Australian Coral Reef Society

Newsletter

Number 43, March 2014

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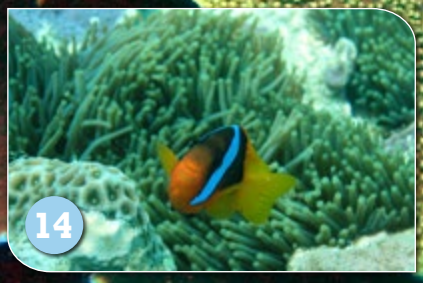

A society promoting the scientific study of Australian coral reefs

Inside this issue

Cristian Munoz Mas

Editorial foreword:

Dear Members,

It is our great pleasure to present to you the 43rd edition of the Australian Coral Reef Society's annual newsletter. 2013 was a busy year for the society and important for the future of Australia's coral reefs with all the many consultations about port developments and re-zoning of marine parks such as Moreton Bay. Several councilors and other ACRS members were very active writing submissions to inform state and federal governments about coral reef scientists' points of view on these matters. Please check the ACRS webpage for more on these important issues.

This newsletter is packed with the many happenings of the last year. The 87th ACRS conference in Sydney was a great success and saw participants from all major Australian universities. With about 112 talks, and over 20 poster presentations this conference was certainly one of the largest to date. Many of our conference award winners have contributed to this newsletter by sharing the new insight they have gained from participating at the conference as well as their own research summaries. Also, throughout this newsletter you might recognize some of the excellent photos that have entered the conference 2013 photo competition.

We have tried to give the newsletter a new face and you might have realized the new outline and design. Another new feature are the various hyperlinks to researcher profiles, papers and more detailed scientific background information which we hope results in a more concise and informative newsletter. We also have a new section that highlights some of the most interesting and novel papers by our members of the last year. Read for example about reef range shifts, meta-analyses on ocean acidification research, same sex pairing in reef fish, coral larval movement through colder water, microscale coral light energy budgets, sea cucumber fishery and integrative approaches of identifying corals.

Some of the old features and newsletter sections do remain. So be sure to read about the newest happenings from our research stations and the dazzling research undertaken by our four student award winners of 2013.

Most importantly, we would like to thank all the many members who have contributed and made this newsletter as diverse as the very system we are dedicated to.

We are always open to opinions and ideas of all sort so please contact us if you have something you would like to share with the wider community or any suggestions to improve the society and the newsletter.

So far we hope you enjoy the current version… and until next year!

With best wishes from your editorial team,

Daniel Wangpraseurt and K-le Gomez

Letter from concerned scientists to Prof Russell Reichelt, chairman of the Great Barrier Reef Marine Park Authority

The letter above was sent to Prof Russell Reichelt, CEO and chair of the Great Barrier Reef Marine Park Authority, to Greg Hunt, Federal Minister for the Environment and Andrew Powell, State Minister for the Environment. It was also sent with a press release to media outlets.

The letter achieved considerable media coverage, which followed from previous media coverage we had over the December decision to approve Abbot Point. The coverage included national newspapers such as The Australian, the Sydney Morning Herald, The Age, the Courier Mail and the Brisbane Times and a multitude of regional newspapers. We had radio coverage across the ABC network and some television coverage, though I am not sure exactly where this was shown.

The letter also received considerable international media interest, especially once GBRMPA made the decision to approve the dredge dumping. This international media included the Canadian National Broadcaster, BBC, Science (news), New Scientist, Aljeseera, Reuters, New York Times and many others.

I think that this letter and the subsequent media attention has changed the discussion in that now the coverage has gone from 'opposition or concern by green groups' to the inclusion of scientists in this list of concerned parties.

Selina Ward

did you know that ?

Double click on any word highlighted and it will link you to more information

SCIENTIST COMMENTARY

PROF. JOHN PANDOLFI DELIVERS THE LATEST COMENTARY ON CURRENT TOPICS IN MARINE SCIENCE IN AUSTRALIA

Your ACRS council

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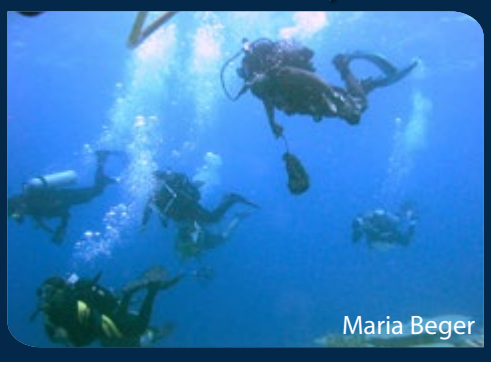


Maria Beger

Images from the 2013 photo competition

Edward Roberts

Tom Hawkins

President's message

I doubt there has ever been a time when the ACRS was more relevant to shaping the fate of the Great Barrier Reef. The last 12 months have seen the levels of reef protection flip between the designation and subsequent overturning of extensive protection in areas like the Coral Sea, and a commitment by the Queensland government to expand a series of ports adjacent to the GBR, necessitating a long-term rise in dredging. All this is happening while the reef is arguably in its worst shape ever.

Not surprisingly, it's been another busy year for the Society with the development of seven submissions to government bodies on topics ranging from port development to a discussion of the strategic assessments conducted by both the Great Barrier Reef Marine Park Authority and the Queensland Government. Several of these submissions were covered widely in the media and it is humbling to see such a collegial and consistent outpouring of concern about several recent policies. I would like to extend my thanks, on behalf of the Society, to all those councillors – and a few notable non-councillors – who contribute their time and energy to give voice to the Society.

Yet despite the rising level of concern being raised about reef futures in Australia, the last 12 months have also seen reason to celebrate. The 87th ACRS meeting in Sydney was one of the largest ever and a great success. Again a huge vote of thanks to Ross Hill (convenor), Selina Ward, and council for working so hard to make it a success. Thanks also to our sponsors I'd like to reiterate my thanks to all those that participated in the auction for a lifetime membership of the ACRS. Congratulations Andrew Baird for his generosity in clinching the winning bid. The 2014 meeting will take place in late August and will be held in Brisbane.

Reef science also received a boost late in 2013 when the Australian Research Council announced the successful funding of a new Centre of Excellence for Coral Reef Studies. The centre provides a great deal of support to students so the next 7 years promise to be as enlightening as the last.

The Society has done well in 2013 with membership currently exceeding 300 and a healthy balance sheet. A very big thank you to Anna Scott (Membership Secretary) and Naomi Gardiner (Treasurer) for their continued hard work filling these roles. Equally, I'd like to extend additional thanks to Daniel Wangpraseurt and his team for putting together the annual newsletter, to Ross Hill for maintaining the website so well, and many of our councillors for their continued hard work judging student awards and taking care of many discreet but vital tasks. These additional members of council – in no particular order – are John Pandolfi (ex-President), David Booth (Vice-President), Shay O'Farrell (Secretary), Andrew Hoey, Justin Marshall, Chico Birrell, Alyssa Marshell, Maria Gomez-Cabrera, Selina Ward, Roger Beedon, Vimoksalehi Lukoshek, and Jo Pollock.

Lastly, I'd just like to return to the first topic I raised; the rising tide of threats to the GBR in particular. I'm not the first to say this but I feel that a frank and honest public conversation is needed on the future of the GBR. While the recent strategic assessments were compelling, there remain some important issues that are not currently being addressed. Central to these are long-term plans by the Queensland Government to expand agricultural production in the state. If agricultural production is set to rise substantially, particularly if that involves development of Cape York, then how is this compatible with the desire to safeguard Australia's biodiversity and maintain a profitable tourism sector? It seems that a conversation would help expose inconsistencies across policy objectives and help develop a robust framework for future decision-making. I've no doubt that the ACRS will continue to play a key role in engaging such debates.

On behalf of the ACRS I'd like to wish everyone a Happy New Year for 2014 and I look forward to seeing you all at the next annual meeting.

Prof Peter J Mumby

ACRS President

AGM, held the 9th of May in the Australian Tropical Science and Innovation Precinct, James Cook University, Townsville

President's welcome

Officers:

Naomi Gardiner	Treasurer
Chico Birrell	Secretary
David Booth	Vice president
Anna Scott	Membership
John Pandolfi	Immediate Past President
Ross Hill and Selina Ward	(Conference organiser)
Ross Hill	Web-master (Lots of help from Diana Kleine)
David Feary	Newsletter wranglers

All councillors:

Roger Beeden, Alyssa Marshell, Kyra Hay, Ida Fellegara, Andrew Hoey, Andrew Chin, Jo Pollock, Kirsty Nash, Uli Siebeck, Justin Marshall, K-le Gomez.

Thanks to UQ, JCU, UNSW, UTS and CoE for technical and logistical support as well as financial.

First, the Commonwealth government published its plans for an **extensive marine reserve network** that included a number of coral reef areas including the Coral Sea. The consultation process for the reserve network has been extensive and the ACRS responded to four reef-related consultations. Having now read the Report of the Director of National Parks on the consultation, it's clear that others echoed our concerns.

The second major event of 2012 was the grave concerns expressed by UNESCO on development plans that are likely to affect the health of the Great Barrier Reef. The report has placed an international spotlight on planning processes and the need for strategic assessments for development. Recently, the **Queensland government solicited feedback on their Ports Strategy** for the GBR. The ACRS submitted a response arguing that all options should be considered including abandoning plans for potential ports in environmentally sensitive areas, and supporting the proposed plan for a statewide view of port requirements rather than planning on a case-by-case basis. We also pointed out the need for a review of offseting options and usage for marine applications.

More recently contributed to **Statement by Concerned Scientists on Port Developments**, organised by WWF. Leanne Fernandez will hopefully say a few more words about that before the end of the meeting.

The **Great Barrier Reef Marine Park Authority** published their **Biodiversity Conservation Strategy** which included a framework for action. Again, the ACRS provided feedback and will continue to do so when the opportunity arises. The ACRS also provided a submission on the proposed **Great Keppel Island port development** which has now been approved.

Contributing to the management consultation process has been time consuming but represents an extremely valuable role for the Society. I'd particularly like to thank the members of Council (both pre and post the 2012 elections) and Society Officers who've work so hard on these in the last 12 months. The submissions can all be downloaded on the ACRS website.

Whether we should have members names on our submissions.

Of course, one of the most enjoyable events of 2012 was the International Coral Reef Symposium in Cairns and I'd like to express my thanks to Terry Hughes and his colleagues for putting on an outstanding meeting.

The ACRS maintained a booth at the ICRS and raised funds by selling a variety of merchanise. I'd particularly like to thank **Naomi Gardiner and Maria Gomez-Cabrera (K-le**) for all their hard work organising this and to all the volunteers that helped staff the stand. The ACRS funded 15 students to attend this meeting and it's great that we continue to do that.

Next meeting on August 29/30th in Sydney in association with ISRS. The represents a move possibly away from huge symposia every 4 years and to place emphasis on regional meetings. We'll see how it goes - it's a test, particularly so soon after holding ICRS in Australia. Promises to be a great meeting and a **big thank you to Ross Hill and his team for coordinating this**.

The Society has done pretty well in 20123 and its membership now stands at 252 which is great. Financially, we have maintained our cash flow despite not having our usual annual meeting, due in part to a donation from Queensland Industry Seafood Association in return for some advice provided by members of Council. **Andrew Hoey will introduce the auditors report later. Mmmm highlight of the evening**.

The website continues to be a useful source of information and I'd like to thank Ross Hill for all his work as webmaster. We've had scientist commentaries from Peter Sale, Laurence McCook, myself, Pat Hutchings, and David Booth. A new one will be available shortly.

David Feary did an amazing job putting together the latest **ACRS Newsletter** and it was a work of art at 67 pages - and not all stuffed with admin, includes book reviews, updates from research stations, though no gossip.

I'd particularly like to acknowledge all the hard work of the officers (John Pandolfi, ex-President), David Booth (Vice-President), Naomi Gardiner (Treasurer), Chico Birrell (Secretary), and Anna Scott (Membership Manager). Many councillors also contribute greatly and I'd particularly like to thank Ulrike Siebeck and Andrew Hoey for judging the 2013 student awards. **Extra mention to Uli in that she is stepping down from Council after a long period of wonderful support to the Society, big thank you for all you have done.**

Winners of **student awards** - competition never gets any easier.

Terry Walker Prize: Cait Newport (UQ)

"Complex pattern discrimination in the Ambon damselfish (*Pomacentrus amboinensis*)"

Danielle Simmons Prize: Alyssa Marshell (UQ)

"The grazing impact of common surgeonfish on macroalgal recruits within the coral reef epilithic algal matrix"

ACRS Award - Jeroen van de Water (JCU)

"The effect of warming oceans on the immune responses of corals to disease"

ACRS Award - Steve Doo (USyd)

"Assessing resiliency in large benthic Foraminifera communities to near future climate change"

Thanks to Kirsty Nash, Jo Pollock and Andy Hoey for putting this AGM together and James Cook University for hosting us once again.

