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## Light and Photosynthesis on Coral Reefs

Postgraduate course Instituto de Ciencias del Mar y Limnología de la Universidad Nacional Autónoma de México

*Emily Howells (AIMS@JCU, Stress in Tropical Marine Systems) has contributed this report outlining the above training course which she attended utilising her 2009 AIMS@JCU travel support award.*



**UNAM research station jetty at Puerto Morelos**

The conversion of sunlight to organic compounds by photosynthesis is the major source of energy in terrestrial and shallow marine ecosystems. Quantification of photosynthetic parameters is necessary to estimate the productivity of ecosystems and to

understand the stress responses of photosynthetic organisms. The *Light and Photosynthesis on Coral Reefs* postgraduate course has been designed to equip participants with the theoretical knowledge and hands-on experience to quantify photosynthetic parameters and apply these skills to their own research. The course is held annually at Puerto Morelos on the Caribbean coast of México and is offered by the Independent National University of México (UNAM) and the Ensenada Scientific and Research Centre (CICESE). In January, Emily Howells joined a group of 16 students from Australia, Indonesia, Germany, Belgium, Spain, the USA, Puerto Rico and México who took part in the 2009 course.

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### About the AIMS@JCU Newsletter:

This newsletter is produced quarterly and distributed by e mail to all AIMS and JCU staff.

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## Darren Coker— Stress in Tropical Marine Systems PhD Candidate

Proximate causes of short-term declines in abundance of coral-dwelling fishes following climate-induced host coral bleaching.

Originally from New Zealand, Darren completed his undergraduate and postgraduate studies at JCU, Townsville. His PhD investigates the role of biotic interactions (specifically, predation and competition), in affecting changes in the abundance of coral-dwelling fishes immediately following the bleaching of host corals.

Corals are central to the physical and biological structure of coral reef habitats, providing important habitat structure for many small fishes. This important habitat provides reef fishes with food, recruitment cues and shelter from predators. Increasing disturbances to coral reefs have been linked to significant and widespread declines in abundance, species extinctions and dramatic shifts in community structure of fishes closely associated with coral reefs. Furthermore, coral-dwelling fishes are declining in abundance before the collapse of structural integrity of the coral suggesting that live coral cover is just as important as the structure itself.

The goal of this project is to identify the factors that influence the decline in coral-dwelling reef fishes immediately following host coral bleaching. This project plans to investigate if fishes that are strongly associated to a host coral will vacate a degrading coral and if they are able to seek out and migrate to an alternative healthy coral. Increased predation on fishes within the bleached coral and during migration to healthier coral habitats will also be observed to see if it could also impact on the abundance of fish. More specifically, it is not known whether these fishes suffer increased mortality (e.g., due to predation) during positive thermal anomalies and coral bleaching, or if they rapidly vacate bleached coral hosts and move *en masse* to seek alternate habitats.



The project will give us an insight into whether the fishes are moving to healthier coral colonies or declining in abundance. This is important because as the spatial scale of disturbance to coral reefs increase, population connectivity (which enables replenishment by recruitment from other parts of the population) will no longer be sufficient to buffer local populations against persistent declines in abundance.

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## Jean-Baptiste Raina— Stress in Tropical Marine Systems PhD Candidate

Coral associated bacteria and their role in the biogeochemical cycle of sulfur

Originally from France, Jean-Baptiste did his Master's degree at JCU on coral-associated bacteria. His PhD study will continue to investigate this field of research, with the aim to better understand the chemical compounds that structure this coral-bacteria association.

Coral-associated bacterial communities are known to be diverse and highly abundant. Despite high bacterial diversity, corals have been reported to harbour species-specific microbial communities for beneficial effects; however their role in coral health is poorly understood. In coral reef environments, bacteria are dependent upon organic compounds produced by photoautotrophic organisms such as endosymbiotic zooxanthellae, therefore photosynthesis-products translocated to coral tissues and mucus may determine microbial communities closely associated with corals.

Sulfur compounds such as dimethylsulfoniopropionate (DMSP) and its breakdown products, are present in extremely high concentrations in corals, however the role of these compounds is unclear. This project will investigate the potential of these compounds to drive coral-associated microbial communities. With the help of culture dependant and genetic techniques, the isolation of the bacteria involved in the utilization of these chemicals will be investigated. Furthermore, the dynamic of the coral-associated communities in relation to the concentration of these compounds will be assessed.

This research will enable us to better understand the complex relationship between corals and bacteria, with important consequences for the health of both corals and coral reef ecosystems.



