

AIMS@JCU 2007 Seminar Schedule

Time	Title	Speaker	AIMS@JCU Program
8.45 am	Registration and tea/coffee		
9.00 am	Opening address – AIMS@JCU Chairperson	Prof. Rhondda Jones	
9.10 am	Population level effects of photo inhibition in two species of microalgae	Marie Magnusson	Coastal Processes & Modelling
9.30 am	Chimerism in broadcast spawning coral, <i>Acropora millepora</i>	Eneour Puill-Stephan	Stress in Tropical Marine Systems
9.50 am	Dynamic uptake of <i>Symbiodinium</i> dinoflagellates in heat-stressed coral juveniles	David Abrego	Stress in Tropical Marine Systems
10.10am	Bacteriophage therapy for the biocontrol of <i>Vibrio harveyi</i> in the larval rearing system of the tropical rock lobster, <i>Panulirus ornatus</i>	Cameron Crothers-Stomps	Tropical Aquaculture
10.30 am	Morning Tea		
11.00 am	Ocean Warming: Modelling and data analysis of the seasonal variation of the mixed layer depth in the Coral Sea	Jasmine Jaffrés	Coastal Processes & Modelling
11.20 am	Linking algal chemistry in <i>Caulerpa</i> with feeding by Opisthobranch Molluscs	Finn Baumgartner	Tropical Aquaculture
11.40 am	Environmental controls on the establishment of symbiosis	Vivian Cumbo	Stress in Tropical Marine Systems
12.00 pm	Drowned shelf-edge reefs as present day substrates and communities	Tom Bridge	Coastal Processes & Modelling
12.30 pm	Lunch		
1.15 pm	Flexibility of response by pelagic foraging terns to climate change on the Great Barrier Reef	Carol Devney	Coastal Processes & Modelling
1.35pm	Growth and intersexuality of <i>Acrocalanus</i> in the Timor Sea.	Luiz Felipe Mendes de Gusmão	Tropical Aquaculture
1.55pm	Coral bleaching: Do genes tell us the story?	Francois Seneca	Stress in Tropical Marine Systems
2.15 pm	Optical detection and measurement of nitrogen fixing Cyanobacteria <i>trichodesmia</i> within the Great Barrier Reef	Lachlan McKinna	Coastal Processes & Modelling
2.35 pm	Coral reef response to abrupt sea-level and climate change	Elizabeth Abbey	Stress in Tropical Marine Systems
3.00 pm	Afternoon Tea		
3.20 pm	Culture of ornamental shrimp	Vasiliki Tziouveli	Tropical Aquaculture
3.45 pm	Poster Presentation / Discussion and Judging		
4.30 pm	Award Prize Presentations		
5.00 pm	Close		

Population level effects of photoinhibition in two species of microalgae

¹Magnusson, Marie, ²Kirsten, Heimann and ³Andrew, Negri

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Pulse amplitude modulation (PAM) fluorometry is ideally suited to rapidly measure the sub-lethal effects of photosystem II (PSII)-inhibiting herbicides. However, the relationships between effective quantum yield [$Y(II)$] measured with PAM fluorometry, and more traditional endpoints such as growth rate (μ) or biomass increase in microalgae are still unknown. Industry and regulators thus prefer the use of these more time-consuming traditional endpoints and remain reluctant to incorporate results emanating from PAM fluorometry-based studies into environmental impact assessments and legal documents. Currently important environmental research therefore risks being excluded from having a practical impact. Here we report on the effects of three structurally different PSII-inhibitors (diuron, atrazine and hexazinone) on $Y(II)$, μ and biomass increase in two species of tropical microalgae. The diatom *Navicula* sp. (NQAIF [North Queensland Algal Culturing and Identification Facility] 110) and the prasinophyte *Nephroselmis pyriformis* (NQAIF 117), were exposed to PSII-inhibitors in three-day static batch culture experiments. Dose response for $Y(II)$ (mini-PAM), μ and biomass increase were recorded. Relationships between all three parameters for both species were consistent ($r^2 \geq 0.90$) and linear (1:1). This validates the utility of PAM fluorometry as a suitable toxicological endpoint that is clearly related to algal growth, and therefore an excellent predictor of population-scale effects, particularly in habitats predominantly affected by PSII herbicides such as the Great Barrier Reef and its catchments. Both test organisms were highly sensitive to PSII-inhibitors, with the order of toxicity (EC_{50} range) being: diuron (16 – 33 nM) > hexazinone (25 – 110 nM) > atrazine (130 – 620 nM). Concentrations of diuron that affected photosynthesis and growth in microphytobenthic organisms in this study have been observed in rivers and estuaries that flow into the Great Barrier Reef lagoon, and populations of these important primary producers are likely to be affected if diuron persists for more than a few days.