Ask Chico to introduce our guests for the evening: Jürgen Freund

	Nominating for 2013-2014	Standing down
Prof. Peter Mumby (president)	X	
Prof. John Pandolfi (past president)	X	
Prof. David Booth (vice president)	X	
Dr. Shay O'Farrell (secretary)	X	
Dr. Naomi Gardiner (treasurer)	X	
Dr. Anna Scott (councillor)	X	
Mr. Chico Birrell (councillor)	X	
Dr. Ross Hill (councillor)	X	
Mr. David Feary (councillor)	X	
Prof. Justin Marshall (councillor)	X	
Dr. Maria Gomez-Cabrera (councillor)	X	
Dr. Andrew Hoey (councillor)	X	
Mr. Roger Beeden (councillor)	X	
Ms. Alyssa Marshell (councillor)	X	
Mr. F. Joseph Pollock (councillor)	X	
Vimoksalehi Lukoshek (councillor)	X	
Daniel Wangpraseurt (councillor)	X	
Selina Ward (councillor)	X	
Ms. Kirsty Nash		X
Mr. Andrew Chin		X
Dr. Kyra Hay		X
Dr. Ida Fellegara		X
Dr. Ulrike Siebeck		X
Total:	**18**	**5**

Coping with climate change: move, respond, evolve or die

by Andrew H. Baird and Nicole S. Webster

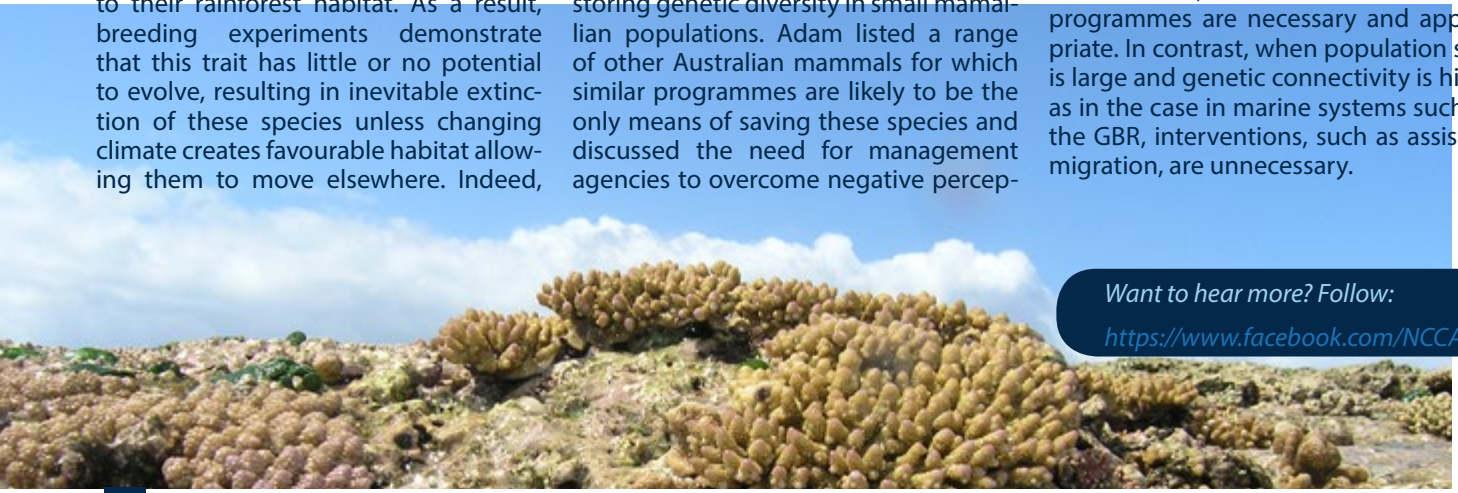
A recent National Climate Change Adaptation Research Facility (NCCARF) funded workshop brought together an interdisciplinary group of researchers to discuss the pathways by which Australian biodiversity might adjust to projected environmental change caused by global warming. The workshop included academics from ten universities and institutions including scientists with expertise spanning marine, aquatic and terrestrial ecosystems. One of the primary objectives of the workshop was to formulate advice for natural resource managers on how best to facilitate adaptation of natural systems to climate change.

The workshop participants identified three broad pathways by which organisms might adjust to a changing climate: they can respond; they can relocate; or, over a potentially longer time frame, species can evolve. The alternative is extinction. Workshop participants presented evidence from recent case studies illustrating how Australian biodiversity has used all three of these mechanisms to respond to changing environments. For example, Dr Adrienne Nicotra of Australian National University described how plant species have responded to recent changes in patterns of rainfall. Adrienne explained how an understanding of phenotypic plasticity in plant water use can lead to better conservation outcomes in addition to increased crop yields. However, phenotypic plasticity has it limits, as discussed by Dr Carla Sgro of Monash University. For example, some traits, such as desiccation resistance, have little variation in certain species of rainforest fruit flies which means that they would be unable to respond to the projected changes to their rainforest habitat. As a result, breeding experiments demonstrate that this trait has little or no potential to evolve, resulting in inevitable extinction of these species unless changing climate creates favourable habitat allowing them to move elsewhere. Indeed, perhaps the most common pathway for adjusting to climate change is to move and there is ample evidence from the fossil record and more recent ecological data showing that Australian biota has tracked changing climates over long time scales. Dr Andrew Baird from James Cook University described a number of recent range expansion of tropical corals into the subtropical regions of Australia, such as the Solitary Islands in northern New South Wales. Similarly, Dr Luciano Beheregaray described recent changes to marine benthic habitats in Tasmania, caused by expansion of the sea urchin Centrostephanus rodgersii. The ecological and economic consequences of such range expansions are highly unpredictable and create a mosaic of patterns of biotic interactions. The workshop participants agreed that research into the role of biotic interactions in mediating range expansions and the cascading effects of novel interactions should be a focus of future research.

The participants also discussed the specific threats from climate change in each of the terrestrial, aquatic and marine realms and whether management strategies to enable organisms to adjust would need to vary among these ecosystems. The scientists concluded that management intervention would be essential for many terrestrial and aquatic habitats. For example, in some ecosystems, habitat loss and fragmentation has resulted in populations that are too small or too disconnected, to ensure sufficient levels of genetic diversity to allow these organisms to respond or evolve. For example, Dr Adam Miller of Melbourne University, presented research documenting the effectiveness of assisted breeding programmes for restoring genetic diversity in small mamallian populations. Adam listed a range of other Australian mammals for which similar programmes are likely to be the only means of saving these species and discussed the need for management agencies to overcome negative perceptions and embrace assisted breeding programmes as a means of conserving Australian biodiversity. The participants agreed that such measures were less likely to be necessary or effective in the marine realm, where populations are generally larger and connectivity among population is well maintained by larval dispersal. Consequently, management of the oceans should largely concentrate on mitigation as opposed to intervention. Dr Linda Beaumont discussed the role of refugia in conservation biology, suggesting that identifying and protecting climate refuges was a crucial element of conserving biodiversity in the face of changing climate. All participants agreed that maximising genetic diversity was the key to achieving most conservation goals.

The need for further research into other mechanisms that contribute to adaptive capacity was highlighted by Drs Nicole Webster and Line Bay from the Australian Institute of Marine Science. These included i) epigenetic modifications which can alter the expression levels of individual genes responsible for the production of heritable changes in the phenotype without altering the genome sequence ii) symbiont shuffling or the acquisition of new symbionts that assist survival in a changed environment and iii) viral mediated lateral gene transfer.

In summary, the workshop participants agreed that climate change presents many challanges to Australian biodiversity. The effects of climate change on Australian biodiversity are likely to vary among habitats and the outcomes are difficult to predict. In some situations, where there is a good understanding of the genetic structure of populations, interventions, such as assisted breeding programmes are necessary and appropriate. In contrast, when population size is large and genetic connectivity is high, as in the case in marine systems such as the GBR, interventions, such as assisted migration, are unnecessary.



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Ningaloo Reef: easily accessible habitat maps with high spatial and thematic resolution

Halina T. Kobryn[1], Ben Radford[2] & Lynnath E. Beckley[1]

In Brief: Recently, the marine habitats of the Ningaloo fringing reef in north-western Australia have been mapped at high spatial and thematic resolution for the first time. The reef, spanning three degrees of latitude, and covering 762 km2 was mapped to 20 m depth using HyMap airborne hyperspectral imagery at 3.5 m resolution. "One of the outcomes of our work was the transformation of the high resolution marine habitat data into a KML file which can be easily viewed and interrogated using either Google Earth or Google Maps", says Halina Kobryn from Murdoch University.

The dataset can be used in the field as it is easily loaded onto portable GPS-enabled mobile devices such as smart phones. Publicly available data for such large areas are rare, particularly for remote and under-studied regions of northern Australia. "We hope that our work will go some way in educating and informing the scientists, managers and the interested public of the complexity of the marine ecosystem of the region."

Introduction

High resolution habitat data for Australia's extensive marine jurisdictions are required for effective planning, monitoring, management and incident response plans, especially in areas with of high levels of human activities such as oil and gas exploration and extraction, shipping and ports, fishing and recreation. In the past decade, the north western region of Western Australia has experienced particularly high level of activities in oil and gas exploration, increased number of approvals for production (ABS, 2013) and growth in tourism, including recreational fishing (Smallwood et al. 2011; Smallwood et al. 2012). At the same time the region has been affected by heating events which led to coral bleaching along the reef (Depczynski et al. 2013). These combined pressures require improved knowledge of the reef ecosystem including high resolution habitat information. Most of these areas are quite remote with shore, and even small-vessel access, quite limited. Remote sensing is often the only means of obtaining a comprehensive picture of the reef, including metrics such as percentage cover of macro-algae at different spatial scales.

Although most of these marine environs are deep, a considerable portion lies in waters less than 20 m deep. Many of these areas are optically shallow, with clear water, allowing for airborne or satellite based sensors to map the habitats and bathymetry with a high degree of detail and accuracy. A number of techniques have been refined in the past decade to deliver reliable, repeatable and quantitative information on bathymetry and marine habitat distribution (Andréfouët and Riegl, 2004; Mumby et al. 2004; Hedley et al. 2012). While lack of a standardized classification system in Australia is still hampering monitoring efforts, less costly remote sensing imagery and improvements in remote sensing data processing have allowed more areas of the coral reefs, in particular, to be mapped at a much higher level of detail than a decade ago (Andréfouët et al. 2013).

High resolution habitat mapping with hyperspectral imagery

The marine habitats of the Ningaloo fringing reef in north-western Australia have been mapped at high spatial and thematic resolution for the first time (Kobryn et al. 2013). The reef, spanning three degrees of latitude, and covering 762 km2 was mapped to 20 m depth using HyMap airborne hyperspectral imagery at 3.5 m resolution Using field-validated, image-derived spectra from a representative range of substrates, the habitat classification combined a semi-automated, pixel-based approach with fuzzy logic and derivative techniques. Five thematic classification levels for benthic cover (with probability maps) were generated, with the most detailed describing coral form in 46 classes. Macro-algae constituted most of the benthic cover, while hard and soft corals represented only about 7% of the total mapped area. Dense tabulate coral was the dominant coral mosaic type (Kobryn et al. 2013).

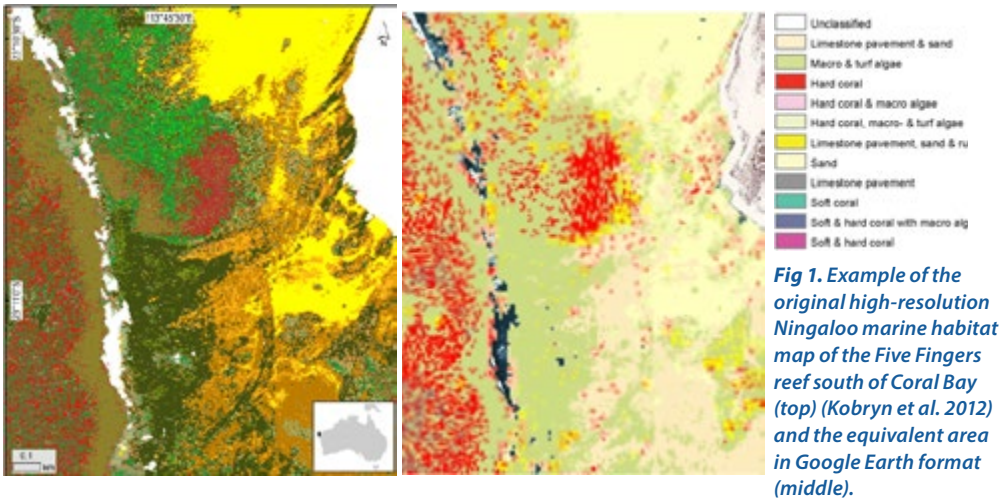

Fig 1. Example of the original high-resolution Ningaloo marine habitat map of the Five Fingers reef south of Coral Bay (top) (Kobryn et al. 2012) and the equivalent area in Google Earth format (middle).

Google Earth compatible data set

To make this product more accessible to managers, ecologists and other end-users the 3.5 GB data set was reduced to a 7 MB Google Earth KML file. This was achieved using the super-overlay hierarchical image tiling and compression method. Super-overlays work by producing hierarchical sets of image tiles which have different image resolution. At a broad scale, only the low resolution tiles are viewed and, with increasing zooming, the corresponding higher resolution image tiles are automatically loaded into view.

Prior to generating the final KML file, the original image was resampled from a 3.5 m pixel to a 9 m pixel using a focal majority filter via the r.neighours function in the GRASS GIS software (version 6.3.1, GRASS GIS Development Team 2012). Thematic classes from the 46 in the original product were combined to create 12 general classes. KML super-overlays were generated using the open source Geospatial data abstraction utility (GDAL) software library "gdal2tiles". The process involves three main steps namely, importing the image into gdal, projecting the image into geographic coordinates and finally generating the hierarchical image tiles using the gdal2tiles.py python script supplied with the gdal2tiles library. The resulting KML file can be easily viewed and interrogated using either Google Earth or Google Maps. The dataset can be used in the field as it is easily loaded onto portable GPS-enabled mobile devices such as smart phones and is accessible from "http://ningaloo-atlas.org.au/content/ningaloo-hyvista-remote-sensing-lagoonal-habitat-dat".

Acknowledgements
We are grateful to for data access and project logistics provided by AIMS (Dr Andrew Heyward) and HyVista Corp. (Dr Peter Hausknecht) for pre-processing. We extend our thanks to CSIRO staff, Dr Mick Haywood and Dr Russ Babcock for providing field validation data and feedback on the results; Murdoch University personnel, Dr Nicole Pinnel, Dr Matt Harvey, Dr Mike van Keulen and Dr Mark Langdon and Kim Marrs for assistance with the fieldwork. We thank the staff at the Department of Parks and Wildlife office in Exmouth and the regional rangers for advice and assistance with field accommodation.

[1] **School of Veterinary and Life Sciences, Murdoch University**

[2] **AIMS and School of Earth and Environment, UWA Oceans Institute**

Ref: Andréfouët, S.and Riegl, B. (2004).. Coral Reefs 23:1-4.
Andréfouët, S.et al (2013). Coral Reefs:1-12, doi 10.1007/s00338-013-1026-0.
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Hedley, J.D., et al (2012). Remote Sensing 4:271-302.
Kobryn, H.T. et al (2013). PLoS ONE 8(7): e70105. doi:10.1371/journal.pone.0070105.
Mumby, P.J., et al (2004). Coral Reefs 23:171-183.
Smallwood, C.B., et al (2011). Ocean & Coastal Management 54:330-340.
Smallwood, C.B., et al (2012). Coastal Management 40:381-400.

