperature treatments and tanks nested within treatments.

**TABLE 3.4.** Statistical results for the band width of brown band syndrome at three temperature treatments (27°C, 28.5°C, and 30.5°C) and a field control during May 2004. A nonparametric Kruskal Wallis test (KW) was used to compare difference in band widths between treatments.

**TABLE 4.1.** Summary of morphological characteristics and location within coral tissues of five cyanobacteria taxa associated with black band disease in Lizard Island, Australia.

**TABLE 5.1.** Phylogenetic affiliations of 18S rDNA sequences retrieved from OTU group 6 clones cultured from *Acropora* coral samples infected with brown band syndrome.

**TABLE 5.2.** Phylogenetic affiliations of 18S rDNA sequences retrieved from OTU groups 1-5 clones cultured from *Acropora* coral samples infected with brown band syndrome.

**TABLE 5.3.** Phylogenetic affiliation of the 16S rDNA sequence retrieved from bacterium strain HB-8 isolated from *Acropora* coral samples infected with brown band syndrome.

## LIST OF FIGURES

**FIGURE 2.1.** Study sites for field measurements of black band disease and brown band syndrome. (a) Horseshoe Reef, off the coast of Lizard Island, Australia (b) Davies Reef, a midshelf reef in the Great Barrier Reef Marine Park ([www.aims.gov.au](http://www.aims.gov.au) images).

**FIGURE 2.2.** Sampling design for measuring the rate of progression, band width, and circumference for black band disease on *Acropora muricata*. The band width was measured during 2004 only.

**FIGURE 2.3.** Sampling design for measuring the transmission of black band disease between branches of *Acropora muricata*.

**FIGURE 2.4.** Sampling design for measuring the rate of progression and band width for brown band syndrome on *Acropora muricata*.

**FIGURE 2.5.** Sampling design for measuring the transmission rate of brown band syndrome between branches of *Acropora muricata*.

**FIGURE 2.6.** Photographic diagram showing brown band syndrome and depicting the tagging method and measurements taken on each branch for both disease states. Photograph taken by Eric Matson.

**FIGURE 2.7.** Average linear rate of progression (measured as cm/day  $\pm$  SE) of black band disease on *Acropora muricata* across time. July 2003 and May 2004 seawater temperatures averaged  $25.7^{\circ}\text{C} \pm 0.5$  and  $27^{\circ}\text{C} \pm 0.5$  respectively, while January 2004 seawater temperatures averaged  $30^{\circ}\text{C} \pm 0.5$ .

**FIGURE 2.8.** Average surface area of tissue loss (measured as  $\text{cm}^2 \pm \text{SE}$ ) of black band disease on *Acropora muricata* across time. July 2003 seawater temperatures averaged  $25.7^{\circ}\text{C} \pm 0.5$ , while January 2004 seawater temperatures averaged  $30^{\circ}\text{C} \pm 0.5$ .

**FIGURE 2.9.** Average band width (measured as cm  $\pm$  SE) of black band disease on *Acropora muricata* across time. January and May 2004 seawater temperatures were measured at  $27^{\circ}\text{C} \pm 0.5$  and  $30^{\circ}\text{C} \pm 0.5$  respectively.

**FIGURE 2.10.** Time taken for in situ black band diseased branches to infect healthy branch fragments (measured in days  $\pm$  SE) on *Acropora muricata* across time. January and May 2004 seawater temperatures were measured at  $30^{\circ}\text{C} \pm 0.5$  and  $27^{\circ}\text{C} \pm 0.5$  respectively.

**FIGURE 2.11.** Average rate of progression (measured as cm/day  $\pm$  SE) of black band disease along in situ diseased *Acropora muricata* branches cable tied to healthy branch fragments (experimental transmission pairings) and single in situ diseased branches (control) on Horseshoe Reef during January 2004.

