AIMS @ JCU

Student Seminar Day 2012
Tuesday, 26th June at AIMS

Time	Title	Presenter
9:00 am	**Opening address**	**Libby Evans-Illidge**
9:15 am	Invading pathogens following physical damage elicit immune response in corals	Jeroen van de Water
9:30 am	Microbial drivers in the development of black band disease	Yui Sato
9:45 am	Corals form characteristic associations with symbiotic nitrogen-fixing bacteria	Kim Lema
10:00 am	Influence of reef-based recreation on coral health and disease	Joleah Lamb
10:15 am	Spatial and temporal patterns of coral mortality on the Great Barrier Reef	James Tan CH
10:30 am	Identification of antimicrobial compounds produced by coral-associated bacteria	Jean-Baptiste Raina
10:45 am	**Morning tea**	
11:15 am	Disrupting pathogenesis? Chemical interference of Quorum Sensing in Australian soft coral	Marnie Freckleton
11:30 am	Revisiting the connectivity puzzle of *Pocillopora damicornis*	Gergely Torda
11:45 am	Connectivity in symbiosis: integrating coral host and *Symbiodinium* spp genetic structure	Patricia Warner
12 midday	Cannibalism on naupliar stages by adult *Acartia sinjiensis*, a tropical *Calanoid copepod*	Thomas Camus
12:15 pm	What drives the narrow intertidal niche of a common coral reef sponge?	Muhammad Abdul Wahab
12:30 pm	**Lunch and tour of AIMS facility and new infrastructure**	
1:30 pm	Reef fish hybridization: lessons learnt from butterflyfishes (genus *Chaetodon*)	Stefano Montanari
1:45 pm	Latitudinal variation in early life history traits of coral reef fishes	Ian McLeod
2:00 pm	Changing feeding preferences of butterflyfishes following coral bleaching	Chiara Pisapia
2:15 pm	A comparison of field methods for assessing boldness in fishes	James White
2:30 pm	Max from the catch? Blood lactate loads of redthroat emperor associated with angling stress and exhaustive exercise	Leanne Currey
2:45 pm	**Afternoon tea**	
3:15 pm	Effects of large-scale storm disturbances on movement and habitat use of coastal sharks within Cleveland Bay	Vinay Udyawer
3:30 pm	Movement and habitat selection of the Australian sharpnose shark *Rhizoprionodon taylori* in a nearshore environment	Samantha Munroe
3:45 pm	Ocean acidification and elasmobranchs: responses of the epaulette shark (*Hemiscyllium ocellatum*) to elevated CO_2	Dennis Heinrich
4:00 pm	**Poster session**	
4:45 pm	**BBQ, drinks & prize presentations**	

9.15am

Invading pathogens following physical damage elicit immune response in corals

Jeroen A. J. M. van de Water[a,b,c,d], Tracy D. Ainsworthc, William Leggat[bc], David G. Bourne[d], Madeleine J.H. van Oppen[c,d], and Bette L. Willis[a,c]

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Reports of rising coral disease prevalence world-wide, indicate that coral diseases have become an important factor contributing to the degradation of coral reefs. Increases in seawater temperature have been shown to affect coral-associated bacterial communities, causing a shift towards pathogenic species. However, factors influencing the onset of coral diseases are still unknown. Physical damage to coral colonies, for example as caused by predation, grazing, cyclones and anthropogenic activities (e.g. diving, fishing), may create lesions that facilitate infection by pathogenic bacteria.

To investigate the role of physical injury in the onset of coral disease, we investigated the response of corals to tissue damage using immunological and microbiological assays. Tissue damage was inflicted on colonies of *Acropora aspera* in its natural habitat and injured colonies were followed over time.

Corals upregulated the expression of fluorescent proteins, indicating a stress and recovery response. Gene expression analysis of immune system-related genes showed two immune responses: an early response, likely to be linked to the initial injury, followed by a second strong and prolonged response, potentially as a reaction to a pathogenic infection. To confirm our hypothesis, changes in the composition of coral-associated bacterial communities and bacterial colonisation patterns are currently being investigated.

In conclusion, we have shown that corals respond quickly to physical damage by eliciting a response that enhances their potential to recover and resist potentially invading pathogenic micro-organisms. However, injury may provide a point-of-entry for pathogens and therefore may play a significant role in the onset of coral disease.

9.30am

Microbial drivers in the development of black band disease

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Black band disease (BBD) is a polymicrobial infection affecting corals worldwide and mechanisms contributing to the development of BBD are poorly understood.
Characteristic cyanobacterium-infected lesions, termed cyanobacterial patches (CP), were found to precede the onset of BBD in ~20% of cases on a GBR reef. Slower progression rates of CP than of BBD indicate that the virulence of lesions intensifies as BBD develops from CP. Concurrently, microbial communities within lesions exhibit transitional changes, including a shift in the dominant cyanobacteria and occurrence of sulphate reducing bacteria (SRB). Bacterial and archaeal communities within CP and BBD and associated microenvironmental parameters were investigated to understand the drivers of microbial dynamics in the development of BBD.
Chemical profiling of the lesions using microsensors illustrated that CP mats are oxygenic and devoid of sulfide in light, whereas BBD mats are anoxic and highly sulfidic in darkness, confirming these microenvironmental factors are keys in the development of BBD. Quantitative PCR targeting the dissimilatory sulphite reductase gene (dsrA) shows that the abundance of dsrA gene copies increased in the transition from CP to BBD. Amplicon-pyrosequencing of archaeal 16S ribosomal RNA genes also showed a shift from aerobic populations in CP to novel archaea related to strictly anaerobic methanogens, syntrophic to SRB, in BBD. Comparative metagenomic approaches to CP and BBD further identified other key players in BBD pathogenicity. These results highlight the importance of sulfur cycle-related microbial communities in the pathogenesis of BBD.