What are the movement patterns of the redthroat emperor (*Lethrinus miniatus*) over the Great Barrier Reef (GBR)?

Little movement information is currently available for this species due to the lack of tag-recaptures, so Leanne Currey a PhD student at JCU, is using two approaches which will provide information beneficial to the management of emperors in tropical fisheries.

Redthroat emperor (Photo credit: M. Heupel)

About: Leanne's PhD project has been funded by the Australian Research Council, AIMS and the School of Earth & Environmental Sciences at James Cook University. She is supervised by Michelle Heupel (AIMS/JCU), Colin Simpfendorfer (JCU), Ashley Williams (SPC/JCU) and Stephen Sutton (JCU).

Contact Leanne Currey for more information.

She asks:

a) How does the redthroat emperor use space (both activity space and depth)?

b) What environmental conditions are responsible for driving movement patterns?

c) Does the redthroat emperor undergo long-distance movements along the Great Barrier Reef?

d) Can otoliths provide evidence of migration with ontogeny?

Passive acoustic telemetry was used to investigate patterns of space and depth use of the redthroat emperor in the southern GBR, and to determine whether movement is linked to changes in environmental conditions. By tracking individuals in the Capricorn-Bunker region, acoustic data so far indicates variability in movement patterns among individuals over a period of months. These findings were presented at the 2nd International Conference on Fish Telemetry in Grahamstown South Africa in July. One more field trip to Heron Island and One Tree Island in January remains, and the environmental data obtained from in situ monitoring will be linked to the tagged fish data to examine the likely drivers for movement.

The potential for broad-scale movement along the GBR was recently explored using otolith microchemistry, via the ratios of oxygen and carbon isotopes. Comparisons of core and edge samples from L. miniatus otoliths were used to determine whether isotopically different environments were inhabited by juvenile and adult stages from different latitudes. This research forms a paper currently in review that examines potential directional migration of this species among GBR regions.

Knowledge of the abundance and distribution of a species is required by managers. Thus, it is hoped that a greater understanding of the dispersal ability of adult L. miniatus across multiple scales (spatial and temporal) will assist in effective management strategies for this species.

Queensland's Marine and Estuarine Classification project.

The Queensland Department of Environment and Heritage (EHP) through the intergovernmental Queensland Wetlands Program is undertaking an integrated intertidal and subtidal habitat classification system for Queensland.

Contact wetlands@ehp.qld.gov.au for more information or to sign up to the mailing list and receive updates about workshops, draft releases and project outcomes. A factsheet about the project is available here.

Population growth and impacts from development can affect marine and estuarine biodiversity. Knowing where the underlying marine and estuarine habitats are and how they support biodiversity and ecosystem services, is needed for effective planning and management. Identifying similarities in ecosystem function can inform classification, assessment and management of marine habitats.

Classifications typically categorise habitats into ecologically relevant groups sharing similar ecological and physical drivers. Benthic and pelagic habitats are dynamic systems affected by complex environmental components and processes in both space and time and this makes the classification of such systems difficult.

To date, various aquatic ecosystem classifications and typologies have been developed for various purposes and scales, resulting in many different datasets. The integrated intertidal and subtidal habitat classification system will adapt and extend the attribute-based, aquatic ecosystem classification and typology work of the Interim Australian National Aquatic Ecosystem (ANAE) Classification Scheme and the Interim National Intertidal Subtidal Benthic (NISB) Habitat Classification Scheme.

Based upon combinations of agreed attributes from existing literature and expert-panel input, a coastal marine and estuarine habitat typology will also be developed to establish meaningful habitat types for general management purposes. The classification system will be applied to selected existing intertidal mapping, enabling integration with regional ecosystem mapping of terrestrial and freshwater aquatic systems. The resulting statewide classification scheme and methodology will be delivered online through WetlandInfo.

The project will be informed by expert participation in both classification and typology workshops. Participants collaborating in the project include the Queensland Government departments (DAFF, DSITIA, NPRSR and EHP), universities, AIMS, CSIRO, GBRMPA and NRM bodies. Gladstone Ports Corporation has provided financial assistance to the project under a fish habitat initiative and to meet offsets requirements.

If you would like further information about the marine and estuarine classification project, know of relevant datasets, or are researching a relevant or related project, we would like to hear from you.

How to identify your reef?

The Reef Finder: a tool for building ocean literacy

By Russell Kelley

1

The first edition of "A coral reef handbook" was largely illustrated with black and white line drawings.

2

The Blue Highway - an A3 educational poster that featured prominently in the debate over the rezoning of the Great Barrier Reef Marine Park

3

The Coral Finder an A4, text minimised, polypropylene aid to coral identification that can be used underwater.

In this article I outline progress on the ACRS sponsored Reef Finder and by way of preamble take a short tour of some other ACRS publications.

Apart from advocacy on conservation issues and mentorship of generations of coral reef students the Australian Coral Reef Society (ACRS) also has a history of activity in reef related education. Figure 1 illustrates some of the ACRS's broad educational brushstrokes.

I recall as a geology student using the 1st edition of A Coral Reef handbook to explore the bewildering biodiversity of Heron Island, in black and white. As the years went by the editions changed format, gained weight and colour. Each iteration providing a compact, up-to-date, multidisciplinary primer of coral reef concepts in an Australian context. The evolution of the ACRS A coral reef handbook concept culminated in the 2008 CSIRO published tome The Great Barrier Reef: biology, environment and management - which provides a great overview of the Great Barrier Reef system.

Along the way the ACRS has also supported the development of a series of educational and capacity building tools with a distinctly visual emphasis, Figure 2. The Blue Highway was an educational poster promoting the notion that ecosystems, and the species they contain, rely on a mosaic of pathways and processes that may be local, cross shelf or even regional.

In 2008 the ACRS supported the development of the Indo Pacific Coral Finder - a do-it-yourself aid to coral identification. Now in its second edition, it is not so much an underwater book as a Visual Decision Tool and is widely used as a capacity building tool throughout the tropical world. It can be used by anyone with a good eye for detail.

Subsequently, the Coral Identification Capacity Building Program (CICBP) was set up to develop the Coral Finder Toolkit - a suite supporting training resources for the Coral Finder and to run capacity building workshops. In 2013 the CICBP developed a Trainers Toolkit and is currently producing a Bahasa Indonesia language version of the Coral Finder Toolkit and its training movies.

The CICBP has now trained over 300 people in coral identification and has equipped trainers to run their own coral ID workshops in Fiji and Indonesia. As part of this process a lot of data was gathered about how people interact with Visual Decision Tools (VDT's) like the Coral Finder. All of this led to the realisation of the need for a tool that could be taken underwater and used to improve basic ocean literacy.

THE REEF FINDER

In 2012 the ACRS was approached to support the development of such a tool - the Reef Finder - a Visual Decision Tool that would allow the interested person (non-specialist) to teach themselves the basics of coral reef biodiversity - visually. The Reef Finder's design ethos follows Visual Decision Tool guidelines: (a) make decisions visual, (b) minimise text, (c) use plain language, and, crucially, (d) **only describe things you can actually see!** select a gallery page number (Think visual hyperlinking). A Reef Finder gallery page. It provides a general scale reference (see legend at side) and the key visual "LOOK FOR" clues for confirming your ID. Think of the Reef Finder as a post-dive conversation starter. "Hey I saw a spoon worm. I know it was a spoon worm because… …and now I'm gonna look it up!"

The Reef Finder spent December and January 2013-14 undergoing Beta testing in the field with a range of end users including ACRS members. Review and final pre-press is scheduled for February - March, 2014. Manufacturing is notionally scheduled for mid-2014.

Fig 5. The Reef Finder's workflow

Fig 6. Reef Finder Gallery page example. Organism groups have their key visual features tersely described and highlighted using yellow "tip triangles" for underwater confirmation. The yellow / black icons help

4

5

6

News from our research stations

One Tree Island Research Station

It has been an exciting year for One Tree Island Research Station (OTIRS). The University of Sydney's research station on the Southern Great Barrier Reef is a rubble cay located on the SE (high energy side) of One Tree Island Reef. OTIRS is pristine, and it is managed sustainably, it is the only scientific area of the GBR with a research station; you need to be a scientist undertaking research to come here. That also makes it remote as there are no regular boat-transfers and most people need to transfer at Heron Island. Last year saw Heron Island Resort undergoing renovations and so transportation ceased for some months. We had to close the station for a while but when it was open, it was busy. This has been my second year as Director of OTIRS and I must say that the learning curve is massive but, with the help of Prof Maria Byrne, I am getting there. Dr Will Figueira and A/Prof Jody Webster have kindly helped in 2013; they picked up OTIRS while I was on maternity leave during the second half of the year.

A curious loggerhead checking out what some USYD researchers are doing

February 2013 was the last month that Russell Graham and Jen Reiffel worked as managers of OTIRS; we were sad to see them leaving as they have been instrumental for the development of OTIRS and my own learning as Director of OTIRS. We have had wonderful managers and caretakers over the year: Graeme and Wendy Russell, Glen and Wendy Shaw, Louise Smith and David Bond. ***But we are still looking for people wishing to become managers of OTIRS on a permanent basis (i.e. returning every year for a few months). So if you have a Master 5 or a Coxswain endorsed for the Capricorn Bunker Group and wish to give it a try, speak with us!***

We have developed a new website (still ongoing work) for OTIRS where we provide detailed information about how to come here to do your fieldwork. OTIRS was present in the 9th World Sponge Conference in Perth , at the Australian Coral Reef Society Conference in Sydney and, for the first time it was also presented in a Geosciences Booth in the American Geophysical Union Fall meeting in San Francisco (USA). One Tree Island was also the focus of media attention last year as ocean acidification research led by Prof Ken Caldeira from the Carnegie Institution for Science (Standford University) was highlighted in the US, one example can be found here.

Some of the research published in 2013 included papers in Marine Ecology Progress Series, Global Change Biology, and, Invertebrate Reproduction & Development by Prof Maria Byrnes research group; in PLoS one, J of Fish Biology, and, Marine Biology by Prof Mike Kingsford's lab; in Geomorphology, Remote Sensing, and, Journal of Coastal Research by Dr Ana Vila-Consejo's and A/Prof Jody Webster's group; Coral Reefs and, Remote Sensing by Dr Sarah Hamylton.

We are collaborating with Q-IMOS and AMSA so they are still maintaining the temperature, wind , and tide sensors in the lagoon. We are also trying to get some permanent wave measurements occurring East of OTIRS; that will make linking our research data to hydrodynamic conditions a lot easier. We have upgraded some of the communications in the island. Phones and internet are much better now! We have also applied for funding to have a proper upgrade of the internet and that will mean that data streaming from OTIRS will be easier.

Dr. Ana Vila-Consejo
OTIRS Director

Aerial photo by D Kauffman showing the reef and the island at OTI

Water tanks and solar panels at OTIRS (Photo by Marco Ferraz)

It is easy to access the lagoon from the Research Station (Photo by Marco Ferraz)

Orpheus Island Research Station

Located in the Palm Island group 120km north of Townsville, Orpheus Island Research Station (OIRS) is the only research station located on the inshore reef area of the Great Barrier Reef. Established in 1979 as a tropical environment research and education facility by James Cook University, OIRS operates year-round accommodating up to 58 research and education visitors. Set within a 2-hectare site surrounded by the Orpheus Island National Park it offers easy access to inshore and mid-shelf reefs.

OIRS Activities during 2013

Usage remained very high throughout the year with 37 research projects and 32 education classes being conducted during the year.

Several major research projects were finalised with PhD-students and researchers succesfully completing their research into:

• Effects of environmental variation on habitat use and movement of blacktip reef shark

• An investigation into climate change effects on Bioeroding Sponges

• A holistic approach towards understanding population demographics and dynamics of an intertidal sponge

• The effects of ocean acidification on soft corals Lobophytum pauciflorum

We also saw the start of a series of collaborative projects involving researchers from France, USA, NZ and Australia looking into VHF transmission improvements and effects on the reef.

The long term ENTOX study was expanded with the addition of researchers from CSIRO and UQ collaborating with the existing study team to investigate similar chemical pollution data in air and sediment samples.

Developing researcher projects undertaken during the year included investigations into:

• Large-scale variation in partial mortality in adult colonies (*Acopora hyacinthus*, *Pocillopora damicornis*, *porities* sp. and *Montipora* sp.)

• Role of carpases in the metamorphosis process of *A. millepora*

• Effects of sediments on coral early life stages

• Gamete recognition in *Acorpora*

• Coral bleaching and carbon translocation

Education program highlights in 2013 included the succesful introduction of the ATSIMS indigenous marine science program.

Developments in 2013 and on into 2014

A major highlight for this year was the delivery of our new transfer vessel Challenger IV as well as two additional dinghies which will provide greater flexibility for clients.

Challenger IV is a purpose designed 10.7m catamaran capable of transporting up to 25 persons to OIRS and around the Palm Island Group as well as up to 12 persons within the Great Barrier Reef area. Fitted out with large cargo carrying capacity, indoor seating, toilet and fresh water shower it offers a new level of comfort and ease for transfers to OIRS. It's large dive deck and seawater pumping system was designed to meet the needs of groups undertaking research, dive and snorkel activities as well as successful transporting of specimens to OIRS and the mainland.

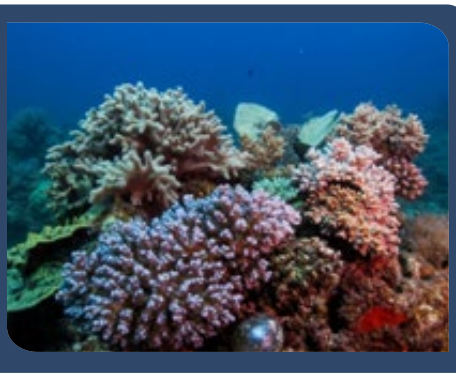
The additional two new dinghies are a similar build to the dinghies recieved in 2012 and are capable of carrying up to 10 persons within Pioneer Bay and 6 further afield. All dinghies are now fitted with sunshade canopies and purpose designed storage areas for oxygen and safety kits eliminating the requirement to load this equipment each day.

