Coral Disease Prevalence of Coconut Island: a Temporal Study between 2007-08 and 2011

Stephan Bitterwolf[1], Greta Aeby Ph.D.[2] & Marilyn Brandt Ph.D.[1]
[1]University of the Virgin Islands
[2]Hawai'i Institute of Marine Biology

Introduction

- Coral reefs cover less than 0.1% of the ocean surface area and harbor up to 25% of all marine fish species. This ecosystem provides humans services valued at approximately $US375 billion worldwide (NOAA, 2010) .
- Coral disease occurrence is on the rise and, working in synergism with other stressors, has caused an estimated 27% coral cover loss worldwide (Sutherland *et al.*, 2004)
- Hawaii exhibits low coral species diversity. Thus its coral ecosystem could be severely impacted by coral disease.
- In 2007-2008 Williams *et al.* (2010) conducted a disease abundance survey on the reefs of Coconut Island, Oahu, Hawaii. The area has since been subjected to many disease outbreaks including a recent outbreak of *Montipora* white syndrome. In 2011, we conducted an identical survey to that of Williams *et al.* to determine whether community structure has changed and what community factors may be related to disease.

STUDY HYPOTHESIS: Coral community structure has changed in response to increased disease outbreaks and coral disease is associated with community factors including coral cover and size structure.

Methods

- 8 sites within an 800 m^2 area were surveyed around Coconut Island (Fig 1).
- Each site was surveyed with 5 transects, 2x10m each.
- Transects were surveyed for Colony Size/Species & Lesion Presence/Type.
- Lesions documented included predation, *Porites* tissue loss, *Montipora* white syndrome, *Porites* and *Montiporid* growth anomalies, *Porites* bleaching with tissue loss, and *Porites* trematodiasis (Fig 2: A-G).
- Species abundance/disease prevalence was statistically analyzed using 2 way-ANOVAs investigating the effect of site and time.
- Lesion vs. abundance (density and cover) and lesion vs. size class were analyzed with linear or polynomial regressions to investigate relationships.

Coconut Island, Oahu, Hawaii

Fig 1: Site locations around Coconut Island, Oahu, Hawaii.

Lesion Types

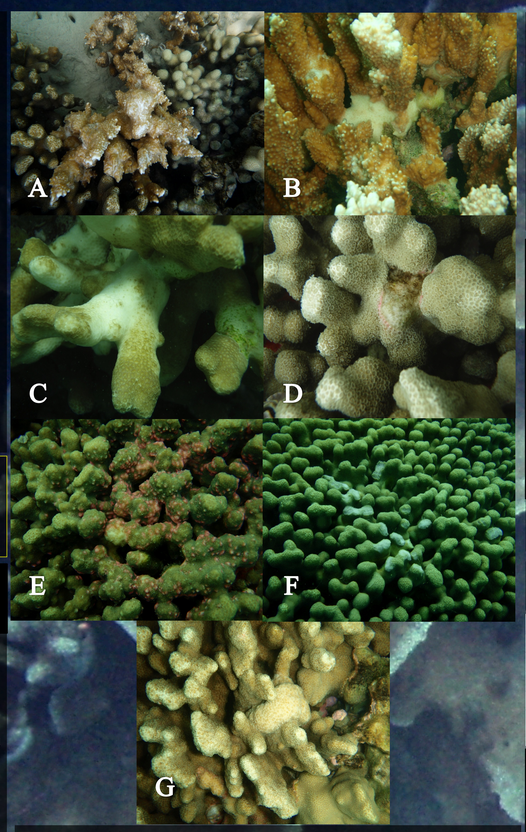


Fig 2: Coral lesions
A: *Montipora* Growth Anomaly B: *Montipora* White Syndrome
C: Bleaching with Tissue Loss D: *Porites* Tissue Loss
E: *Porites* Trematodiasis F: Predation
G: P*orites* Growth Anomaly

Results: Frequency of Disease

- In all, 6189 coral colonies of 4 species (*Fungia scutaria (FC), Montipora capitata (MC), Pocillopora damicornis (PD)* and *Porites compressa (PC))* were surveyed from July-August, 2011.
- 2654 colonies (43%) exhibited one of the following lesion types: 929 predation, 58 bleaching, 8 bleaching with tissue loss (BLwTL), 158 *Montipora* white syndrome (MWS), 257 *Porites* growth anomaly (PGA), 171 *Porites* tissue loss (PTLS), 1068 *Porites* trematodiasis (PorTrem), 5 *Montipora* growth anomaly (MGA) (Fig 3).