9.45am

Corals Form Characteristic Associations with Symbiotic Nitrogen-Fixing Bacteria

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The complex symbiotic relationship between corals and their dinoflagellate partner *Symbiodinium* is believed to be sustained through close associations with mutualistic bacterial communities, though little is known about coral associations with bacterial groups able to fix nitrogen (diazotrophs). In this study, we investigated the diversity of diazotrophic bacterial communities associated with three common coral species (*Acropora millepora*, *Acropora muricata*, and *Pocillopora damicormis*) from three midshelf locations of the Great Barrier Reef (GBR) by profiling the conserved subunit of the nifH gene, which encodes the dinitrogenase iron protein. Comparisons of diazotrophic community diversity among coral tissue and mucus microenvironments and the surrounding seawater revealed that corals harbor diverse *nif*H phylotypes that differ between tissue and mucus microhabitats.Coral mucus *nif*H sequences displayed high heterogeneity, and many bacterial groups overlapped with those found in seawater. Moreover, coral mucus diazotrophs were specific neither to coral species nor to reef location, reflecting the ephemeral nature of coral mucus. In contrast, the dominant diazotrophic bacteria in tissue samples differed among coral species, with differences remaining consistent at all three reefs, indicating that coral-diazotroph associations are species specific. Notably, dominant diazotrophs for all coral species were closely related to the bacterial group rhizobia, which represented 71% of the total sequences retrieved from tissue samples. The species specificity of coral-diazotroph associations further supports the coral holobiont model that bacterial groups associated with corals are conserved. Our results suggest that, as in terrestrial plants, rhizobia have developed a mutualistic relationship with corals and may contribute fixed nitrogen to *Symbiodinium*.

10.00am

Influence of reef-based recreation on coral health and disease

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Although first-hand experience of coral reefs is one of the best ways to promote public awareness of conservation issues, achieving the dual objectives of providing recreational opportunities and preserving natural environments is challenging. Much of what is currently known about the effects of recreation and tourist activities on coral reefs comes from studies of changes in percent coral cover or impacts associated with direct physical damage and breakage. The results of previous studies show that the effects of recreation and tourism activities on corals are few and isolated. However, a variety of human-related disturbances have been associated with elevated levels of coral disease and ongoing tissue loss caused by even slowly progressing diseases could cause greater levels of coral mortality than immediate but short-term effects associated with localized breakage. In partnership with reef managers and industry partners, we conducted coral health surveys at sites with both low and high-levels of tourism and recreational activities over several years. Our results suggest that coral disease prevalence may represent a more valuable metric for identifying local impacts associated with human activities on coral reefs. Establishing clear and long-term monitoring protocols, coupled with reactive management strategies will ensure ongoing conservation of coral assemblages and recreational activities on the GBR.

10.15am

Spatial and temporal patterns in coral mortality on the Great Barrier Reef

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Disturbances on coral reefs are predicted to increase consequently of global warming, however, the effect of disturbance on coral population dynamics remains unclear. This study quantified the mortality of 180 tagged *Acropora millepora* colonies: 30 at each of two sites at each of three locations along the Great Barrier Reef, between April 2009 and April 2011. Contrary to prevailing theories, neither whole-colony nor partial-colony mortality were related to colony size. Partial-colony mortality rates varied seasonally, and were generally higher between December and April, possibly reflecting seasonal stress associated with warmer water and high light during summer months. During the first year, 20% of colonies died and most mortality occurred in the Palm Islands. In the second year whole-colony mortality increased 70%. Five of the six sites were affected by acute disturbances that caused high whole-colony mortality: Cyclone Ului in the Whitsundays (March 2010), flooding of the Fitzoy River in the Keppels (January 2011) and Cyclone Yasi in the Palms (February 2011). Spatial patterns of mortality varied with the type of disturbance. Whole-colony mortality was patchy in response to category 3 Cyclone Ului: 75% of colonies at Hook Island died, but no whole-colony mortality was recorded at Mid-Molle Island just 3km away. In contrast, the flooding of Fitzroy River killed 100% of colonies in the Keppels. In the course of this study acute disturbances caused higher proportion of tissue loss than chronic disturbance. If acute disturbances increase as climate change predictions suggest, coral population dynamics are likely to be vastly altered.