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# Light and Photosynthesis on Coral Reefs—

Postgraduate course Instituto de Ciencias del Mar y Limnología de la  
Universidad Nacional Autónoma de México

(continued from page 1)

An intensive schedule of lectures and laboratory sessions was delivered over 3 weeks. Major subject areas included: the behaviour of light fields in the water column, organization and function of photosynthetic structures,



capture and transfer of light energy, as well as environmental constraints on physiological performance. Laboratory sessions reinforced fundamental concepts and provided students with experience in the range of instruments used to measure light fields, as well as light absorption and emission by photosynthetic pigments. Students

were able to take advantage of the availability of model study organisms (corals and seagrasses) from the local fringing reef as well as microalgal cultures grown at the UNAM culturing facility. Each of the course participants gave a seminar outlining their research projects at their home institutions which focused on a diversity of topics: species abundance and distribution (phytoplankton, seagrasses), functional roles (cyanobacteria), responses to thermal stress and ocean acidification (coral and anemone symbionts, *Symbiodinium*), characterizing photoprotective mechanisms (macroalgae), and invasive species management (seagrasses).

Emily Howells describes the course as very intense, but also very informative. She is looking forward to applying knowledge she gained during the course into her future PhD experiments investigating the resilience of *Symbiodinium* populations, hosted by reef building corals, to climate change. Experiments will aim to determine what genes in *Symbiodinium* are up and down regulated in response to thermal stress, and how variable these functional genes are between *Symbiodinium* populations from different thermal environments on the Great Barrier Reef. Photo-physiological measurements will be essential for verifying relative levels of stress on *Symbiodinium* from different treatments during the time course of the experiment.

Thank you to the instructors of the 2009 course: Dr. Anastazia Banaszak, Dr. Flor Colombo, Dr. Susana Enríquez, Dr. Ernesto García Mendoza, Dr. Roberto Iglesias Prieto, Dr. Helmut Maske, Dr. Eugenio Mendez, Dr. Nadine Schubert, Dr. Mark Warner and Luis González.

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## Scott Smithers—New JCU Program Leader for Coastal Processes & Modelling

Scott is a coastal geomorphologist and Associate Professor in the School of Earth and Environmental Sciences at JCU. His broad research interests are centred around the Quaternary evolution of coastal environments, especially coral reefs and tropical coasts. Scott obtained his PhD in 1997 from the University of Wollongong where he studied the sea-level records preserved in the skeletons of coral microatolls on the Cocos Keeling Islands. His research on mid-ocean reefs and sea level has continued since he arrived at JCU, with active projects focused on reef growth, island formation and sea-level change on atolls in both the Indian and Pacific Oceans.

Scott's early research interests were focused on the nature and rates of carbonate sedimentation and reef growth in systems with excellent reef growth potential, but recent work has focussed on reef growth in more marginal settings, including inshore turbid-zone and fringing reefs on the Great Barrier Reef. The theme of this research is to provide a longer-term but detailed context to improve understanding of recent changes in reef growth. A second focus of Scott's research is aimed at understanding the geomorphological development and dynamics of reef islands. This work involves establishing the growth history of reef islands, establishing the range of recent morphodynamic variability and linking this to climate and sediment budget drivers. Overall, Scott's research strives to better understand the formation of reefs and reef islands and the environmental drivers that influence this in order to better predict how they may respond to future challenges.



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### Thank you to Michael Ridd



We would like to thank Michael Ridd for his years of support and enthusiasm to the Coastal Processes & Modelling AIMS@JCU program. Michael will still be involved in the joint venture as a member, but the role of JCU Program Leader is handed to Assoc. Prof. Scott Smithers.

We wish Michael the best of luck.

## Heather Welladsen—Tropical Aquaculture Honours Student

The effects of ocean acidification and temperature on the shell morphology and physiology of tropical bivalves.

I am originally from Sydney, and completed my BSc. (Aquaculture) at JCU last year. Doing honours has always been a goal of mine, and is the next step on my way to a PhD. My supervisors are Paul Southgate and Kirsten Heimann, and my project is titled: The effect of ocean acidification and temperature on the shell morphology and physiology of tropical bivalves. My experiments will test the interaction between ocean warming and acidification, and determine the possible effects this may have on commercially important tropical bivalves. The aquaculture of tropical bivalves such as pearl oysters and giant clams supports the economies and livelihoods of many communities throughout the south Pacific, Indo-pacific and Australia. These species are typically cultured in the ocean and not in a controlled environment, so the potential for ocean acidification and warming to affect these industries and the economies that rely on them is great. There also may be ecological implications if wild animals were affected.