Additional improvements were also made in the stations laboratory areas with new insulated floors being installed in the five Temperature Control Rooms improving control of temperature in the rooms. The saltwater supply system also saw improvements with two new pumps, VSD and Magflo meter being installed and both lines were cleaned enabling us to now pump up to 450,000ltrs per day.

Significant funding has been allocated for further improvements to the lab areas in early 2014 including fitting additional tables to TCR's, upgrading DDC control units, improving air and filtered water supply systems and purchase of additional lab equipment including microscope cameras, meters and replacing the spectrophotometer.

Mid 2014 should also see the arrival of a new 6.3m catamaran which will be used as a secondary transfer vessel to OIRS as well as being capable of taking small research groups around the Palm Island Group area and out to mid-shelf reef sites.

Haley Burgess
Station Manager



Heron Island Research Station

The focus for HIRS in 2013 was to grow and strengthen the operational and budgetary management of the Station. We focused heavily on management of assets, operational planning, preventative maintenance and budgetary control. Such efforts have produced a stronger, more confident Station putting us in an excellent position to pursue more varied strategic opportunities in 2014.

This year saw the introduction of a new pricing structure for HIRS. The number of pricing categories was greatly decreased, reducing the accommodation costs for Researchers (UQ, Non-UQ and International) up to as much as 50% with continuation of these prices into 2014.

The Station faced some challenges in 2013. A six week Resort closure and months of restrictions on Catamaran travel proved problematic in bookings. Both the Station and our clients responded well to the challenges. The Station has spent much time and effort this year working to forge stronger ties with Heron Resort and will continue to do so into 2014. A key focus towards the end of 2013 has been to improve the security of utilities to the Station to ensure clients are enjoying the best conditions possible while on the Island. This will continue to be a priority in 2014 as we work to make the strategies developed in 2013 a reality.

Giovanni Bernal Carrillo and Matheus Mello Athayde with their experimental system. Photo Bluedog Photography

HIRS welcomed VIP visitors Professor Max Lu, Deputy Vice-Chancellor (Research) and the Minister for Environment and Heritage Protection, the Hon. Andrew Powell to the Station in July. We took this opportunity to showcase the Island, the Station and its current research projects. We'd like to thank Associate Professor Sophie Dove and Professor Peter Mumby for generously taking the time to talk about their research.

HIRS will introduce a number of new early career researcher (PhD and Honours) scholarships in 2014 to improve Island access to students and support novel and innovative research at the Station. These scholarships will be advertised on the Station website.

This year, and continuing into 2014, engagement will be a priority for the Station. With operational strength now achieved, our focus turns to promotion of the Station, engaging the research community and the 'local' community in general. This year, the Station organised a Photography School – Bluedog Photography and Journalism – to run a workshop on the Station to capture images of the Research Station in action. 2014 will also see a focus on streamlining our customer experience, simplifying the process that clients undertake in order to visit the Station and providing customer service excellence to all visitors.

For more information on news and events at the Research Station, you can access our newsletter here.

We look forward to a happy and prosperous year ahead and can't wait to welcome visitors, new and old, to the Station in 2014.

Elizabeth Perkins
Station Manager

Moreton Bay Research Station

This year has seen the Station benefit from a busy 2012 with new equipment, station upgrades and a new 4WD Toyota troop carrier. As part of the recently developed operational plan – funded by a solid financial model – the Station is concentrating on replacing ageing assets, with a focus on research and teaching equipment.

The introduction of reduced research tariffs for MBRS in 2012 has seen the Station's boating usage increase in 2013, with over 300 hours logged on Glaucus, the Station's twin engine inflatable. With the support of the Quandamooka Yoolooburrabee Aboriginal Corporation, The Quandamooka Land & Sea Management Agency, and SEQ Catchments, the Station has upgraded its mooring. Through funding from the Australian Government's Caring for our Country Program and the support of the Queensland Government, the existing block and tackle mooring was replaced with a seagrass friendly design.

This year, some new outreach programs were trialled. For the local community, a six-week after-school program was developed for local Dunwich State School students. The project culminated in an after-school science fair held during National Science Week. The second outreach program worked directly with school teachers around Australia via the TeachWild program. TeachWild is a Shell sponsored Earthwatch program in which high schoolteachers contributed directly to research the impact of marine debris. Teachers worked alongside leading scientists from CSIRO and UQ, learning about and contributing to hands-on field based data collection and research. The Station also supported early career researchers through the MBRS Community Research Scholarship (won by Honours student Brandon Meteyard) and the MBRS Research Scholarship (won by PhD student Anne Winters). These scholarships will be available again in 2014 and will be advertised on the Station website.

The Station recently signed an agreement to install and maintain 30 acoustic receivers, or 'listening stations', across Moreton Bay. The listening station network is a joint effort between the University of Queensland, James Cook University, CSIRO and the Australian Animal Tagging and Monitoring System (AATAMS). The Moreton Bay acoustic array is part of a larger South East Queensland array, stretching from the southern Great Barrier Reef to the NSW border. There are currently over 165 locations and projects jointly sharing information through receivers linked into the AATAMS network. The listening stations will collect data on fish, dugong and turtle movements in the Bay. These listening stations are available for use by all researchers – please contact MBRS if you are interested in utilising them.

For more information on news and events at the Research Station, you can access our newsletter here.

We look forward to an exciting and productive 2014, filled with even more opportunities for collaboration, research and education and hope to welcome you back on Station in the near future.

International students conducting research projects in the MBRS wet lab. Photo: Office of Marketing and Communication, The University of Queensland.

Kevin Townsend
Station Manager

2013 ACRS Research Award

Climate change and coral disease – How does the coral holobiont respond to pathogenic bacteria under elevated seawater temperatures?

Jeroen A.J.M. van de Water

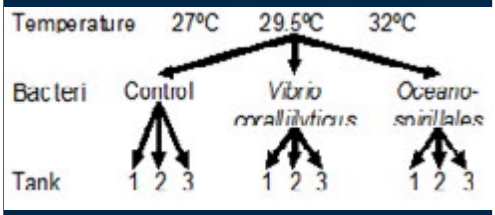


Figure 1 - Experimental design
Coral fragments were subjected to 9 different treatments: corals were exposed to 27°C (control), 29.5°C (medium stress) or 32°C (high stress) and every three days challenged with *Vibrio coralliilyticus* (pathogen), *Oceanospirilalles sp.* (commensal) or no bacteria (control) for 22 days

Figure 2 - Overview of part of the experimental set-up in the climate-controlled experimental room at the Australian Institute of Marine Science. Corals were maintained in aquaria with high water flow and aeration. Aquaria were placed inside plastic tanks to create a closed system and illuminated with actinic fluorescent lights.

Science communication

Results of this study have been presented at various conferences, including the 87th Annual Australian Coral Reef Society Conference in Sydney, the 8th International Conference on Coelenterate Biology in Eilat, Israel (best student presentation award) and the Ocean Science Meeting 2014 in Honolulu, Hawaii, USA.

Jeroen is based at the School of Marine and Tropical Biology, JCU.

The prevalence of coral disease is increasing worldwide and coral diseases have been linked to 6.5% of total coral cover loss on the Great Barrier Reef (Osborne et al. 2011). Coral diseases are more prevalent in summer, suggesting a link with elevated seawater temperatures (Willis et al. 2004). Given the predicted increases in temperature due to climate change, there is a need to investigate the effects of rising seawater temperatures on the health of the coral holobiont.

Vibrio coralliilyticus, the causative agent for some types of white syndromes, has been shown to be more virulent at higher temperatures (Ben-Haim et al. 2003). A recent study on the heat-sensitive coral *Pocillopora damicornis* showed that this coral was unable to mount a significant immune and stress response to this pathogen at high temperatures, resulting in white syndrome lesions and mortality (Vidal-Dupiol et al. 2011). However, how the holobiont of heat-tolerant corals and their symbionts would respond to such stressors is unknown.

To address this question, I collected fragments of the coral *Montipora aequituberculata* from the reefs around Magnetic Island and set up a controlled closed-systems tank experiment (Figure 1 and 2) at the Australian Institute of Marine Science. Coral fragments were randomly distributed over the 27 tanks and acclimated. Corals were challenged with bacteria every 3 days for 22 days. Samples were collected for analysis in triplicate from each tank 24 hours after each bacterial challenge.

Over the course of the study, the number of diseased coral fragments in any of the treatments was minimal. Using pulse amplitude modulation (PAM) fluorometry, I found a minor, but significant, decrease in the photochemical efficiency of the coral endosymbiont *Symbiodinium* at 32°C, which was amplified by *V. coralliilyticus*. At this temperature, this bacterium also appeared to inhibit a highly conserved and main component of the invertebrate innate immune response: the prophenoloxidase system. To further investigate how the coral host responds to and is affected by heat stress and bacterial challenges, I constructed a full transcriptome of *Montipora aequituberculata* (which will soon become available) and conducted RNA Seq analyses using the 3'-end method (Meyer et al. 2011) in the laboratory of Dr. Mikhail Matz at the University of Texas at Austin, Texas, USA. I found significant differences in gene expression profiles of approximately 1400 genes between the three temperature treatments, regardless of the bacterial challenges. A significant portion of these genes are involved in coral stress and immune responses. In addition, several genes were differentially expressed in response to *V. coralliilyticus*, regardless of temperature. However, surprisingly, the coral-associated bacterial communities analysed by 16S rDNA amplicon sequencing showed changes over time, but not in response to bacterial challenge.

Our results show that individual partners within the holobiont of the heat-tolerant coral *Montipora aequituberculata* are affected by elevated seawater temperatures and bacteria, but that this does not make the overall holobiont more susceptible to white syndrome over a 3-week period, as assessed in this study. This suggests that the combined responses by partners within this coral holobiont are sufficient to prevent invading bacteria from establishing and that the coral holobiont may regulate its associated microbial community.

Acknowledgements

I would like to thank the Australian Coral Reef Society for their 2013 ACRS Research Award. This award provided me with funding to cover most of the expenses related to the analysis of the full coral transcriptome response using RNA Seq. Additional funding was provided by Dr. David Bourne, AIMS and the Australian Research Council through an ARC Centre of Excellence for Coral Reef Studies grant to Professor Bette Willis, JCU. I would also like to thank Dr. Mikhail Matz and his team at the University of Texas at Austin, Texas, USA for their hospitality and guidance, the team of the National Sea Simulator (SeaSim) at AIMS for logistical assistance and Maryam Chaib De Mares, who assisted me greatly with this study as part of her MSc thesis at the University of Groningen, The Netherlands.

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2013 Danielle Simmons Award

The role of different herbivorous fish functional groups in inhibiting macroalgal recruitment.

Alyssa Marshell

Introduction. Coral reef deterioration is often associated with macroalgal blooms that can lead to a phase-shift from a coral-dominated to an algal-dominated ecosystem state[1,2]. Herbivorous fish exert top-down control on algal biomass[3], productivity[4], and succession[5]; reducing the establishment and growth of algal communities that compete with corals for space and inhibit coral recruitment[6]. Therefore, herbivory is considered a key ecological process that structures benthic communities and is important for the resilience of coral reefs[7].

When considering processes that control macroalgal blooms, previous studies have largely focused on the top-down reduction of adult macroalgae by browsing, roving, medium-to-large herbivorous fish[8,9]. Although it has been a long-held assumption that algal turf grazing fish incidentally remove macroalgal recruits from within the epilithic algal matrix (EAM), the impact of grazers on macroalgal recruitment dynamics has received little attention (but see 10).

This is the first study to empirically evaluate the grazing impact of different herbivorous fish functional groups on macroalgal recruits (*Sargassum* spp.) settled with the EAM. Four common EAM grazing fish species were chosen that represent different herbivorous fish functional groups and foraging methods: (1) parrotfish that 'scrape' (initial-phase *Scarus* spp.), (2) blennies that 'comb' (*Salarius fasciatus*), and surgeonfish with different jaw morphologies and feeding strategies - (3) *Acanthurus nigrofuscus* ('crop'), and (4) *Ctenochaetus striatus* ('comb'). The aim of this project was to investigate: (1) the patterns of *Sargassum* recruitment dynamics across different reef zones, and (2) how different herbivorous fish functional groups impact *Sargassum* recruit abundance within the EAM.

Methods. This study was conducted at Heron Island Research Station. The grazing impact of herbivores on natural *Sargassum* recruitment dynamics in different zones (inner, mid, outer reef flat, and reef slope) of Heron Island reef was investigated by deploying preconditioned, rough-textured, limestone settlement tiles for five weeks within three treatments (caged, partially-caged, and open tiles), during the annual peak reproductive/biomass period of adult *Sargassum* beds (April - May 2013). The tiles were collected after five weeks and the number of *Sargassum* recruits (< 2 mm) quantified. Settlement tiles with macroalgal recruits were then randomly chosen to be subjected to grazing by fish from different functional groups (n = 5 per species) in experimental aquarium trials.

Aquarium experiments were conducted to empirically evaluate the grazing impact of different herbivorous fish functional groups on macroalgal recruits by quantifying the removal of *Sargassum* spp. recruits (< 2 mm) settled within epilithic algal turfs. To quantify the number of *Sargassum* recruits on each tile, the tiles were removed from holding aquaria, photographed in a container with seawater, and the average algal turf height was recorded. A plastic mesh 12.5 cm2 quadrat (divided into 2.5 cm2) was used as a guide to examine the settlement tile systematically. To accurately count the number of recruits, each 2.5 cm2 was thoroughly searched using fine forceps and probes to scrutinize amongst algal turfs at high-resolution under a stereomicroscope (1.2 x zoom magnification). The approximate position of Sargassum recruits was mapped, and the total number of recruits per tile recorded.