10.30am

Identification of antimicrobial compounds produced by coral-associated bacteria

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Bacterial communities associated with healthy corals have long been suspected to produce antimicrobial compounds potentially inhibiting the colonization and growth of invasive microbial species and potential pathogens. To date, however, bacteria-derived antimicrobial molecules have not been identified nor characterized. Here we report the isolation of two antimicrobial compounds produced by bacteria associated with three common species of reef-building corals. All bacterial strains were selected because of their demonstrated ability to degrade dimethylsulfoniopropionate (DMSP), a sulfurous molecule produced by reef-building corals and suspected to play a role in structuring healthy coral-bacteria associations. All strains inhibited the growth of the coral pathogen *Vibrio coralliilyticus* (the causative agent of some white syndromes in the Indo-Pacific) and a newly identified marine pathogen *V. owensii* in agar diffusion assays. Flash column chromatography and HPLC were used to isolate the antimicrobial compounds and spectroscopic techniques, including nuclear magnetic resonance spectroscopy (NMR) and mass spectrometry (MS), enabled their identification. One of the antimicrobial molecules was identified as thiotropocin, a sulfur-containing compound likely derived from DMSP catabolism. Thiotropocin was produced in large quantities by the coral-associated bacteria *Pseudovibrio spp*., and prevented the growth of *V. coralliilyticus* and *V. owensii* at very low concentrations (<1µg/ml). Whole genome sequence of this isolate provided insights into its DMSP-metabolising and thiotropocin-producing capabilities. These results provide additional evidence for the integral role of DMSP in structuring coral-associated bacterial communities and the ability of these DMSP-metabolizing communities to contribute to coral disease prevention.

11.15am

Disrupting Pathogenesis? Chemical Interference of Quorum Sensing in Australian Soft Coral

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Soft Corals, important members of the marine benthos, produce bioactive secondary metabolites and, unlike scleractinian corals, rarely demonstrate signs of bacterial infection. Quorum Sensing is a known mechanism of virulence regulation in pathogenic coral bacteria, whereby small molecules known as acyl homoserine lactones (AHLs) trigger pathogenesis. The dominant secondary metabolites of soft corals, cembranolides, share structural similarities with these bacterial signalling molecules.

We hypothesised that soft corals interfere with Quorum Sensing and potential infection through these cembranolide molecules. To this end, the bacterial biosensors *Agrobacterium tumefaciens* A136 and *Chromobacterium violaceum* CV026, were used to screen extracts of 16 soft coral specimens collected from Orpheus Island on the Great Barrier Reef for their ability to activate or inhibit AHL regulated Quorum Sensing. Eight of the 16 soft corals tested demonstrated interference with Quorum Sensing. The active fractions isolated all contained cembranoid metabolites.

Four cembranolide molecules: Isolobophytolide, Lobolide, Flexibilide and dihydro-Flexibilide were isolated from the genera *Lobophytum* and *Sinularia* and tested for interference of Quorum Sensing. The activity profiles of these compounds reflect the level of structural similarity to bacterial Quorum Sensing molecules.

The results of this study indicate that cembranoid compounds are involved in interactions with soft coral associated bacterial communities. The purified compounds will now be assessed for their interference with Quorum Sensing regulated biofilm formation and virulence factor production in soft coral bacterial isolates and known hard coral pathogens.

11.30am

Revisiting the connectivity puzzle of *Pocillopora damicornis*

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Pocillopora damicornis (Linnaeus, 1758) is a widespread and common scleractinian coral on the Great Barrier Reef (GBR), comprised of five newly identified, reproductively isolated, genetic lineages. It is one of the most extensively studied coral species, yet its reproductive biology, population genetic structures and connectivity rates remain poorly understood. Here we present the results of a population genetic study from the GBR that focused on the two most common genetic lineages within the species complex. The analyses revealed spatially complex genetic structure, including both high genetic similarity over hundreds of kilometres, and sharp genetic breaks among adjacent populations. Despite the common occurrence of asexual reproduction in this species, relatively low numbers of clonal offspring were found. An opportunistic life history strategy that maintains options for both sexual and asexual reproduction and suits short and long pelagic larval phases, combined with spatial and temporal stochasticity in water circulation patterns, potential hybridization, and high predator pressure on asexually produced, brooded larvae may explain these patterns. The results of this study contribute to our understanding of coral reef connectivity, and may feed into science-based reef management planning.

11.45am

Connectivity in symbiosis: Integrating coral host and *Symbiodinium* spp. genetic structure

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While most coral species have broad geographic distribution ranges and larvae with significant dispersal potential, coral recruitment is mostly localized. Here, we assess genetic population structure in the brooding coral, *Seriatopora hystrix*, at local and regional scales (100s m – 100s km) in order to infer the shorter range of larval dispersal occurring locally, and how that drives broad-scale connectivity of this species along the Great Barrier Reef. Moreover, we integrate genotypic data from both host and vertically-transmitted algal symbiont (*Symbiodinium* sp.) populations to facilitate a comprehensive understanding of the dispersal ecology of this symbiotic partnership. We sampled coral colonies from two sites at each of five reefs in the Palm Islands and four reefs at Lizard Island, Australia (n≈850). Each island region was further separated into two habitats: sheltered-shallow (<6m) and exposed-deeper (7-15m) margins of islands. All samples were genotyped at ten host microsatellite markers. Samples from half of the sites were also genotyped for ITS2 Symbiodinium type and eight microsatellite loci to explore *Symbiodinium* population structure and diversity. Our results indicate that the coral host populations are highly structured according to habitat, as connectivity between patches of the same habitat (i.e. sheltered or exposed) even between regions was higher than that between habitats (i.e. sheltered vs. exposed) within regions. Moreover, different ITS2 Symbiodinium types in sheltered and exposed host populations support strong genetic and ecological separation. In comparison to studies limited to coral or algae alone, concurrent information from both partners allows a more holistic understanding of coral connectivity. Understanding the patterns and processes of connectivity, particularly at local scales, allows recognition of essential populations and habitats and provides direction to successful conservation and management efforts.