**FIGURE 2.12.** Comparison of the average rate of progression (measured as cm/day  $\pm$  SE) of brown band syndrome on *Acropora muricata* on two reefs (Davies and



Horseshoe Reef) across time. December 2003 and May 2004 seawater temperatures were measured at  $27.3^{\circ}\text{C} \pm 0.5$  and  $27^{\circ}\text{C} \pm 0.5$  respectively.

**FIGURE 2.13.** Average band width (measured as  $\text{cm} \pm \text{SE}$ ) of brown band syndrome on *Acropora muricata* on two reefs (Davies and Horseshoe Reef) across time. December 2003 and May 2004 seawater temperatures were measured at  $27.3^{\circ}\text{C} \pm 0.5$  and  $27^{\circ}\text{C} \pm 0.5$  respectively.

**FIGURE 2.14.** The rate of progression (measured as  $\text{cm}/\text{day} \pm \text{SE}$ ) of brown band syndrome along in situ diseased *Acropora muricata* branches cable tied to healthy branch fragments (experimental transmission pairings) and single in situ diseased branches (control) on Davies Reef during December 2003.

**FIGURE 2.15.** Comparison of the May 2004 average rate of progression (measured as  $\text{cm}/\text{day} \pm \text{SE}$ ) between black band disease (BBD) and brown band syndrome (BrB) on *Acropora muricata* at Horseshoe Reef, Lizard Island.

**FIGURE 2.16.** Comparison of the May 2004 average band width (measured as  $\text{cm} \pm \text{SE}$ ) between black band disease (BBD) and brown band syndrome (BrB) on *Acropora muricata* at Horseshoe Reef, Lizard Island.

**FIGURE 3.1.** Sampling design for measuring the natural rate of progression and band width for black band disease (BBD) and brown band syndrome (BrB) on *Acropora muricata*.

**FIGURE 3.2.** Sampling design to determine the effect of increasing temperatures on the rate of progression of black band disease in *Acropora muricata* during January 2004.

**FIGURE 3.3.** Sampling design to determine the effect of increasing temperatures on the rate of progression of black band disease in *Acropora muricata* during May 2004.

**FIGURE 3.4.** Sampling design to determine the effect of increasing temperatures on the rate of progression of brown band syndrome in *Acropora muricata* during May 2004.

**FIGURE 3.5.** The average rate of progression ( $\text{cm}/\text{day} \pm \text{SE}$ ) of black band disease on branches of *Acropora muricata* in experimental temperature treatments [ambient ( $30^{\circ}\text{C}$ ) and elevated ( $32^{\circ}\text{C}$ )] and a field control ( $30^{\circ}\text{C}$ ) at Horseshoe reef, Lizard Island in January 2004.

**FIGURE 3.6.** The average band width ( $\text{cm} \pm \text{SE}$ ) of black band disease on *Acropora muricata* in January 2004 on branches acclimated to two experimental temperature treatments [ambient ( $30^{\circ}\text{C}$ ) and elevated ( $32^{\circ}\text{C}$ )] and a field control ( $30^{\circ}\text{C}$ ) at Horseshoe reef, Lizard Island.

**FIGURE 3.7.** Comparison of the average rate of progression ( $\text{cm}/\text{day} \pm \text{SE}$ ) of black band disease on branches of *Acropora muricata* acclimated to three experimental temperature treatments [ambient ( $27^{\circ}\text{C}$ ) and two elevated ( $29^{\circ}\text{C}$  and  $31^{\circ}\text{C}$ )] and a field control ( $27^{\circ}\text{C}$ ) at Horseshoe reef, Lizard Island during May 2004.

**FIGURE 3.8.** Average band width (cm  $\pm$  SE) of black band disease on *Acropora muricata* branches acclimated to three experimental temperature treatments [ambient (27°C) and two elevated (29°C and 31°C)] and a field control (27°C) at Horseshoe reef, Lizard Island in May 2004.

**FIGURE 3.9.** Average rate of progression (cm/day  $\pm$  SE) of brown band syndrome on branches of *Acropora muricata* exposed to three experimental temperature treatments [ambient (27°C) and two elevated (28.5°C and 30.5°C)] and a field control (27°C) at Horseshoe Reef, Lizard Island in May 2004.