Chimerism in broadcast spawning coral, *Acropora millepora*

Eneour Puill-Stephan

Spawning corals broadcast their gametes typically once a year in very high densities with the resulting larvae often settling in aggregations. This provides opportunities for chimera formation: the fusion of genetically distinct larvae into a single colony. This study examines the extent of chimera formation in juvenile *Acropora millepora* corals under experimental conditions, and the frequency of chimeras in natural populations of this species.

When larvae of *Acropora millepora* were settled in aquaria, more than 47% of juveniles ($n = 2168$ recruits) settled in contact or had grown into contact with one or more adjacent recruits within the first month. Significant differences in the size of solitary (mean surface area = $6.3 \times 10^{-3} \pm 0.4 \times 10^{-3}$ cm², $n=20$) versus aggregated recruits (mean surface area = $17.3 \times 10^{-3} \pm 2.4 \times 10^{-3}$ cm², $n=20$) highlight potential benefits of chimera formation, in particular an immediate increase in colony size. Size could be positively correlated with an increase in early survivorship for juveniles, and chimera formation may therefore optimise survivorship in the early life histories of corals, particularly for spawning species.

Fusion within aggregations was assumed when the coral's tissue was continuous within the colony and when new polyps appeared at the contact margin (i.e. no rejection between the different juveniles). In order to assess if different genotypes remained distinct within fused aggregations, microsatellites were used to genotype sub-samples of potential genetic chimeras. Preliminary results highlight the occurrence of genetic chimeras (different alleles at 2 loci), indicating that *Acropora millepora* juveniles are able to form chimeric entities in the early stages of their life.

Although *Acropora millepora* juveniles form chimeras under experimental conditions, screening the extent of genetic chimeras within adult populations will help to understand if chimerism also arises naturally within populations. Chimerism was assessed in two populations ($n=30$ adult colonies per population) by comparing the genotypes of branches within colonies (8 per colony) using 7 microsatellites. Chimerism was estimated between 3 and 6 percent within each population (or 5% overall). Within chimeric colonies, one genotype was usually very dominant, suggesting that our study probably underestimated the occurrence of chimerism in adult colonies of *A.millepora* (at the two locations investigated). Thus, chimerism also appeared to be a natural (but rare) possibility for *Acropora millepora* on the Great Barrier Reef.

As chimeras represent greater genetic diversity within a coral colony than a non-chimera, the presence of chimeras within natural populations of spawning corals of the Great Barrier Reef could suggest that possessing more than one genotype at the colony level may give a selective advantage in a heterogeneous environment.

Dynamic uptake of *Symbiodinium* dinoflagellates in heat-stressed coral juveniles

David Abrego

The uptake of *Symbiodinium* dinoflagellates by newly settled corals is well documented under normal, non-stressed conditions, but virtually nothing is known about the capacity of aposymbiotic coral recruits to establish new symbioses while undergoing temperature stress. Here we examine the uptake of *Symbiodinium* by newly settled *Acropora millepora* corals kept at four different temperatures and show that although the relative survival of newly settled recruits after two weeks at 32 °C is similar to those kept at lower temperatures (28 to 31 °C), the proportion of corals that failed to establish a symbiosis at this temperature was almost seven-fold higher than recruits at lower temperatures. Furthermore, using real-time quantitative PCR, we were able to quantify the proportion of symbionts taken up from a pool of two phylotypes offered. We will discuss the results in terms of the environmental conditions surrounding the recruits and how these affected the dynamics of initial uptake with regards to the available phylotypes.

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Cameron Crothers-Stomps

YET TO COME.