12.00midday

Cannibalism on naupliar stages by adult *Acartia sinjiensis*, a tropical calanoid copepod

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Cannibalism, defined as intraspecific predation, is believed to play a major role in limiting copepod productivity, especially under intensive culture conditions. The present study will investigate cannibalism in *Acartia sinjiensis*, a tropical calanoid copepod indigenous to North QLD with high potential as live feed for marine hatchery.
Cannibalism by adult females was significantly higher than by males (1.2±0.3 vs 0.1± 0.1 nauplii/copepod-1/day-1; $p < 0.05$). Early nauplius stages (NI to NIII) were significantly ($p < 0.05$) more susceptible to adult female predation than the later naupliar stages (2.2± 0.6 vs 0.4±0.2 nauplii/female-1/day-1). Both the quantity of microalgae provided as food ($p < 0.05$) and naupliar prey density ($p < 0.01$) significantly influenced female predation rates. When microalgal food ration was increased from 50% to 100% of the optimal feeding concentration the average cannibalism rate decreased significantly ($p < 0.05$) from 1.8±2.1 to 1.0±1.6 nauplii female-1 day-1. Meanwhile, average predation rate increased significantly with prey concentration ($p < 0.01$) from 0.0±0.0 nauplii female-1 day-1 at a prey density of 1 nauplius l-1 to 5.7±0.5 nauplii female-1/day-1 when naupliar concentration was up to 1320 l-1. Predator starvation was also found to be a factor significantly influencing *A.sinjiensis* cannibalistic behaviour ($p < 0.01$). The average predation rate was 1.4±0.2 nauplii female-1 day-1 when predators were fed, increasing to 3.1± 0.3 nauplii female¬1 day-1 when predators were starved for a duration of 24h. Knowledge obtained from these experiments will be significant in improving management of *A.sinjiensis* culture for aquaculture hatcheries.

12.15pm

What drives the narrow intertidal niche of a common coral reef sponge?

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The dispersive larval phase of sessile organisms such as sponges allows for population replenishment, habitat colonization and range expansion, and is a key factor in species maintenance and persistence. *Phyllospongia* sp. is a common coral reef sponge but is paradoxically only found on intertidal reefs (+0.2 – 0.9m). To explore the biological and ecological processes that define the narrow niche of this sponge, larval supply and release, and key larval pre-settlement behaviours were quantified, including the influence of habitat specific cues (biofilms) on larval settlement and metamorphosis. *Phyllospongia* sp. spawn consistently throughout the year producing up to 800 larvae sponge-1 day-1 during daylight hours over the peak spawning period (October to December). When released larvae are negatively phototaxic and swim to the bottom but can migrate to the water surface up to 22h post-release upon removal of a light cue (nightfall), thereby facilitating dispersal. However, all larvae adopt a demersal habit after 34h post-release. At the benthos, intertidal and subtidal biofilms accelerate settlement (intertidal = 15.0% ± 0.6, subtidal = 17.0% ± 0.4 and sterile = 0% at 6h post-release) and increase final metamorphosis (intertidal = 62.0% ± 0.5, subtidal = 17.0% ± 0.7 and sterile = 34.0 ± 0.4 at 46h post-release) with an equal likelihood of larvae settling successfully to either habitat. These results demonstrate the larval dispersal potential for *Phyllospongia* sp., which is inconsistent with the extremely narrow niche of adult populations. This suggests an important role for post-settlement processes in the successful recruitment of this species.

1.30pm

Reef fish hybridization: lessons learnt from butterflyfishes (genus *Chaetodon*)

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Natural hybridization is widespread among coral reef fishes..However, the ecological promoters and evolutionary consequences of reef fish hybridization have not been thoroughly evaluated. Butterflyfishes form a high number of hybrids and represent an appropriate group to investigate hybridization in reef fishes. This study provides a rare test of terrestrially derived hybridization theory in the marine environment by examining hybridization between *Chaetodon trifasciatus* and *C. lunulatus* at Christmas Island. Overlapping spatial and dietary ecologies enable heterospecific encounters. Nonassortative mating and local rarity of both parent species appear to permit heterospecific breeding pair formation. Microsatellite loci and mtDNA confirmed the status of hybrids, which displayed the lowest genetic diversity in the sample and used a reduced suite of resources, suggesting decreased adaptability. Maternal contribution to hybridization was unidirectional, andnointrogression was detected, suggesting limited, localized evolutionary consequences of hybridization. Comparisons to other reef fish hybridization studies revealed that different evolutionary consequences emerge, despite being promoted by similar factors, possibly due to the magnitude of genetic distance between hybridizing species. This study highlights the need for further enquiry aimed at evaluating the importance and long-term consequences of reef fish hybridization

Montanari, S. R., van Herwerden, L., Pratchett, M. S., Hobbs, J.-P. A. & Fugedi, A. 2012 Reef fish hybridization: lessons learnt from butterflyfishes (genus *Chaetodon*). *Ecology and Evolution* **2**, 310-328.