For these reasons, my study will focus on two of the most commonly cultured bivalves in the tropics, pearl oysters and giant clams. These organisms will be exposed to 2 treatment levels of pH and 2 treatment levels of temperature, with appropriate controls, and various factors investigated. Pearl oysters will be used at the start of the study and shell characteristics such as composition, strength and SEM will be investigated. Giant clams will then be brought in and factors such as zooxanthellae photosynthetic capacity and density will be investigated, along with the composition of the haemolymph. Growth and mass will also be measured for both species. These results will provide good basic information on the effects ocean acidification and warming may have on tropical bivalves, which has been overlooked in the literature.



## Alexander Vail— Stress in Tropical Marine Systems Honours Student

Non-lethal predator effects on settlement of reef fish.



Alex Vail is from Lizard Island, and has lived there most of his life. He completed his BSc. at JCU in 2007, majoring in marine biology and zoology, and received a University Medal for his efforts. He has spent extensive time overseas gaining experience in various areas of biological research. He assisted Dr Redouan Bshary in the Red Sea in 2004; assisted a Swiss research group studying vervet monkey behaviour in South Africa in 2006-7; and was a research assistant for a WCS conservation and movement ecology project on wild leopards in South Africa in 2008.

Alex began his Honours in September 2008, and is supervised by Dr Mark McCormick from JCU, and Mark Meekan from AIMS. Alex's research focuses on the non-lethal effects of predators on settlement-stage reef fishes. Predators can non-lethally affect their prey's morphology, physiology, development, and behaviour; sometimes known as the effect of fear. Non-lethal effects make up the majority of a predator's total effect in aquatic systems, due in part to a single predator being able to non-lethally affect many prey simultaneously. However, surprisingly little is known about non-lethal effects in marine environments, especially coral reefs. Over half of all settling reef fish are eaten within their first 2 days on the reef, meaning their populations are strongly governed by small differences in survival around settlement. Avoiding predators at settlement, even if to only gain short term reprieve, should be evolutionarily advantageous. Most settlement is nocturnal, and olfaction is a key sense for detecting many stimuli on which settlement is based. Olfaction is therefore the most likely method by which reef fish may detect predators at settlement. Alex's research determined firstly if settling reef fish were capable of recognising predator odours, and if these odours non-lethally affected settlement patterns.

Alex's results to date have been highly informative. Using a small two chambered choice flume, two species of pomacentrids were found to significantly avoid predator odour over non-predator odour. This shows a probable innate recognition of predator odour, and combined with work by Danielle Dixon, will be the first published account of this occurring in a marine fish. Alex conducted a field experiment on patch reefs which showed a significant spatial avoidance of predator odour by settling pomacentrids. This is the first demonstration of a non-lethal effect on settlement patterns, and could be an important process by which piscivores affect reef fish community dynamics. If this is the case, it may mean yet another way in which removal of piscivorous fish by overfishing alters reef community processes. Alex will present his findings at the Indo Pacific Fish Conference in May-June, plans to publish at least 2 papers from his work by October, and begin a PhD next year.

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## From the Research Director

As you will have noticed this quarter we have re-styled the newsletter. We will also soon be releasing e-news research updates. In these short articles between newsletter updates we plan to feature research outcomes produced by group members. If you have a research item you would like to see featured please contact the office. Thanks to Lauren and Vanessa for their continued efforts to update the newsletter and the information that goes out to all of our members. If you have feedback about the newsletter format or the e-news updates please let us know.

In addition to these changes, AIMS@JCU has had a busy start to the year with the recent awarding of 14 student travel bursaries. These awards will see student members present the results of their research at 8 different conferences ranging in location from Melbourne, Adelaide, Perth and Darwin to Mexico, France, Tahiti and Spain. It is great to see student members getting such national and global exposure and spreading the results of AIMS@JCU research efforts. We look forward to hearing reports about these events from all of you.

Finally, we are in the process of developing the AIMS@JCU biennial report. Thanks to everyone who has provided information or made contributions to that document. We plan to have it in press soon and will distribute copies to the membership as soon as it is available.

Thanks to all of our members for your continued efforts and support.

Michelle

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Photographs in this publication were submitted by the students/staff themselves or have been sourced from the AIMS Long Term Monitoring Team.