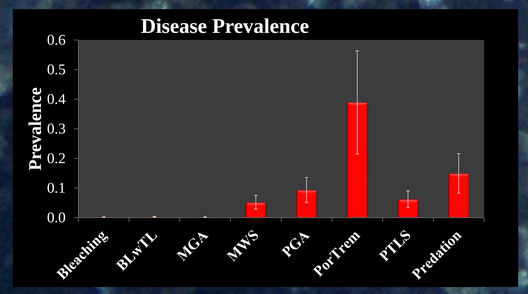


Fig 3: Average disease prevalence (± SEM) for all sites combined in 2011

Results: Change in Host Abundance

- PTLS and PorTrem lesion prevalence showed significant effects of Year and Site (Fig 4).
- MC and PC showed significant effects of site, year and interaction between site and year (Table 1, Fig 5 & 6). At sites H & I a decrease in MC and corresponding increase in PC relative abundance was observed between 2007 & 2011.
- For all other species, abundances were low and no obvious temporal trends were observed between site or year.

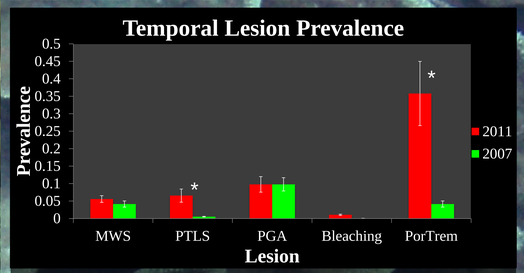


Fig 4: Lesion prevalence (± SEM) by year of survey.
* *indicates significant difference*

Table 1: F Ratio and P value by Species, Site, Year and Interaction between Site & Year

Species	Site		Year		Interaction Site*Year	
	F Ratio	p	F Ratio	p	F Ratio	p
Montipora capitata	19.20	<.05	12.36	<.05	3.95	<.05
Porites compressa	18.34	<.05	17.33	<.05	5.58	<.05
Fungia scutaria	4.97	<.05	1.97	0.07	0.41	0.89
Pocillopora damicornis	0.42	0.52	5.30	<.05	2.52	<.05

Results: Relationship to Community Factors

- PTLS prevalence was significantly related to *P. compressa* abundances ($F = 6.109$, $p < 0.05$, arcsin-root transformation applied). No other relationships were found between disease prevalence and host abundances.
- All lesions, except BlwTL, exhibited significant relationships between size class and prevalence (Table 2, Figures 7-9).

Table 2: Regression formulas for lesions as a function of colony size. * *significant regression,*** *low sample size*

Lesion	Formula	F ratio	p	R^2
MWS	y=0.1546x - 0.3377	172.6392	<.0001*	0.78748
PTLS	y = 0.0807x - 0.1806	58.8812	0.0006*	0.74028
BL	y = 0.0063x - 0.0085	67.5828	0.0012*	0.89643
PGA	y = 0.1243x - 0.2803	35.6806	0.0019*	0.70732
PorTrem	$y = -0.015x^3 + 0.1472x^2 - 0.2502x + 0.1169$	50.2247	0.0046*	0.99391
Predation	y = 0.1519x - 0.276	173.8442	<.0001*	0.9413
BLwTL**	$y = 7*10^{-5}x + 0.0016$	0.3242	0.5937	0.00275

Disease Prevalence vs. Size

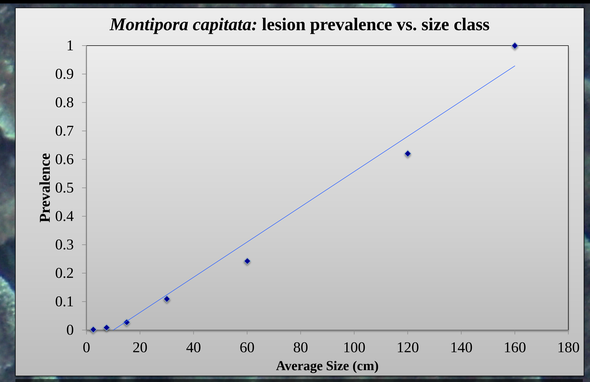


Fig 7: MWS prevalence vs. average colony size with 1st order regression fit.

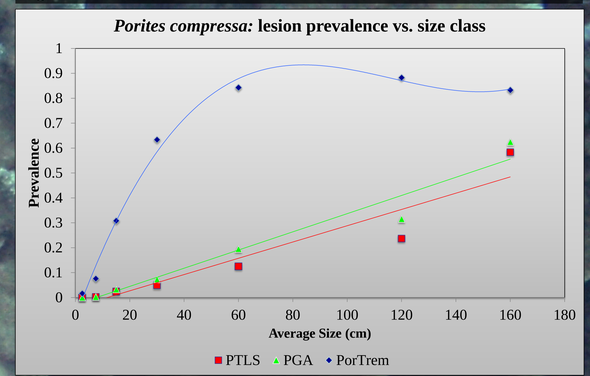


Fig 8: Prevalence of PTLS, PGA and PorTrem on *Poritids* vs. average colony size with corresponding 1st and 2nd order regression fits.