1.45pm

Latitudinal variation in early life history traits of coral reef fishes

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Water temperature is one of the main environmental factors controlling the physiological processes of fish larvae and ocean temperature is predicted to increase with global warming. Experimental studies have shown a strong relationship between temperature and early life history traits such as larval growth, condition and pelagic larval duration. However, the effects of temperature on coral reef fish larvae have received little attention in the natural environment. The present study examined latitudinal variations in early life history traits of five species of coral reef fish from two families (Pomacentridae and Labridae) in relation to natural latitudinal temperature variation. Recently settled fish were collected from nine locations from northern Papua New Guinea (Kavieng) to the southern Great Barrier Reef, spanning 21° of latitude. Otolith microstructure was analyzed to assess pelagic larval duration (PLD), daily growth, size at age, condition (for the *Labrid* species) and size at settlement. Preliminary results from latitudinal comparisons for two species revealed an optimal temperature slightly above 29°C where the highest larval growth, shortest PLDs, and largest settlement size were observed with fish collected from the northern Papua New Guinea (warmest) sites having lower larval growth and longer PLD's. This latitudinal pattern was likely to be shaped by either: 1) Species-wide thermal optima, 2) local adaptation, or 3) location-specific environmental and demographic characteristics. The significant correlations of early life history traits with natural temperature gradients strongly emphasize the susceptibility of fish larvae to expected oceanic temperature increases.

2.00pm

Changing feeding preferences of butterflyfishes following coral bleaching

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Climate-induced coral bleaching poses a significant threat to reef fishes, especially for those fishes that rely on corals for food. Aside from the direct effects of coral loss, whereby many fishes decline in abundance in accordance with loss of live coral, coral-feeding fishes often exhibit a reduction in feeding intensity upon bleached colonies. These observations suggest that the nutritional quality of bleached corals may be compromised, but this is yet to be examined. In this study, we compared feeding preferences of coral-feeding butterflyfishes on bleached versus unbleached corals, and quantified total lipid content of the corals to assess whether changes in prey preferences reflected changes in food quality. The study was conducted in experimental aquaria with two species of corallivorous butterflyfish *Chaetodon plebeius*, and *Chaetodon lunulatus*. Only *C. plebeius* reduced feeding on bleached coral colonies compared with healthy (unbleached) colonies, while *C. lunulatus* showed no preference in feeding between bleached and unbleached corals. However, no decline in total lipid content of corals was observed following bleaching, suggesting that it is not changes in prey quality (measured based on total lipid content) that led to observed changes in patterns of prey use.

2.15pm

A comparison of field methods for assessing boldness in fishes

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Boldness represents the propensity of an animal to take risks and reflects a growth/mortality trade-off. Many techniques are used to assess the boldness of individual animals using variations on novel-object or novel-environment tests. However, it is unknown how these measures compare or whether they assess behaviours in relation to an ecological aspect of fitness. This study compares individual's in four variations of these tests, their relationship with survival, and inter-observer consistency. Newly metamorphosed damselfish, *Pomacentrus moluccensis*, were placed onto patches of cleared habitat. Individual behaviours were quantified under four tests: overall activity within and latency to being released into a novel environment, and reactions to threatening and benign novel objects. Individual survival was monitored twice daily for 2 days, after which ~40% of fish died. No single measure adequately described the boldness-survival relationship. However, a combination of novel environment tests did, encompassing many measures which influenced survival (latency at release, maximum distance ventured, and feeding rate). Observer variation was low for most measures except distance moved and threat tests. Measures which described natural behaviours of an individual within a new environment were useful for assessing the boldness-survival relationship. Novel object tests were more difficult to quantify and provided limited additional value.

2.30pm

Max from the catch? Blood lactate loads of redthroat emperor associated with angling stress and exhaustive exercise

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Capture of the important fishery species, redthroat emperor (*Lethrinus miniatus*), results in elevated blood lactate levels reflective of intense muscular activity. Since excessively elevated lactate has been linked with decreased survival, we measured baseline, post-angling and absolute maximum attainable lactate levels for *L. miniatus* to estimate the general condition of fish released following a standard fisheries capture. Onboard a research vessel, whole blood lactate was measured from timed blood samples (n = 27). Mean baseline lactate levels were low (1.5 ± 0.1 mmol L-1), obtained from initial measurements within two minutes of landing. The time required to attain peak lactate loads post-capture was determined by repeated blood samples (5 and 15 minutes or 2 and 30 minutes post-capture) from fish that were allowed to recover in tanks onboard. Peak lactate occurred between 15 and 30 minutes and reached a value around 6 mmol L-1. The maximum attainable lactate load of 10.9 ± 0.5 mmol L-1 was determined from fish subjected to a chasing and air exposure treatment during a 60 minute period post-capture, which was significantly higher than all other measurements ($F = 97.727$, d.f. = 61, $p < 0.001$). Thus, the lactate response to angling and handling was significantly lower than maximum attainable values, suggesting that *L. miniatus* is not maximally exhausted during a standard fisheries capture. Low lactate levels for released fish combined with preliminary movement data suggest high post-release survival for this species.