Ocean Warming - Modelling and Data Analysis of the Seasonal Variation of the Mixed Layer Depth in the Coral Sea

Jasmine B.D. Jaffrés

School of Earth and Environmental Sciences, James Cook University, Townsville, QLD 4811, Australia

The seasonal variability and trends of the mixed layer depth (MLD) within the Coral Sea, including the Great Barrier Reef (GBR) on its western border, are investigated. Output from a high resolution, physical model (Regional Ocean Model System, ROMS) is compared with Coral Sea data gathered from various online databases. A distinct seasonality in the mixed layer depth was found throughout the entire Coral Sea, but was generally more pronounced in higher latitudes as a result of greater seasonality in sea surface temperature (SST). Throughout the Coral Sea, austral winter MLDs tend to be significantly deeper compared to summer MLDs, with a strong gradient existing during winter months and a relative homogeneous MLD evident during warmer months. Deeper winter mixed layers can be attributed to a combination of cooler SSTs and higher wind speed, which both facilitate mixing of the upper ocean. A possible future shallowing of the MLD as a result of global warming and changing wind regime could have dire consequences for the GBR as SST is expected to increase more rapidly within a shallow mixed layer, thus likely resulting in more severe and more frequent coral bleaching events. Further MLD profiling is required throughout the Coral Sea in order to accurately determine the long-term trends in the mixed layer depth.

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Finn Baumgartner

YET TO COME

Environmental controls on the establishment of symbiosis

Vivian Cumbo

The initial establishment of symbiosis is critical for coral that acquire their zooxanthellae via horizontal transmission because it gives them an opportunity to associate with different, more beneficial strains of zooxanthellae. Corals can associate with many different species of zooxanthellae, some which are more tolerant of high temperature. Consequently, one possible way for corals to cope with projected increases in sea surface temperature attributed to global warming is to initially associate with heat tolerant symbionts. This study tested this mechanism by determining whether environmental conditions affect the establishment and development of symbiosis for the coral, *Acropora monticulosa*. Coral larvae were exposed to 25, 28 or 31°C and given either *Symbiodinium* clades A, C or D. Some strains of *Symbiodinium* clade D are known to be heat tolerant, while clade C is generally considered heat sensitive. Symbiosis was established with all clades of zooxanthellae under every temperature treatment. The proportion of larvae infected with clade C decreased as temperatures increased, while the proportion of larvae infected with clade A peaked at 28°C then decreased. In contrast, the proportion of larvae infected with clade D increased as temperature increased. Additionally, the density of zooxanthellae within the larvae decreased significantly for clade A and C but increased for clade D as temperature increased. These results suggest that as seawater temperatures increase, the coral host may be able to shift to more heat tolerant clades of zooxanthellae and potentially aid coral's ability to cope with global warming.

Physical Habitats and Biological Communities of Deep-Water Reefs in the GBR

Tom Bridge

Drowned Reef Systems are common features on the edge off continental shelves and oceanic islands in many parts of the world, including Barbados, Hawaii and Papua New Guinea. Preliminary studies indicate that the shelf-edge of the Great Barrier Reef, seaward of the modern reef, is occupied in many areas by a succession of drowned reef and terrace features. Semi-submersible observations of Ribbon Reef 5 and Myrmidon Reef in 1984 also suggest that these deep-water reefs harbour diverse biological communities quite different from those found on the modern, shallow-water reef. Despite their apparent abundance, widespread geographical distribution, and significance both as a record of the evolutionary history of the GBR and as a unique modern-day habitat, no systematic or high-resolution study had ever been attempted. However, in September-October 2007 a research cruise on board the *RV Southern Surveyor* explored 4 sites along the Great Barrier Reef margin; Ribbon Reefs, Noggin Pass, Viper Reef and Hydrographer's Passage. High-resolution multibeam bathymetric data, seismic profiling, Autonomous Underwater Vehicle imagery and dredge sampling are being used to characterise the physical habitats and biological communities present on shelf-edge reefs. The study aims to determine (1) The physical habitats which are present on submerged shelf-edge reefs in the GBR, (2) The species and communities which occur on deep-water reefs in the GBR, how they vary within and between sites.

Flexibility of response by pelagic foraging terns to climate change on the Great Barrier Reef