Each experimental grazing trial consisted of placing a mapped tile into the experimental tank where it was subjected to grazing by an individual fish (n = 5 of each species) for three hours. Each trial was filmed using a GoPro HD video camera. After each trial, the number of *Sargassum* recruits remaining was determined using the same method as above. During the experimental trials, control tiles were treated identically to experimental tiles, but with grazing prevented.

Results and Conclusions. This is the first study to investigate the effect of grazing on early stages of post-settlement macroalgal recruitment dynamics in different reef zones, and quantify the foraging impact of common grazing fish on newly settled macroalgal recruits within epilithic algal turfs. Grazing significantly reduced the number of *Sargassum* recruits overall, and *Sargassum* recruitment patterns followed adult distribution patterns, with most recruits settled in the inner and mid reef flat zones, where adult plants were most prolific.

EAM grazing surgeonfish and parrotfish removed significant numbers of *Sargassum* recruits settled within the EAM through their foraging activity, while blennies had an insignificant impact. *Ctenochaetus striatus* removed the most *Sargassum* recruits settled within epilithic algal turfs per trial, with 59% of total recruits removed on average. This is an interesting result as *C. striatus* is currently functionally classified as a detritivore that feeds upon sparse algal turfs and calcareous algae, 'combing' detritus from the EAM surface, and causing little damage to algae[11] (but see 12).

Figure 1 - Aquarium experiment with *S. fasciatus* (photo: A. Marshell).

Figure 2 - Aquarium experiment with *Scarus* spp (photo: A. Marshell).

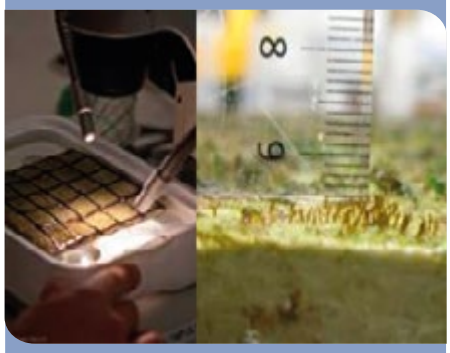

Figure 3- Counting *Sargassum* recruits settled within algal turfs (left), and < 2 mm recruits (right) (Photo: M. Priest).

The capability of surgeonfish and parrotfish to remove macroalgal recruits settled within the EAM is of significant ecological importance, as these species intensely graze the EAM with fast average bite rates, and are abundant species on most coral reefs[13].

These results suggest that small, common EAM grazing fish contribute significantly to-

wards reducing overall macroalgal cover on reefs, and are likely to have important ecological roles, potentially providing a mitigation service that reduces the risk of macroalgal blooms on coral reefs. However, it is not yet known if 'prevention' is better than 'cure'. While the role of EAM grazers in reducing macroalgal recruitment is undoubtedly important, the role of browsing herbivores that can reverse established macroalgal blooms is certainly equally essential, and management policies that protect a combination of key species with different functional roles is likely to be a wise strategy.

In summary, investigating the specific ecological role of key herbivorous fish species is critical to understand key processes that underlie reef resilience. Protecting key herbivore species with 'prevention' and/or 'reversal' capabilities in disturbed coral reef areas may prove vital to reducing algal overgrowth, macroalgal blooms and subsequent coral reef degradation.

Acknowledgements

Many thanks to the ACRS for granting me the 2013 Danielle Simmons Award which helped fund the fieldwork costs of this project at Heron Island Research Station. I also greatly appreciate the help of my field volunteers: Mark Priest, Lauren Hughes and Cory McShane; and am very grateful for HIRS staff logistical support and assistance, and MSEL helpful discussions and advice.

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Figure 4 - Browsers on Heron Island (Photo: A. Marshell)

Alyssa is based at the Marine Spatial Ecology Lab, School of Biological Sciences, UQ

2013 Terry Walker Award

Figure 1 - Ambon damselfish (Pomacentrus amboinensis) near lizard Island, Australia (photo: Ulrike E. Siebeck).

Identifying the visual cues used for complex pattern discrimination in the Ambon damselfish (*Pomacentrus amboinensis*)

Cait Newport

The visual world around coral reefs contains a multitude of colours and patterns that form an important part of the language of its inhabitants. For example, bold splashes of colour can alert predators to the toxicity of potential prey and intricate body patterns can identify individuals. As a result, the recognition and classification of visual signals is essential to the survival of many animals. Errors in interpretation are costly, and in extreme cases, such as the incorrect classification of a predator, can lead to death. Much work has been dedicated to understanding the use of visual signals in animal communication by studying the importance of simple features within a few model species. Traditional experiments have focused on the importance of a particular pattern feature, such as the presence of a tell-tale spot, and not the pattern as a whole. In addition, the visual system of humans differs to that of fish yet the features tested have been selected based on the visual system of the experimenter, not the fish. As a result, previous studies focused on selected features may be limited by human observer's bias. In the past, it has been practically impossible to design visual signalling experiments that comprehensively analyse patterns because natural patterns are so complex. Attempting to test the individual importance of all the visual information would require a vast number of experiments. The advent of machine learning may provide a solution that will eliminate the need to test individual features and instead identify underlying mechanisms. Machine learning is a branch of artificial intelligence that uses real data to train a machine to solve classification problems. Once the machine has learned to classify the training data, it can then apply the learning rules it used to classify novel information. For example, machine learning systems have been employed for human facial recognition software. In a simple case, the machine can be trained using many pictures of human faces to distinguish male and female faces. Once it has learned, the machine can then be given new faces to classify. In the case of animal behaviour, a machine learning system can be trained to mimic the learning behaviour of an animal based on example data. In order to use this technique to study the visual perception of fish, real data from behavioural experiments that describe how fish perform a specific task can be used to train the machine. The benefit of this technique is that, unlike the fish, once the machine is trained we can then ask how it made each decision. The machine can identify complex relationships and underlying mechanisms within the visual information and create a model of discrimination. The outcome is a ranked list of possible visual cues that the fish is likely to use for discrimination which can then be verified experimentally. The application of machine learning to the study of animal sensory systems has recently been pioneered by Yovel et al. [1, 2]

to study the echolocation calls of bats. The aim of my project was to identify a method to apply machine learning for the first time to the study of fish visual perception. Ambon damselfish (*Pomacentrus amboinensis*), a common species found on the Great Barrier Reef, were used in this study as a model for complex pattern discrimination as they naturally use intricate ultraviolet facial patterns to discriminate heterospecifics as well as conspecific individuals. As this is a new application for machine learning, it was important to first determine an appropriate procedure that could be used. As a result, the first aim of my project was to use behavioural experiments to analyse the ability of Ambon damselfish to discriminate between complex patterns when four pattern elements (size, resolution, contrast and brightness) were altered. Once this data was collected, the second aim was to use the results from the behavioural experiments to train the machine learning system.

The 2013 Terry Walker Prize, covered the costs of field work at the Lizard Island Research Station and gave me the opportunity to carry out the behavioural experiments.

Field studies: behavioural experiments

Behavioural experiments were used to test what visual information the Ambon damselfish use to discriminate between individual facial patterns. The facial pattern stimuli were images of real Ambon damselfish faces taken using a camera with an ultraviolet filter (see Siebeck et al. 2010 for further details on how images were made [3]). In addition, the photographs were further altered using Photoshop CS5 to remove patterns beyond the operculum and to standardize head shape. This was done to ensure only the facial patterns were used for discrimination.

Fifteen Ambon damselfish were caught using hand nets around Lizard Island, Australia. Fish were housed in individual aquaria that served as both holding and experimental tanks. The fish were first trained to discriminate between two faces following methods outlined previously by Siebeck et al. [4]. Briefly, fish were presented with two images of conspecific faces on a white plexiglass board. When the fish pecked at the image, it was given a food reward (a paste made from fish flakes and water dispensed through a syringe). Training continued until each fish achieved an accuracy above 75% correct choices over two consecutive sessions (n=10 trials per session).

Four tests were then used to determine the threshold at which the fish could no longer reliably distinguish between the patterns. Rather than concentrating on a single feature within these patterns, the sensitivity of the fish to global transformations (i.e. size, resolution, contrast and brightness) of the patterns was tested. The point at which the fish could no longer discriminate the two patterns is the point at which something crucial for discrimination has been lost and it is this information that is required for the machine learning technique. Testing methods were similar to training whereby the fish were presented with two faces that they must discriminate however, each session consisted of eight test trials where the images were manipulated and two control trials with the original training stimuli. Testing was run until each fish completed a total of 10 replicates for each of the test images.

Data analysis

The machine learning analysis was done in collaboration with Prof. Franz from the University of Applied Sciences in Konstanz, Germany. In August 2013, I visited Prof Franz, in order to develop the machine learning protocol. During my visit, we discussed how to develop our methods to be more applicable to the machine learning system and used the behavioural data I had collected to run pilot studies. This allowed us to design an improved experimental procedure for future studies. The most difficult part of applying this technique to animal behaviour is finding a method that allows the fish to be tested in a way they can understand but also provides the sort of data required for the machine learning analysis. This project is still ongoing and future work will focus on refining both behavioural experiments and the machine learning procedure.

Figure 2 - Examples of binarised Ambon damselfish faces used for behavioural experiments.

Figure 3 - Image of an Ambon damselfish making a decision between two stimuli during training (photo: Cait Newport).

Cait is based at the Laboratory of Visual Neuroethology, School of Biomedical Sciences, UQ

Acknowledgements

Thank you to the Australian Coral Reef Society for awarding me the Terry Walker Prize 2013 which allowed me to conduct field work. I would also like to thank Christoph Braun for help catching fish in the field and the staff at the Lizard Island Research Station for making everything run smoothly.

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2013 ACRS Research Award

Understanding the contribution of tropical symbiont-bearing large benthic foraminifera to carbonate reef budgets

Steve Doo

Figure 1 - Algal reef rim habitat on One Tree Reef, Southern Great Barrier Reef

Figure 2 - Macroalgae with multiple species of LBF epiphytes

Declining coral coverage and fish populations along the Great Barrier Reef (GBR), Australia attributed to anthropogenic effects of ocean warming, acidification has been widely documented (Hoegh-Guldberg et al., 2007). Traditional model organisms of coral and fish have received the majority of the attention, while research has largely neglected other important taxa that serve an important role in a healthy reef ecosystem (Przeslawski et al., 2008). Symbiont-bearing large benthic Foraminifera (LBFs), an abundant group of protists that occur throughout tropical and sub-tropical waters along the GBR are one such taxa. While living, Foraminifera are an important reef primary producer through symbiotically associated algae, and post-mortem, serve a crucial role in sediment production. Along the GBR, populations of Foraminifera compose up to 95% of sediments produced in beach sands and are involved directly in buffering of diel oscillations of lagoonal pH (Yamamoto et al., 2012). In addition, Foraminifera shell production is crucial for maintenance of sand cays (Yamano et al., 2000). Due to their rapid life cycle, quick calcification and ecological importance, these protists are an important yet extremely understudied component of coral reef ecosystems.

One interesting aspect about LBF biology lies in their symbiotic association with microalgae. In addition to the dinoflagellate *Symbiodinium* that is commonly associated with corals, LBFs also form symbioses with diatoms, red algae, green algae and cyanobacteria. The importance of these symbiotic relationships is highlighted in a recent study that observed increased calcification/growth in higher pCO2 conditions in a diatom symbiont-bearing species verses a dinoflagellate symbiont-bearing species (Fujita et al., 2011), contrary to the majority of current findings (Schmidt et al., 2011, Uthicke et al., 2012). The authors credit this trend to the symbiotic differences between algal species that is hosted by the foraminifers, but further work is crucial to fully understand the mechanisms.

This portion of my PhD focused on establishing baselines of carbonate production and storage of LBF populations at One Tree Reef (OTR), South GBR with the goals of:

1. Comprehensive surveys of LBF populations at OTR to assess the main contributors of carbonate production to the reef

2. Assessing seasonal changes in population density and composition, and upscaling findings to the entire reef using habitat mapping and remote sensing images

3. Determining short and long term physiological effects of near-future ocean warming and acidification on LBFs health

Methods and Initial Results

A thematic algal habitat map using a World View-2 satellite image was used to represent the mixed nature of reef communities based on the decomposition of each pixel into community subcomponents. Photo-records taken across the OTR flat were used to ground-truth field samples. Remote sensing satellite data and the percentage cover data determined in the field to a continuous digital map across the complete reef flat system (Doo et al., 2013a). In our July 2013 sampling season, the LBF carbonate production on the algal reef rim was estimated to be 950 ± 95 g m-2 yr-1 (average ± S.E.), making this one of the highest productive reefs recorded worldwide. The main carbonate producing species found were *Baculogypsina sphaerulata* (444.6 ± 66.3 g m-2 yr-1), *Marginopora vertebralis* (298.7 ± 30.1 g m-2 yr-1), *Peneroplis* sp. (73.5 ± 20.4 g m-2 yr-1), Calcarina sp. (62.2 ± 11.4 g m-2 yr-1) and *Amphistegina* sp. (58.1 ± 6.7 g m-2 yr-1). Specifically, the reef rim habitat provides high percentage of algal cover (see yellow, Figure 3), where LBFs live in high densities as epiphytes.