3.15pm

Effects of large-scale storm disturbances on movement and habitat use of coastal sharks within Cleveland Bay

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Cyclones are extreme weather conditions that are experienced on a regular basis during the wet season in the tropics. Behavioural responses to these severe weather conditions have been documented in many species with previous research reporting flight behaviour during the onset of such conditions in elasmobranchs, teleosts and marine reptiles. The use of environmental cues as indicators for this behaviour is examined using movement data for four elasmobranch species (*Carcharhinus tilstoni*, *C. sorrah*, *C. amboinensis* & *C. melanopterus*). The presence and movements of individuals were recorded via an array of acoustic receivers deployed within Cleveland Bay during Cyclone Anthony and Cyclone Yasi. Environmental parameters including barometric pressure, wind speed, and wave height were investigated in conjunction with presence data. Individuals were recorded leaving the study site prior to or during the storm events. Interestingly, flight behaviour was observed in young-of-the-year and juvenile individuals that have not experienced such conditions before, which may suggest that this behavioural response is innate. The majority of the animals that left prior to the arrival of these events returned to the study site after the passage of the cyclones, which further validates this behaviour as a flight response to extreme storm conditions. For the animals that did not return, this extreme weather event may have led to a re-distribution of individuals and/or temporary dispersal from the region.

3.30pm

Movement and habitat selection of the Australian sharpnose shark *Rhizoprionodon taylori* in a nearshore environment

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Species vulnerability to environmental change is in part determined by their resource use strategies, specifically distribution and habitat selection. However, little is known about the habitat preferences of many species and it is unclear how species use ecosystems or are affected by change. To define the spatial utilization and habitat selection patterns of a locally abundant shark species, 17 Australian sharpnose sharks *Rhizoprionodon taylori* were monitored in Cleveland Bay, Townsville, QLD using a passive acoustic telemetry array. Spatial utilization was analysed by defining activity space using 50% and 95% kernel utilization distributions (KUDs). Habitat selectivity was assessed across five benthic habitat types (outer bay, seagrass, reef, sandy inshore and intertidal mudflats) and quantified using Strauss's linear index of selectivity. Sharks were monitored for 1 to 60 days and revealed varying movement patterns. Activity space ranged between 7.9 to 28.5 km^2 (mean 14.7 km^2) for 50% KUDs and 27.8 to 114.0 km^2 (mean 54.1 km^2) for 95% KUDs. Preliminary results indicate *R. taylori* utilized all habitats in Cleveland Bay but spent the majority of time in outer bay (37.2%) and seagrass habitat (34.2%); and little time in intertidal mudflats (1.7%). Strauss's index showed *R. taylori* selected for multiple habitats, specifically outer bay, seagrass, and sandy inshore. However, individual patterns were highly variable, with individuals selecting for different habitat assemblages. These findings support the hypothesis that *R. taylori* are habitat generalists and would be less affected by environmental changes than species that are dependent on a single habitat.

3.45pm

Ocean acidification and elasmobranchs: Responses of the epaulette shark (*Hemiscyllium ocellatum*) to elevated CO_2

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Ocean acidification is a major issue associated with rising atmospheric CO_2 concentrations. However, early research on the matter has been focused on certain groups of calcifying organisms. Only in recent years there has been an increasing interest in the effects of elevated CO_2 on marine fishes. A number of studies have demonstrated significant negative effects on the olfactory and auditory behaviour, as well as the behavioural lateralization in reef fishes. Furthermore, it has been shown that ocean acidification may have severe impacts on the growth and development of early life history stages, whilst lowering the aerobic scope in juveniles and adult teleosts. However, this recent research effort did not expand beyond the group of marine teleosts, with the effects on condrichtyans remaining unknown. We will investigate the effects of ocean acidification on the epaulette shark (*H. ocellatum*), a small long-tailed carpet shark commonly found on reef flats on the GBR, with respect to its physiological and behavioural response. We will be testing the effects of a long-term exposure to elevated CO_2 (~550 and ~950 atm) on the metabolic rate, using oxygen consumption rate as a proxy. Further experiments will include the investigation of a behavioural effect during food stimuli and the comparison of critical oxygen values between treatment groups and current day controls. The results will provide an insight to the potential effects of ocean acidification on elasmobranchs and help us understand the implications for some of the top predators of the ocean. The response of the epaulette shark with respect to its extraordinary tolerance to short-term hypoxia will be of particular interest due to its importance for the survival on reef flats.