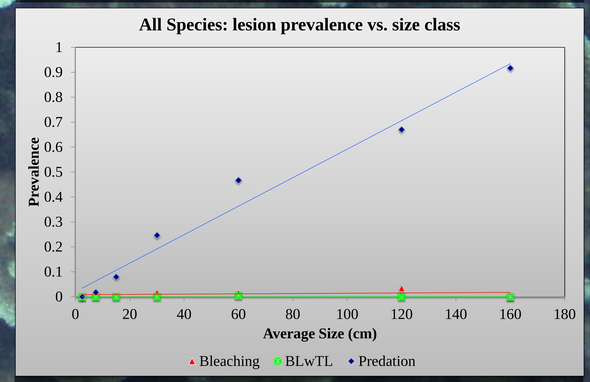
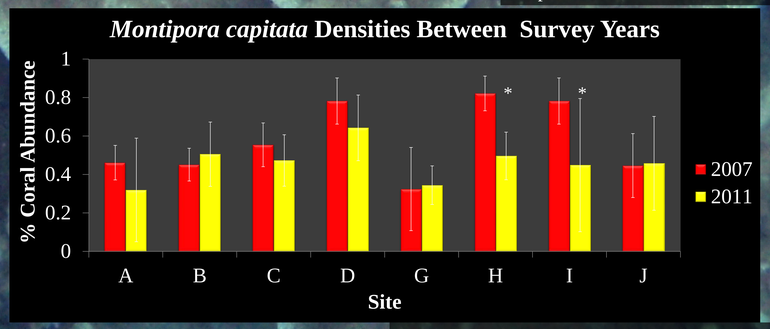


Fig 9: Prevalence of bleaching, BLwTL and predation lesions vs. size class with corresponding linear regressions. These conditions affected all species.



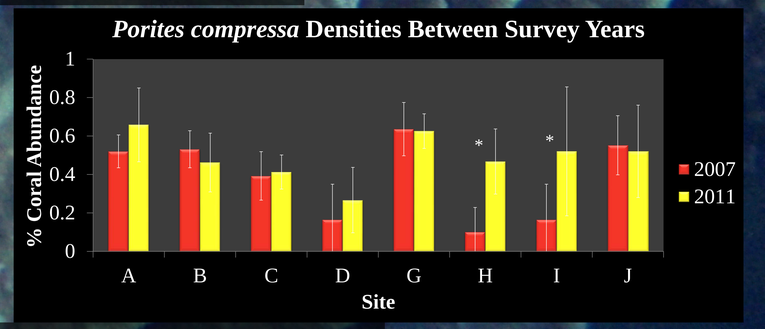


Fig 5 & 6: Relative abundnaces (± SEM) of *Montipora capitata* and *Porites compressa* by site in 2007 and 2011. * *Indicates significant difference determined by post-hoc tests.*

Conclusions

Community change in relationship to disease

- Due to the low coral species diversity in Hawaii, disease can have great implications for benthic composition/community structure, consequently affecting the productivity of the coral reef ecosystem.
- *Montipora capitata* is structurally more complex than *Porites compressa*. At two of the sites with the highest starting *M. capitata* abundances, *M. capitata* declined while *P. compressa* increased.
- Disease may have affected these sites more significantly because of higher starting host densities. The observed change in species composition could mean a decrease in rugosity or habitat space necessary for other species' survival.

Disease levels as a function of site and time

- PorTrem and PTLS showed significant effect of site and time. This may indicate an epizootic lesion outbreak and is not conclusive for lesion prevalence at other times of the year.

Relationships between community factors and disease

- PTLS prevalence vs. abundance showed increasing trend with *Porites compressa* abundance indicating that it may be a population dynamic lesion.
- Lesion prevalence was found to increase with size for all diseases except BLwTL. This may correspond to a greater surface area of contact and increased exposure time to factors leading to lesion development (e.g., predation, pathogens, bleaching, parasitism).

Overall Conclusions

- Results from this study will aid in the identification of important factors influencing coral disease and community change in coral reef communities. Understanding the dynamics of disease among heterogeneous coral reef habitats can provide insight into how disease acts within complex communities.

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"Disease and immunity in Caribbean and

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