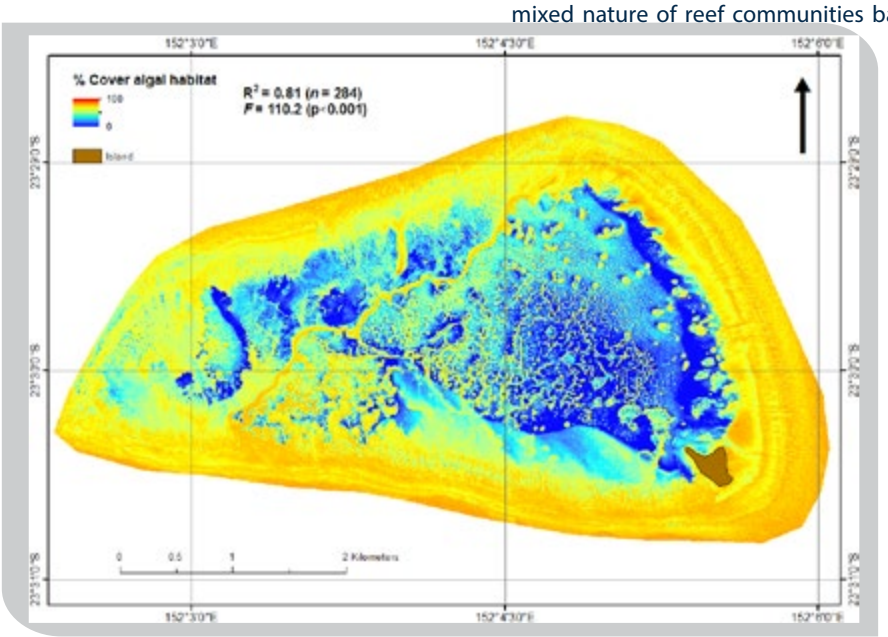

Figure 3 - Map of One Tree Reef showing % of habitat cover by algae

The LBF populations at OTR reside in shallow to intertidal

reef flats that are highly variable environments, experiencing up to ±10°C change daily. To better characterize the intertidal habitat in which LBFs live, I also monitored changes in carbonate chemistry during daytime low tides. Seawater pH and total alkalinity (proxy for calcification) were measured over a 6 hr period. Calcification increased rapidly over time during ponding (decrease in alkalinity), and pH increased up to 8.8 pHsw (see Figure 4). This indicates a highly variable chemical and physical environment marked by tidal and temperature fluctuations photosynthesis and calcification, in which LBFs are well adapted for living.

Ongoing Work

Additional experiments have been initiated to assess physiological responses of LBFs to dual temperature and acidification stressors. Experimentally modified seawater with increased pCO2 and temperature will be used to expose Foraminifera (5-30 specimens per replicate, dependent on the species) to near-future climate change scenarios. Measurements of maximum dark-adapted yield (photochemical efficiency), respirometry and growth measurements will be taken throughout the experiment to assess the health of the foraminiferal holobiont. At the termination of experiments, specimens will be preserved in liquid nitrogen for further protein expression work (eg. Rubisco, D1 proteins; Doo et al., 2013b).

Acknowledgements

I would like to thank the Australian Coral Reef Society for funds. The funds have been used for bench fees and travel expenses for field work. I would also like to thank my field assistants Paula Cisternas, Kennedy Wolfe and Joshua Finfer for their help in sample collection and analysis. Sarah Hamylton is thanked for the generation of the remote sensing images.

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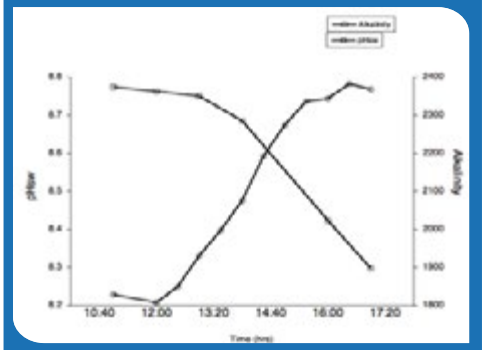


Figure 4 - Changes in carbonate chemistry during daytime low tide.

Steve is part of the Coastal and Marine Ecosystems Group, School of Biological Sciences, USYD

Images from the 2013 photo competition

Ciemon Caballes

Andrew Baird

Edward Roberts

The 87th Annual ACRS Conference
"Reefs in a Time of Change"

Keynote speakers

Prof. David Booth – ACRS Vice President and Director of the Centre for Environmental Sustainability, UTS

Prof. Peter Ralph – Executive Director of The Plant Functional Biology and Climate Change Cluster, UTS

Dr Andrew Baird – ARC Future Fellow, JCU

Dr David Wachenfeld – Director, Ecosystem Conservation and Sustainable Use, GBRMPA

Student awards

Vicki Harriott Award

Christopher Goatley, "Sediments suppress the functional roles of herbivorous fishes on coral reefs"

Bench fees

Simon Brandl, "A novel analysis of functional niche overlap applied to a herbivorous coral reef fish community"

Brett Taylor, "Effects of fishing and environment on protogynous sex change dynamics at multiple scales"

Dominique G Roche, "Plastic lateralization in parasitised coral reef fish"

Matthew Nitschke, "Physiological responses to thermal stress of free-living Symbiodinium cultured in reef sediment"

Honourable mention

Toni Mizerek, "Predicting changes to Australia's scleractinian coral ranges using traits"

Bridie Allan, "Parental effects improve escape performance of juvenile reef fish in a high CO2 world"

Shaun Wilkinson, "Hybridization in coral symbionts"

Poster prizes

Paloma Matis, "Dynamics of fish-coral associations across latitudes from the Southern Great Barrier Reef to Sydney"

Sandra Binning, "Finding the best estimates of metabolic rates in a coral reef fish"

Non-Student awards

•**Alexandra Campbell,** "Tropicalisation of temperate marine ecosystems: Herbivore-mediated phase-shifts from kelp to coral?"

Joshua Madin, "Mechanical vulnerability explains size-dependent mortality of reef coral growth forms"

Kenneth Anthony, "Cumulative impacts, risks and informed deci-

The 87th Annual ACRS Conference was held from 28-30th August at the Menzies Hotel, Sydney and was the first to be run in conjunction with the International Society for Reef Studies (ISRS). Delegates participated in a number of social activities, including the welcome function at Sea Life Sydney Aquarium and the conference dinner at the Star Room. Delegates showcased the latest in reef research across a series of thematic sessions. In total, there were 112 oral presentations spread over two days in three concurrent sessions, and 20 posters presentations.

A number of workshops were run for delegates including the ARC Centre of Excellence for Coral Reef Studies National Student Mentoring Day, and the coral identification workshop. An excursion was also run to the Sydney Institute of Marine Science (SIMS) where delegates were given a short presentation and tour of the research facilities, including laboratories, aquaria and teaching spaces.

A Public Forum on Port Developments on the Great Barrier Reef was held on Thursday 29th August at The Menzies Hotel. The panel discussed the ramifications of the proposed developments for the region from a number of perspectives and included:

- Prof John Pandolfi – Facilitator
- Dr Jamie Oliver – Australian Institute for Marine Science
- Jon Brodie – James Cook University
- Dr Michael Gardner – Queensland Seafood Industry Association
- Larissa Waters – Queensland Senator and Greens spokesperson for the GBR
- Tom Coughlin – Fitzroy Basin Association
- Felicity Wishart – Fight for the Reef Campaign

We look forward to welcoming you all to the 2014 ACRS Conference at the Mercure Hotel in Brisbane, 27-29th August.

Poster session

Dr Ross Hill and Dr Selina Ward
Conference Committe Chairs

A Reminiscence of the 87th Annual Australian Coral Reef Society Conference: "Reefs in a Time of Change"

A.W.D.Larkum

It is easy to gloss over that number! However, it may take us a moment's reflection to grasp the fact that 87 annual meetings takes us back to 1926! Well, of course that was the time of the Royal Society Low Isles Expedition, which brought so much coral reef research to Australia, under the auspices of the ACRS and the Royal Society of London. I have no idea what went on between then and 1951 when the Great Barrier Reef Committee was formed and with it the Heron Island Research Station. Not a great deal one would guess! I remember attending my first ACRS Annual Conference in early 1970s and that was a very small meeting dominated by fish researchers and a smattering of people working on other subjects such as corals, algae and beach rock.

What a contrast the 87th Conference was with 112 speakers, 20 posters and 3 concurrent sessions over 2 days, held in the plush Menzies Hotel and not in some dusty University Department as formerly was the case. And opened by the NSW Governor, her excellency Professor Marie Bashir and not as in the past by a harried Vice-Chancellor or one of his minions.

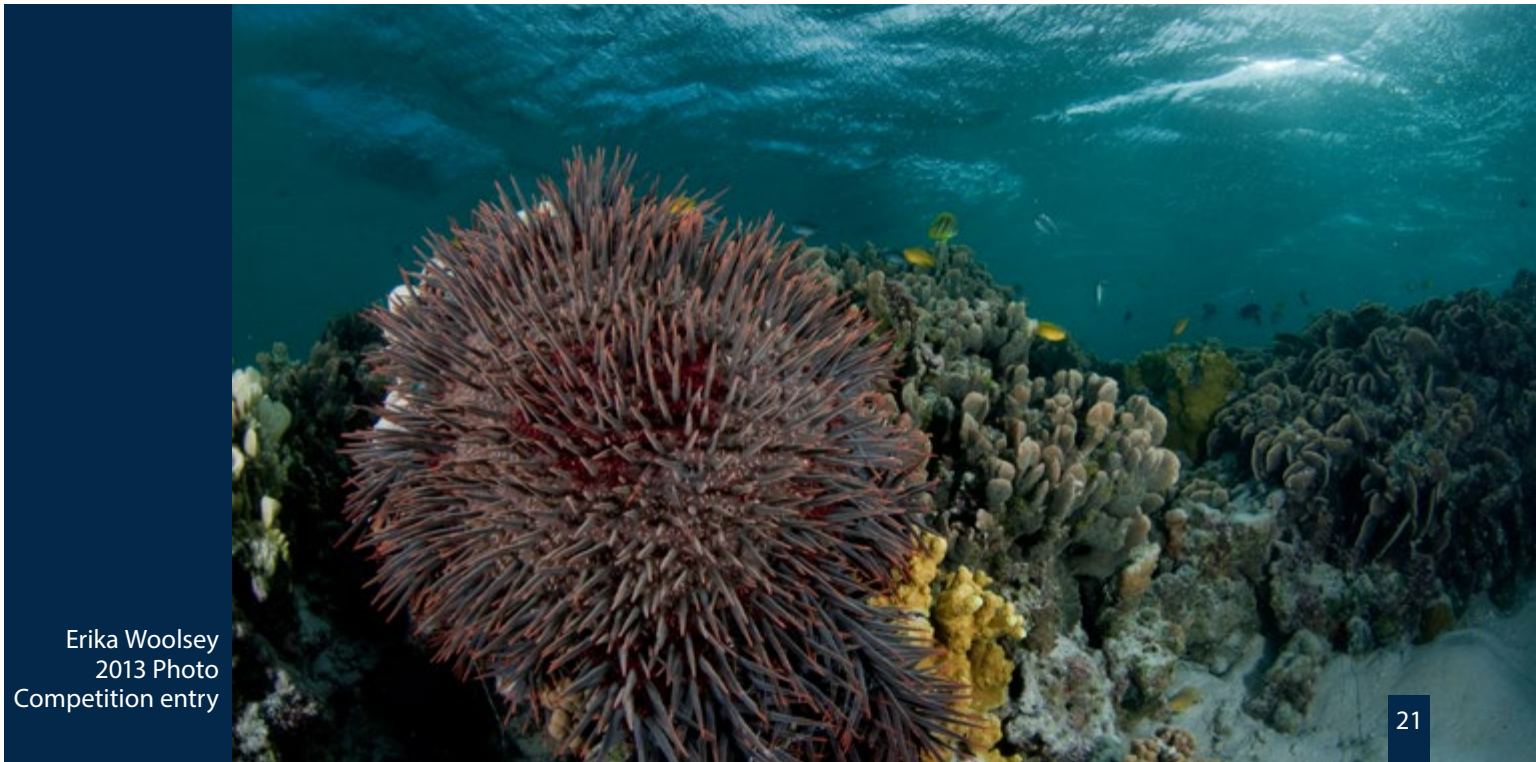
Fish studies are still very popular with 6 sessions on this topic. However, vying with this there were 7 sessions on corals and coral bleaching, 5 sessions on ocean acidification, environmental and climate change. Then there were single sessions on a number of interesting topics such as physical disturbances, algae and microbes, benthic diversity, past reefs and marginal reefs.

Of course ocean acidification has only been a program item for the last half dozen or so meetings and it has only recently got into its stride because of the conceptual challenges and high cost of carrying out worthwhile experiments. Unless, of course you pay to travel to places such as the volcanic CO2 seeps of Papua-New Guinea, as Julia Strahl and Nickolas Vogel and coworkers did. And the net take-home lesson from a wide range of studies on fishes, corals, invertebrates, *Aplysia* and even the immune response of corals was that the results of enhanced levels of CO2 in the atmosphere to reef organisms are deleterious and usually highly significant.

Coral bleaching is generally ascribed to temperature rise of reef waters in response to global rise in greenhouse gases. There were two sessions devoted to this topic and a number of interesting new ideas were canvassed as to the initial trigger to the loss of zooxanthellae from corals, such as nitric oxide (Hawkins and woworkers) and repair of photosystem II (Hill and Takahashi), as well as the usual culprits (Reactive Oxygen Species, Photosystem II damage or damage to the Calvin Benson Cycle of photosynthesis).

Perhaps the greatest change that a time-traveller from the first meeting of the Society might have noticed would have been in the sophistication of the molecular science. And by this I do not just mean DNA, although this is a notable aspect. For example Gibbin and coworkers used a confocal microscope to measure the pH inside coral cells, with and without a *Symbiodinium* cell, using a fluorescent dye and were able to show important differences when the cells were exposed to low external pHs, i.e. ocean acidification conditions. And Salih and coworkers used the same technique to visualize green fluorescent pigments (GFPs) and how they are photoinduced by high light following bleaching. The workers on the Royal Society Great Barrier Reef Expedition who grappled with showing a role for the zooxanthellae (then called zoochlorellae) of corals could not but have marveled at the changes that have occurred in such a relatively short stretch of time.

Prof. Larkum is Emeritus Professor USYD and Adjunct Professor UTS



Erika Woolsey
2013 Photo
Competition entry

2013 ACRS conference:

Thoughts by our students

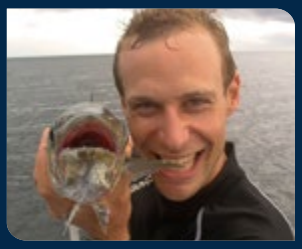
Following the Indo-Pacific Fish Conference in Japan, the ACRS Conference was the second symposium I attended in 2013. I initially expected to meet similar people and prepared myself to sit through talks I had already seen in Japan, but I was eager to present a new paper to the audience. Yet, as usual, my experience at the symposium proved to be quite different from what I expected.