Poster

Benthic nitrogen cycling in a shrimp farm settlement pond

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Effluent from aquaculture ponds is an increasing source of anthropogenic nitrogen (N) to coastal areas worldwide. "Zero net nutrient discharge" regulations proposed for land-based aquaculture across tropical Australia will require sound mitigation measures to treat effluent prior to release. Currently, settlement ponds are used to clarify aquaculture effluent. However, there are opposing biogeochemical processes in settlement ponds. The mineralisation of settled organic matter returns dissolved N back into the effluent. In addition, the processes of dissimilatory nitrate reduction to ammonia (DNRA) and inorganic N immobilisation conserve fixed N within the system. In contrast, denitrification and anammox are the only microbial processes capable of complete removal of fixed N from these ponds. The net result of these opposing processes determines the remediation capacity of the settlement pond, but few studies have ever quantified their rates or potential. In this study we employed state of the art isotope tracer techniques to quantify the rates and relative importance of the major biogeochemical N pathways in shrimp farm settlement ponds.

Poster

Interactive effects of live coral and structural complexity on the recruitment of reef fishes

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Coral reefs are subjected to multiple disturbances that modify levels of coral cover and structural complexity of the reef matrix, and in turn influence the structure of associated fish communities. With disturbances predicted to increase, insight into how changes in substrate condition will influence the recruitment of many fishes is essential for understanding the recovery of reef fish populations following biological and physical disturbances. While studies have revealed that both live coral cover and structural complexity are important for many fishes, there is a lack of understanding regarding how a combination of these changes will impact the recruitment of fishes. This study used experimentally constructed patch reefs consisting of six different habitat treatments; three levels of live coral cover (high, medium, low) crossed with two levels of structural complexity (high, low), to test the independent and combined effects of live coral cover and structural complexity on the recruitment and recovery of fish communities. The abundance and species diversity of fishes varied significantly among the six habitat treatments, but differences were not clearly associated with either coral cover or structural complexity and varied through time. More striking, however, was a significant difference in the composition of fish assemblages among treatments, due mostly to disproportionate abundance of coral-dwelling fishes on high coral cover, high complexity reefs. Overall, it appears that coral cover had a more important influence than structural complexity, at least for the contrasting levels of structural complexity achieved on experimental patch reefs. Furthermore, we found that live coral cover is important for the recruitment of some non-coral dependent fishes. This study confirms that live coral cover is critical for the maintenance of high biodiversity on tropical coral reefs, and that sustained and ongoing declines in coral cover will adversely affect recruitment for many different species of reef fishes.

Poster

The role of non-reef sharks in coral reef ecosystems: movements and trophic ecology of top predators along the Great Barrier Reef

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Recent studies have reported large declines in reef-associated shark populations worldwide, which have increased management and conservation concerns. Sharks are thought to play a significant ecological role as top predators in aquatic ecosystems, and their disappearance may be linked to the release of prey populations from predatory control, followed by other changes in the ecosystem through indirect trophic cascades. Reef-associated sharks are thought to exhibit limited movement and strong site fidelity to coral reefs and thus may benefit from marine protected areas. However, movement patterns of reef sharks are poorly understood, and there is little empirical data available on their degree of site attachment to coral reefs. Additionally, other species of sharks that are not considered reef-associated (or residents) have also been reported in or near coral reefs, suggesting that reef ecosystems may potentially provide habitat and resources to other large marine predators. In order to better understand the role of sharks in reef ecosystems it is important to understand how long they spend in or near reef habitats, what type of habitats and depths are they using, if they move between reefs or to other adjacent areas, whether or not they exhibit diel and seasonal movements, and if these movements occur in predictable patterns. In this study, abundance data, acoustic telemetry and stable isotopes analysis will be used to examine the distribution, movements, habitat utilization and trophic ecology of reef and non-reef sharks in reef ecosystems along the Great Barrier Reef. This information is crucial in defining the ecological role of sharks in coral reef habitats.

Poster

Functional Groups and Coral Reef Health

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Coral reefs around the globe experience various levels of degradation. Although some are considered to be healthy and well managed, other coral reefs show strong signs in the reduction of functions and processes. Human induced impacts on critical functional groups, weakens and reduces the links and processes within the system. Overfishing of herbivores can consequently increase macroalgae populations beyond a beneficial threshold to a state where increased biomass is negative to the system. The composition of functional groups shows great diversity between reefs and between habitats within one single reef. The question is if the composition of functional groups changes in a system less exposed to human disturbance. Ningaloo reef on the west Australian coast is a unique reef ecosystem due to its west-continental location and relative low human impact. Ningaloo has limited documented history of commercial fin-fishing, minimal fresh water run-off and low human development hence is dominated by natural disturbances like high wave energy and cyclones. It was therefore of interest to map the distribution of herbivorous functional groups within this coral reef ecosystem.