Carol Devney, Julian Caley, Brad Congdon

Despite increasing evidence that recent population declines in many species of seabirds breeding on the Great Barrier Reef are directly related to changes in climate associated with global warming, we lack knowledge of the capabilities of these species to resist climate change effects. Determining whether, and to what extent, species can resist predicted climate change associated shifts in temperature through behavioural and/or physiological plasticity is crucial for predicting the impacts of global warming. We investigated the plasticity of sex-specific adult foraging behaviour and chick development of black noddies (*Anous minutus*) on the southern Great Barrier Reef during two breeding seasons. The first season had anomalously high sea surface temperatures (SSTs) and low prey availability. The second breeding season was a normal year with respect to SST. During this second season supplementary feeding of chicks was used to manipulate offspring nutritional status in order to mimic conditions of normal and high prey availability. Chicks from 2005, which were not supplemented and whose parents were exposed to extremely high SSTs, were fed smaller and fewer meals with increasing SSTs. Supplementary feeding of chicks in 2006 resulted in the delivery of smaller meals by parents, but did not influence feeding frequency. However, reductions in meal sizes appeared to be due to the chicks' inability to process extra food, rather than adult behavioural responses to chick condition. Our results suggest that at both the population and individual level this species expresses limited plasticity with respect to provisioning their young, implying that black noddies currently have limited capacity to resist environmental variation associated with climate change.

Growth and Intersexuality of *Acrocalanus* in the Timor Sea

Luiz Felipe M. Gusmão and David McKinnon 2007

Small Paracalanids are one of the most common Calanoid copepods present in tropical waters. Among the copepods of this family, *Acrocalanus* is a ubiquitous genus in Australian tropical waters. In this study the growth rate of *Acrocalanus gracilis* was estimated and the full development of juveniles followed in the Timor sea in 2005. The sex ratio and occurrence of intersex individuals were also evaluated. The growth rate of *Acrocalanus* was 0.44 d^{-1} at $\sim 28^\circ\text{C}$, and presented a good linearity during the development of the juvenile stages from nauplius to copepodite IV. The population was composed mainly by females, and older animals tended to be females or intersexual individuals rather than males. During the whole experiment there were no adult males, but different levels of intersexuality were observed in CV and Adults. These results suggest that environmental factors may be important in the sex determination of *Acrocalanus*. This work is the first report of intersexuality in *Acrocalanus* copepodites.

Lachlan McKinna Abstract

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Vasiliki Tziouveli

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Posters

Mesozooplankton biomass and copepod growth rates in the Whitsunday Islands, Great Barrier Reef, Australia

Luiz Felipe M. Gusmão and David McKinnon 2007

Copepod nauplii are the most abundant form of multicellular animal in the planet, and the most abundant component of marine zooplankton. These animals are an important food source for the micronekton, and also promote the linkage between the microbial food web and larger mesozooplankton. Understanding of the growth process is fundamental for the comprehension of the role of mesozooplankton in carbon cycling and in the transformation of nutrients in the ocean. Notwithstanding this, little is known about their growth dynamics in nature. This is particularly true in tropical seas, where the great diversity of small zooplankton species makes copepod growth estimation a problem. This obstacle can be overturned by the use of the Artificial Cohort Method (AC) in association with digital image processing. In this work we estimated the growth rates of guilds of copepod nauplii using the AC Method in the Whitsunday Island Group and adjacent reefs of the Great Barrier Reef (GBR) and compared these estimations with current models. We also used the Open Source Software ImageJ for digital image processing – a fast and non-destructive biomass estimation procedure. Finally, we also estimated the size-fractionated mesozooplankton biomass, and measured the chlorophyll and nutrients in the field.

Modelling Physical and Biological processes driving larvae supply in reef systems

Paulina Cetina Heredia

The majority of marine organisms have a bipartite life, which involves a period of planktonic development, followed by a sessile or sedentary adult stage (i.e. Kingsford *et al.* 2002, Sponaugle *et al.* 2002). Therefore local populations of reef patches are connected into a regional scale meta-population through larval dispersal. Meta-population dynamics in turn, have major implications in ecological and evolutionary processes. Hence it is important to improve on estimates of dispersal patterns to facilitate informed decisions regarding the establishment of marine protected areas (Palumbi 2003).

Meta-population dynamics can occur over regional spatial scales (~100 km) (Roberts 1997, Cowen *et al.*, 2006) while some physical processes that mediate larvae transport occur at reef scales (~100 m). Further, recent literature suggests that larval behaviour can have a great impact on their dispersal kernels and so the estimation of connectivity degrees along reef systems remains a challenge.

The overall objective of this study is to thoroughly assess how physical mechanisms and different larval behaviours interact to determine larval supply into reef systems using as a tool a three dimensional hydrodynamic model.

The final aim is to offer an alternative framework for the study of meta-population dynamics by constructing an analytical solution for larvae abundance over time around reefs that would account for the most relevant physical and biological processes driving larval transport in reef systems.