As a scientist based in Townsville, I was impressed with the extensive coral reef research performed outside the Townsvillian coral reef hub. Consequently, I embraced the opportunity to meet many outstanding Australian coral reef scientists as well as previous researchers that are now contributing to the conservation of coral reefs through careers in politics and management. While the International Coral Reef Symposium in Cairns in 2012 offered similar possibilities, the smaller scope and collegial atmosphere of the ACRS provided the key for establishing new connections to local scientists. In particular, the social events associated with the conference facilitated dialogue with people I had not previously known. In summary, the ACRS provided an ideal chance to become familiar with Australian coral reef scientists and their work, which I consider the overarching objective of a conference held by the Australian Coral Reef Society.

Simon Brandl
PhD student, JCU.
Bench fee award winner

Last August's conference in Sydney was my first ACRS conference so I wasn't sure what to expect. I really enjoyed every aspect of the event; the welcome function and conference dinner, the keynote speakers, the public forum, the many presentations as well as the main venue. The comparatively small size of the conference was a nice contrast to, say, the International Coral Reef Symposium, providing a more personal experience that facilitated networking opportunities with experts from our region. The presentation topics were very up-to-date and many were highly relevant to recent and ongoing port expansion issues. Altogether, the 87th ACRS was a great place to present my latest research and I look forward to attending next year's conference.

Brett Taylor
PhD Student, JCU
Bench fee award winner



The ACRS 2013 in Sydney was an absolute success! The friendly welcome function at the Sydney Aquarium was a fantastic way to kick-start the meeting. The social events and ample coffee breaks were also ideal to reconnect with and meet new fellow students from across Australia. Canberra being only three hours away, I find it surprising how little ANU students get to interact with PIs and students from Sydney Unis. ACRS filled that gap for me and I was very pleased to get to meet and chat with a number Sydney-based researchers in my field, including Liz and Josh Madin, David Booth, Emma Johnston, David Feary and Will Figueira, among others. Above all, it's the outstanding quality of the student talks and posters that really made this conference worthwhile for me. I'm also pleased to announce that the follow-up study to the talk I gave 'Plastic lateralization in parasitised coral reef fish' will be coming out soon in Animal Behavior: Binning et al. (Accepted) Ectoparasites modify escape behaviour, but not performance, in a coral reef fish. Those interested in parasitism and fish behaviour, should keep their eyes peeled!

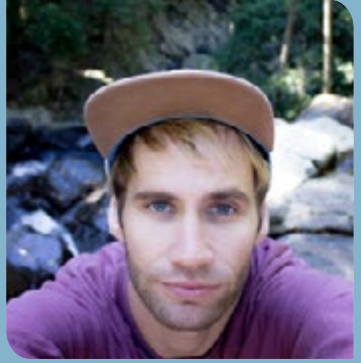
I'd like to thank the ACRS and the One Tree Island Research Station for awarding me one of the student talk prizes.

Dom Roche
PhD student, ANU
Bench fee award winner

Twin Waters (2011) was my first experience of an ACRS annual conference. I was as fresh as they come (around 1 month into my PhD) and somewhat ignorant of the many networking opportunities the event facilitates. Nevertheless, I met inspiring scientists and made lasting friends; influential people who would continue to pop-up in "coral-reef meetings" to come. For myself, the weeks leading into ACRS Sydney were in anticipation of reunions between good friends, and a great chance at making many more.

I made a repeat attendance in the student day workshops, and while several of the lessons to be learned were a reminder of those I received in Twin Waters, I thought them timely as I entered the final year of my PhD. The registration event at the SEA LIFE Sydney Aquarium quickly confirmed that this conference would be the reunion and networking event I had hoped for. I received greetings from friends made at previous conferences and met fellow students visiting from as far as Saudi Arabia and South Africa. The presentations during the following days were an absolute pleasure. It was inspirational to sit in session and receive great talks from students at a similar stage of their candidature as myself, witnessing first-hand how individuals had broadened their career and developed skills to apply within the coral-reef field. In giving my own presentation I was able to gather valuable insight from the audience, directly enhancing the output of my future work. Overall, the event had a well-organised feel to it, and I have a new appreciation for the value of being in conference with colleagues and friends.

And who could forget the conference dinner, or the final song of the night? The spectacle that was a room full of marine biologists dancing to "Gangsters Paradise"? I am thoroughly looking forward to ACRS, Brisbane 2014.



Matthew Nitschke
PhD student, UQ
Bench fee award winner

Can immigrant fish find a home?

Paloma A. Matis

The climate change induced strengthening and warming of the East Australia Current (EAC) are responsible for rapid and dramatic poleward range shifts for a large variety of marine organisms. Previous research testing the potential for vagrant tropical fishes to establish populations in NSW has shown that lower thermal limits do not completely explain the lack of population establishment. It is imperative to explore other ecological factors such as habitat availability at the source and sink locations, which may be a key indicator of whether tropical species can establish populations in southeastern Australia. Understanding habitat associations of species is vital in determining an organisms' vulnerability to environmental change and anthropogenic stress.

My research aims to advance our understanding of how range expansion of tropical reef fishes may be limited by habitat type and complexity in temperate and subtropical locations. Specifically, I am exploring how spatial patterns in reef fish abundance reflect habitat availability and determine importance of architecture in habitat selection within systems. Furthermore, I am investigating how variation in habitat structure and complexity affect the performance of reef fish species, allowing prediction of future tropical species expansion at higher latitudes. Greater knowledge of this significant factor is essential for effective conservation, planning and management of Marine Protected Areas (MPAs). With approximately 10% of coral reef fish classified as coral dependent at some stage of their life, a reliance on live coral is likely to constrain shifts into subtropical and temperate latitudes (Fig. 1).

I aim to fill current knowledge gaps on how tropical reef fishes associate with available habitat to gain a better understanding of what factors limit survival in subtropical and temperate regions. This is one of few studies to look at finer scale habitat complexity in relation to habitat use of tropical vagrants at the edge of their range and innovative in its approach to compare habitat use of tropical reef fish across tropical, subtropical and temperate reefs. My research locations span from the tropical natal reefs of Cairns, One Tree Island in the southern Great Barrier Reef, the subtropical coral reefs of the Solitary Islands and sink location of temperate Sydney as part of a study of southern coral reefs (CIs Dr Josh Madin MU, Dr Andrew Baird JCU, Prof David Booth UTS).

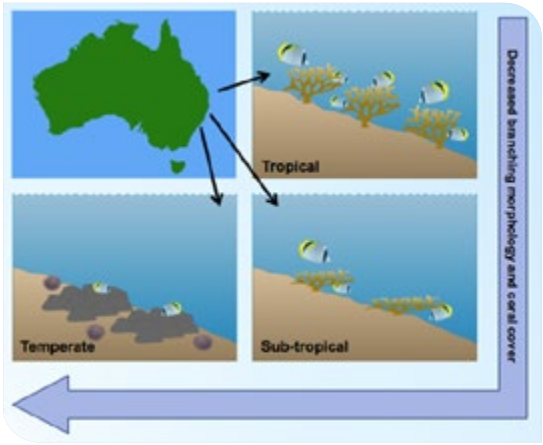


Figure 1. Coral reef communities markedly differ between the tropical, subtropical and temperate latitudes, with corals typically less diverse and abundant, and lower in morphology.

Paloma is a PhD student at the Fish Ecology Lab, School of the Environment, UTS

Poster award winner

Finding the best estimates of metabolic rates in a coral reef fish

Sandra A. Binning

As biologists, we try to gain a broader understanding of the natural world in which we live. Of course, many different approaches can be used to bring us closer to the all-important "truth." Often, studies in the biological sciences offer either proximate or ultimate explanations for the phenomena observed. Perhaps for this reason, the worlds of physiologists, mostly concerned with proximate mechanisms, and evolutionary ecologists, focused on ultimate mechanisms, seem to rarely overlap. Fortunately, this is changing. Ecological- , evolutionary- and conservation-physiology are all growing fields, and play increasingly important roles in elucidating the effects that shifting environmental conditions have on the physiological tolerances and ability of organisms to adapt.

This merging of ideas has necessitated the development of novel methodologies designed to answer new questions. While this offers exciting possibilities for integrative solutions to real-world problems, there is a danger that comes with a jack-of-all-trades approach to science. Often systems are so complex, details so important, that anything less than a complete understanding of the underlying processes or procedures used to gain information can lead to misinterpretation.

Increasingly in the aquatic sciences, the development and refinement of tools to measure underwater respiration have been applied to glean insight into questions on life-history trade-offs, effects of climate change, host-parasite interactions and behaviour, to name a few. Respirometry equipment and software have become increasingly accessible tools to quantify the metabolic performance of organisms. However, there is fear that the growth of these fields, and the corresponding broad-scale use of different respirometry techniques, has occurred without the necessary quality control and rigorous standards for protocol and procedure as is seen in many other technically-challenging disciplines (see Clark et al. 2013).

For these reasons, myself and colleagues began a project using a common coral reef fish, the bridled monocle bream (Scolopsis bilineata), to compare some commonly-used techniques in aquatic respirometry in an attempt to develop guidelines for scientists unsure of how to best answer their questions of interest (Roche et al. 2013). This study, which I presented during the poster session at the 2013 ACRS conference in Sydney, is intended to help researchers develop a "best practice" data collection and analysis protocol for their system depending on which metabolic measures they are interested in estimating. Follow-up studies are currently in the works to determine the general applicability of the results we obtained for the bridled monocle bream. Hopefully this research provides useful insight for researchers interested in delving into the fascinating world of respiratory physiology for their next ecological, evolutionary or conservation projects.

Clark, T. D., E. Sandblom, and F. Jutfelt. 2013. Aerobic scope measurements of fishes in an era of climate change: respirometry, relevance and recommendations. Journal of Experimental Biology 216:2771-2782.

Roche, D. G., S. A. Binning, Y. Bosiger, J. L. Johansen, and J. L. Rummer. 2013. Finding the best estimates of metabolic rates in a coral reef fish. Journal of Experimental Biology 216:2103-2110.

Sandra is a PhD student at the Division of Evolution, Ecology and Genetics, ANU

Poster award winner

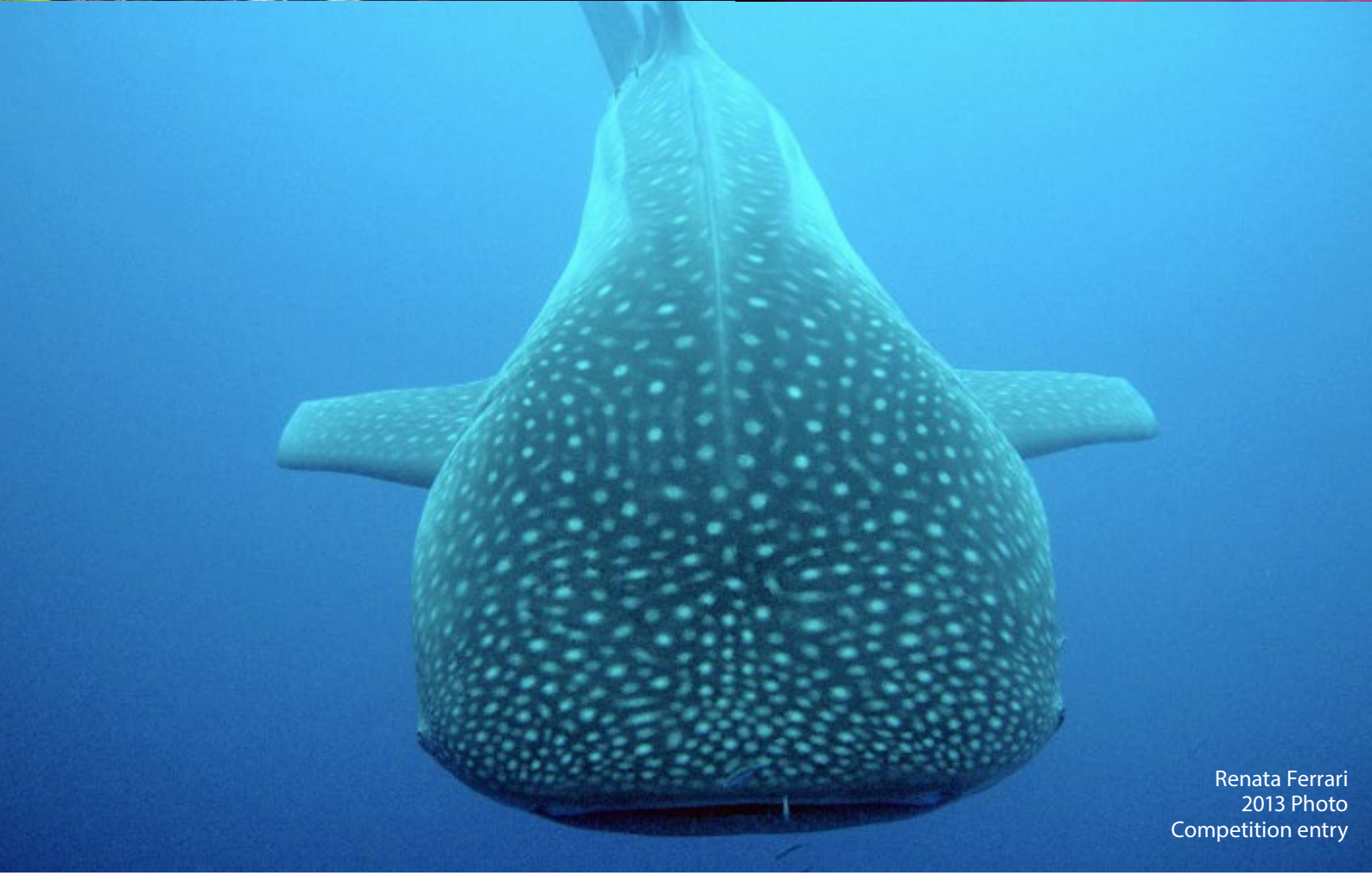
Get ready for the 88th Annual ACRS Conference

We would like to invite you to the 88th Annual ACRS Conference to be held in Brisbane, Australia from 27-29 August 2014.