Poster

A new model for predicting nitrate/nitrite dynamics in microalgal batch cultures

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Although rarely considered in nutrient-limited microalgal models, nitrite can be an important nitrogen source, as it can be either released due to incomplete reduction of nitrate, or taken up to supplement low nitrogen availability. Predicting nitrite dynamics from nitrate supply is important, as imbalance can be costly for both microalgal aquaculture facilities and for the remediation of nitric oxide from flue gas. For aquaculture, undersupply of nitrate results in reduced biomass yields, whereas an oversupply of nitrate requires expensive wastewater treatment. Conversely, for nitric oxide remediation from flue gas from coal-fired power stations, excessive nitrate provision can result in extracellular build up of nitrite, driven by incomplete reduction of nitrite to ammonium and the conversion of flue gas NOx to nitrite in water. A multi-nutrient quota model was therefore modified to describe the coupled dynamics of nitrate and nitrite utilization for four microalgal species, *Picochlorum atomus*, *Nannochloropsis oculata*, *Isochrysis sp*., and *Pyrocystis lunula*. The model accurately characterizes the dynamics of nitrite uptake and excretion, nitrate uptake and assimilation efficiency, and population growth for the study species in batch culture, despite the fact that the species display a range of qualitatively different nutrient utilization patterns. The good performance of the model suggests that per-capita secretion and re-assimilation of nitrite, together with changes to the per capita internal nitrogen supply, can be inferred from daily observations of medium nitrate/nitrite utilization and population growth. Our model therefore provides a new framework for describing and predicting nitrite utilization in microalgal cultures.

Poster

Thermal stress-related gene expression in corals with different *symbiodinium* types

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The endosymbiotic relationship between scleractinian corals and *Symbiodinium* spp underpins the biodiversity and productivity of coral reefs worldwide. The genetic and physiological characteristics of *Symbiodinium* have large effects on coral host physiology and thermal tolerance; however, the degree to which molecular responses to thermal and oxidative stress vary among corals with different symbiont types is still not well understood. We examine gene expression in response to laboratory-based thermal stress in 1 year-old juveniles of *Acropora millepora* hosting different dominant *Symbiodinium* types. We detected significant changes in symbiont dominance through time, with 59.7% of coral juveniles changing their symbiont type during a 12-month growth period in the wild and 22% hosting two types simultaneously. Only three of 50 genes with a putative role in heat and oxidative stress were differentially expressed. Heat Shock Proteins 70 and 90 were expressed at higher levels in juveniles hosting multiple symbiont types during early stages of heat stress, whereas a NOS-interacting gene (a gene regulating nitric oxide production) was up-regulated concurrently with a decline in maximum quantum yield during heat stress. Our results support an important role for symbiont complements in the transcriptomes of corals and highlight high variability among individuals.

Poster

Modelling Site-specific Suspended Sediment Concentration for Optimum Dredge Operation Management

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Seafloor sediment dredging is necessary for the construction of marine structures but poses a mortality risk to marine ecosystems due to elevations in suspended sediment. Coral reef habitat loss has been attributed to elevated suspended sediment concentration (SSC) levels during dredging operations, however different coral species respond differently depending on the intensity, frequency and duration of SSC levels. Establishing water quality thresholds for dredge-related SSC levels is a complex issue due to the variation in sediment processes and ecosystem response at different sites. Water quality threshold levels at new dredging sites are often not established or are too broad for optimum management. Quantifying the impact of dredging on SSC levels requires decoupling the naturally occurring and dredge-induced SSC levels. This project will decouple the SSC source by modelling pre-dredge SSC levels using estimates of primary re-suspension processes; waves and tidal currents. Dredge induced SSC levels will then be estimated by comparing in situ SSC levels during dredging operations to model predictions. A dredging risk index will be established to reflect the extent of increased dredge related SSC, and can be correlated to coral health to establish appropriate water quality thresholds. An appropriate data analysis method will be developed to identify ecosystem response to varying SSC event time intervals. Water quality thresholds can be used for dredging management guidelines at similar environment sites. Coral ecosystem response to the intensity, frequency and duration of dredge-induced elevated SSC levels can also be used for future dredging operation management.

Poster

The use of automated acoustic tracking and GPS/ARGOS tracking to describe and quantify fine use of habitat and to evaluate threats to dugongs (*Dugong dugon*, Müller, 1776): A comparison of applied tracking technologies

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Fifteen dugongs (*Dugong dugon*, Müller, 1776) will be tagged with GPS/ARGOS tags and acoustic transmitters in Moreton Bay, Queensland in July 2012. Data collected from each tracking system will be analysed to describe the dugongs' habitat use at a fine scale. The data will be further analysed within the context of Moreton Bay's commercial and recreational boat traffic to evaluate current anthropogenic threats to the dugongs and their seagrass habitat within a typical port setting. Depth and temperature collected by the acoustic transmitters and Time-Depth Recorders (TDRs) will also be compared. GPS/ARGOS tags have been used to track dugongs for many years but they are expensive and track animals for a few months at best. Acoustic tags have been previously used to track other large marine animals such as the black-tip shark, grey reef shark, cownose ray and hawksbill turtle over periods ranging up to several years. Successful application of the acoustic transmitter to create accurate tracking data for the dugong will mean that tracking costs can potentially be reduced around port regions and made readily available for management authorities. Making use of the Australian Animal Tagging and Monitoring System component of the Integrated Marine Observing System and eliminating the separate TDR device has the potential to greatly reduce the cost of the tracking equipment and to provide data on individual animals for much longer periods than the GPS/ARGOS tags.