**FIGURE 3.10.** Comparison of the average band width (cm  $\pm$  SE) of brown band syndrome on *Acropora muricata* acclimated to three temperature treatments [ambient (27°C) and two elevated (28.5°C and 30.5°C)] and a field control (27°C) at Horseshoe reef, Lizard Island in May 2004.

**FIGURE 4.1.** The number of cases the consortium contains 1, 2, 3, 4, and all 5 of the cyanobacteria taxa associated with black band disease on the Great Barrier Reef (N = 30 coral specimens).

**FIGURE 4.2.** Mean trichome width ( $\mu\text{m} \pm$  SE) of the different cyanobacteria taxa associated with black band disease on the Great Barrier Reef.

**FIGURE 4.3.** Histological photograph of black band disease on the coral *Pocillopora verrucosa*. Cyanobacteria Taxa A appears red in the Picro Gomori stain.

**FIGURE 4.4.** Histological photograph of black band disease on the coral *Acropora florida*. Cyanobacteria Taxa A appears blue in the Gram stain.

**FIGURE 4.5.** Histological photograph of black band disease on the coral *Porites* spp. Cyanobacteria Taxa B and C appear red in the Picro Gomori stain.

**FIGURE 4.6.** Histological photograph of black band disease on the coral *Porites* spp. Cyanobacteria Taxa D appears reddish-purple in the Gram stain.

**FIGURE 4.7.** Histological photograph of black band disease on the coral *Porites* spp. Possible endolithic algae appears red and stringy in the Picro Gomori stain.

**FIGURE 4.8.** Histological photograph of black band disease on the coral *Porites* spp. depicting the hyphae of the unknown fungus.

**FIGURE 5.1.** Experimental design for controlled aquarium infection trials investigating the effect of the most virulent bacteria (HB-8) isolated from brown band syndrome on healthy acroporid branches collected from Davies Reef, Australia.

**FIGURE 5.2.** Scanning electron micrographs of a brown band ciliate showing its external morphology and the buccal cavity (1) on the ventral side. Photos taken by Dr. Kevin Blake, JCU.

**FIGURE 5.3.A. - 5.3.B.** Living specimen of a brown band ciliate showing (1) uniform ciliation, (2) 3 distinct caudal cilia, and (3) zooxanthellae within the ciliate. Photos taken by Neal Young, AIMS.

**FIGURE 5.4.** 18S rDNA gels of (1) Amplified PCR products clones #6-33, (2) *Hha-I* Restriction Enzyme Digests – 6 OTU groups (\*) identified after RFLP analyses.

**FIGURE 5.5.** Phylogenetic tree showing the relationship between the BrB ciliate and selected reference ciliates based on 18S rDNA sequences listed in GenBank. Complete reference sequences were used to initially construct the tree and partial sequences were added later with the special algorithm in the ARB software package (Strunk *et al.* 1998). These additions did not result in changes in the overall tree topology. The sequenced BrB ciliate is denoted in bold face type while the bar represents 10% estimated sequence divergence. The outgroup used in the construction of this tree was the dinoflagellate, *Cryptothecodinium cohnii*.

**FIGURE 5.6.** Phylogenetic tree exhibiting the relationships between the 16S rDNA sequence bacterium strain HB-8 and chosen reference *Vibrio* sequences listed in the GenBank database. Complete sequences were used to construct the tree and did not result in changes in the overall tree topology. The sequenced BrB strain HB-8 is denoted in bold face type while the bar represents 1% estimated sequence divergence. The outgroup used in the construction of this tree was the bacterium *Vibrio cholerae*.

**FIGURE 5.7.** Average percent tissue loss  $\pm$  SE in coral branches exposed to a bacterium strain HB-8, control bacterial strain HB-7, and a control with no bacterial addition across time (hours).

**FIGURE 5.8.** The survival of healthy *Acropora* branch fragments exposed to a bacterium strain HB-8, control bacterial strain HB-7, and a control with no bacterial addition across time (hours).