The 2014 ACRS Conference will be held at the Mercure Hotel. There will be a welcome function on the evening of 27th August with two days of talks on the 28th and 29th August. The conference dinner will be held in the beautiful level 12 Rooftop Room at Rydges Hotel at Southbank on the 29th August.

Make sure to register early! More details will soon be found here.

Tom Hawkins
2013 Photo
Competition entry



Renata Ferrari
2013 Photo
Competition entry

Fresh insights: Research highlights of the year

Colder water unlikely to prevent coral larvae from heading south

From the publication:

Woolsey E, Byrne M and Baird A (2013) **The effects of temperature on embryonic development and larval survival in two scleractinian corals.** Marine Ecology Progress Series 493: 179-184

Raised temperatures effect early development in many organisms, but we know much less about the effects of lowered temperatures. This is important to examine because cold water barriers might prevent tropical marine invertebrate species from dispersing to high-latitude locations. In addition, slower development resulting from lower temperatures may reduce the amount of larvae settling in the natal habitat because fewer larvae will be retained. In this study, we looked at the relationship between temperature, development rate and larval survival at temperatures over an 8°C temperature range (-4 to +4°C around the ambient temperature at the time of spawning, 24°C) in two reef-building corals, *Goniastrea favulus* and *Acropora spathulata*, from One Tree Island in the southern Great Barrier Reef. Raised temperatures significantly reduced survivorship in both species, however *A. spathulata* larvae were more sensitive to temperature rise than *G. favulus*. In contrast, temperatures below ambient did not affect larval survivorship in either species. In addition, embryos of both species developed more slowly at lower temperatures. These results suggest that fluctuations in temperature at the time of spawning will influence patterns of coral larval dispersal and also that colder water is unlikely to prevent the dispersal of tropical corals to sub-tropical locations.

Coral reefs legalize same-sex marriage

From the publication:

Brandl SJ, Bellwood DR (2013) **Pair formation in the herbivorous rabbitfish *Siganus doliatus*.** Journal of Fish Biology 82, 2031 – 2044. DOI: 10.1111/jfb.12131

What the Australian government seems to be incapable of appears to be common practice on Australian coral reefs. While admittedly, there is no evidence for official fish weddings, a paper by Simon Brandl and David Bellwood shows that in the rabbitfish *Siganus doliatus*, individuals form stable same-sex pairs, providing the first quantitative and qualitative investigation of this phenomenon in coral reef fishes.

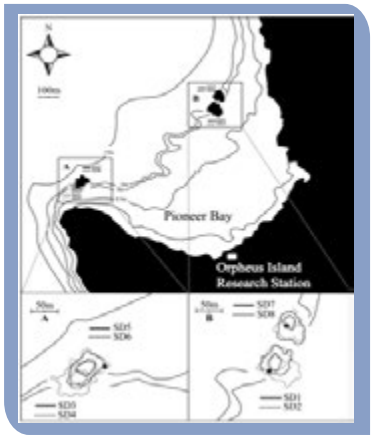
S. doliatus is a herbivorous reef fish that is abundant on inshore reefs of the GBR and as other rabbitfishes, this species occurs mostly in pairs (Figure 1). In their paper, Brandl and Bellwood begin with quantifying the social system of *S. doliatus* at Orpheus Island, showing that individuals most commonly associate in pairs (67.4% of all observed individuals) and that this is consistent among all size classes, starting in individuals as little as 5cm (prior to maturation) and increasing in strength as the fishes grow. While this suggests that pairing is an important feature of the life history of *S. doliatus,* it also raises the question of whether pairs are an ephemeral bond or a strong, tight association. Using acoustic telemetry and kernel utilization densities, the article shows that the pair bond in *S. doliatus* is in fact a stable system, in which partners maintain close contact throughout the day and spend the night in the same resting site. Consequentially, the paper demonstrates that the home ranges of pairs overlap almost entirely (Figure 2).

The manifest explanation for pairing behavior in *S. doliatus*, and possibly all rabbitfishes, is that individuals assemble in monogamously reproducing pairs, for which the maintenance of a tight, stable pair bond is beneficial by increasing reproductive success. But is this really all of it? Apparently not. Of all examined pairs, a quarter (25.0%) was found to comprise same-sex individuals, arguably reproductive mismatches that commonly yield little reproductive success. So what is the function of pairs in *S. doliatus*?

Siganus doliatus pair. Photo authors

The authors conclude that, given that 75.0% of all pairs were heterosexual, monogamous reproduction and the benefits of long-term pair bonds associated with monogamy are still likely to remain a strong driver of pairing behavior. However, given the apparent preference for a reproductively unfeasible partner over being single suggests that other factors may exert a strong influence on the social life of *S. doliatus*. Specifically, this may relate to enhanced vigilance in pairs and a specialized foraging behavior that has recently been identified for rabbitfishes.

In summary, the pair bond in rabbitfishes appears to be a complex social system that goes beyond pure reproductive strategies and holds intriguing questions regarding its eco-evolutionary causes and consequences. In the greater scheme of things, the paper by Brandl and Bellwood demonstrates that pairs of animals might not always be as simple as they look and that stable, long-term associations between same-sex individuals are legitimate from an evolutionary perspective.



Experimental sites in Orpheus Island

Is the sea cucumber fishery well managed in Australia?

From the publication:

Eriksson, H; Byrne, M. (2014) The sea cucumber fishery in Australia's Great Barrier Reef Marine Park follows global patterns of serial exploitation. Fish and Fisheries DOI: 10.1111/faf.12059

Sea cucumbers are harvested around the world to produce the product 'trepang' or 'beche-de-mer' which is especially popular in China. In recent years more than 24 sea cucumber fisheries in tropical nations including Samoa, Papua New Guinea and the Solomon Islands have had their fisheries closed due to overfishing. Over 70 percent of tropical sea cucumber fisheries are now considered depleted, fully exploited or over-exploited. Sea cucumber fishing in the Great Barrier Reef Marine Park (GBRMP), the East Coast Beche-de-Mer Fishery, is also showing worrying signs of being unsustainable. Many species being targeted are endangered and vulnerable to extinction, as determined by the International Union for Conservation of Nature. Sea cucumbers play a vital role in reef health and may help reduce the harmful impact of ocean acidification on coral growth. The viability of their numbers may well be crucial to the condition of coral reef ecosystems. Until we have a better understanding of levels of sustainable harvest - and the impact this will have on the reef - we recommend introducing precautionary reductions in sea cucumber fishing in the GBRMP. Overfishing is often blamed on the limited capacity to manage fish stocks in these, often poor, countries. We conducted the study on this fishery on the Great Barrier Reef to see what Australia could share with low-income developing countries that lack management capacity. Sadly we found striking similarities with low-income countries. Our analysis of catch reports over a 20 year period (1991 to 2011) showed the same pattern of exploitation with no baseline data to assess change. In the Great Barrier Reef fishery, the only industrial scale tropical fishery, the high value sea cucumber species, teatfish, has been replaced with lower-value sea cucumber species such as curryfish. Pursuing profits by targeting abundant species which sell for less while continuing to fish scarce high-value species is a pathway to their extinction. This substantial shortcoming in fishery management is not appropriate for a fishery in the iconic Great Barrier Reef Marine Park. While most fisheries in developing countries struggle to monitor catches, in Australia the data exist but are confidential. We question whether this confidentiality in catch data - the main source of information for fishery management - is best practice. It appears that providing relatively few fishers with exclusive access to a large fishing area through licenses does not safeguard sustainable sea cucumber harvests.

What we learned from a decade of ocean acidification research

From the publication:

Chan NCS and Connolly SR (2013) Sensitivity of coral calcification to ocean acidification: a meta-analysis. Global Change Biology 19, 282-290

Ocean acidification has been dubbed 'the other climate change problem' that corals are facing as it reduced the concentration of carbonate ions (the building blocks on calcification) available to corals. In the last decade, there has been a dramatic increase in experimental studies seeking to estimate the sensitivity of calcification to acidification. However the response estimates in these studies have varied enormously. In this study, we collated 25 published estimates of the relationship between coral calcification and acidification and used them to calculate a weighted average response of calcification to acidification. We also tested whether methodological and biological factors that have been hypothesized to drive variation in results explained a significant proportion of among-study variation. If the existing body of experimental work is indeed representative of likely responses of corals in nature, our results suggest that under business as usual conditions, coral calcification will have declined by ~22%, on average, by the end of the century. This is toward the low end of the range of published projections. We also found that studies employing the buoyant weighting method of measuring calcification found significantly smaller decreases in calcification, compared with studies using the alkalinity anomaly technique.

Images from the 2013 photo competition

Emma Gibbin

Jennifer Atherton

Can high-latitude reefs show us the way for the future?

From the publication:

Sommer B., Harrison P. L., Beger M., Pandolfi J.M. (2013). Trait-mediated environmental filtering drives assembly at biogeographic transition zones. Ecology. In press. DOI: 10.1890/13-1445.1

In the coming decades, altered environmental conditions and shifts in the distribution and abundance of organisms have the potential to fundamentally alter ecosystems at the transition of biogeographical zones, which are sometimes heralded as potential refugia under climate change. The identification of mechanisms that drive their assembly and allow perseverance in marginal environments is thus a necessary prerequisite to predicting how they may respond to future change and for their management and conservation. Shifts in species abundances and association patterns along environmental gradients can be indicative of environmental filtering, which is predicted to be stronger in areas of high abiotic stress and to promote increased similarity of ecological characteristics among co-occurring species. Here we tested these hypotheses for scleractinian corals along a broad latitudinal gradient in high-latitude eastern Australia, where corals occur at the margins of their ranges and environmental tolerances. High-latitude reefs therefore provide natural laboratories in which to explore how certain species traits allow survival in marginal habitats and possibly also perseverance in changing climates. We quantified variation in taxonomic, zoogeographic, and functional patterns combined with null model approaches and demonstrate systematic spatial variation in community structure and significant covariance of species abundance distributions and functional characteristics along the latitudinal gradient. We described a strong biogeographic transition zone, consistent with patterns expected under abiotic filtering, whereby species are sorted along the latitudinal gradient according to their tolerances for marginal reef conditions. High-latitude coastal reefs are typified by widely distributed, generalist, stress-tolerant coral species with massive and horizontally spreading morphologies and by diminishing influence of tropical taxa at higher latitudes and closer to the mainland (Fig. 1). Higher degree of ecological similarity among co-occurring species than expected by chance supports the environmental filtering hypothesis. Among individual traits, the structural traits corallite size and colony morphology were filtered most strongly, suggesting that characteristics linked to energy acquisition and physical stability may be particularly important for coral survival in high-latitude environments. Growing evidence points to a shift in life-history strategies on contemporary reefs impacted by anthropogenic and climatic stress, away from sensitive, fast growing species (e.g. branching *Acropora* spp.) to morphologically simpler, more stress-tolerant species and to opportunistic species with good colonising ability. Our findings therefore support the notion that coral communities in marginal environments may provide predictive models for potential future states of tropical coral reefs that may become marginal under climate change.

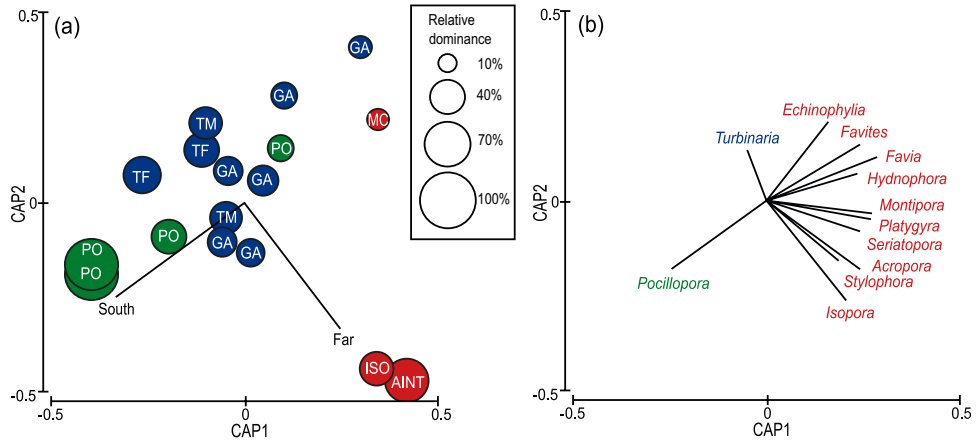


FIG. 1. (a) Canonical analysis of principal coordinates (CAP) revealing variation in coral community structure of subtropical eastern Australian reefs (bubbles) in relation to latitude (South) and distance from the mainland (Far). Letters adjacent to bubbles identify the dominant species at the locations and bubble colours denote their zoogeography: GA, *Goniastrea australensis*; PO, *Pocillopora aliciae*; TM, *Turbinaria mesenterina*; TF, *Turbinaria frondens*; ISO, *Isopora* sp.; MO, *Montipora* sp.; AINT, *Acropora intermedia*; red indicates tropical species; blue indicates cosmopolitan species; green indicates subtropical species. Bubble size indicates relative abundance of the most abundant species. (b) Vectors identify genera that primarily discriminate communities along spatial gradients and their zoogeography.

Plate 1. Coral assemblage in the Solitary Islands Marine Park (30°S)

Cue for a coral killer!

From the publication:

Garren M, Son K, Raina JB, Rusconi R, Menolascina F, Shapiro OH, Tout J, Bourne DG, Seymour JR, Stocker R (2013) **A bacterial pathogen uses dimethylsulfoniopropionate as a cue to target heat-stressed corals**. ISME J 1-9.

Coral reefs are threatened globally by disease and bleaching, and in many cases this threat appears to be strongly linked to rising seawater temperatures. Research partially funded by the 2012 ACRS Terry Walker award, which was recently published in the ISME Journal has identified an ecological mechanism by which the coral pathogen, *Vibrio coralliilyticus,* locates thermally stressed corals. Using a combination of microfluidics and video microscopy this research revealed that the pathogen directs its swimming behaviour in response to the sulfurous compound dimethylsulfoniopropionate (DMSP). Coral reefs are important global hotspots for the production of copious amounts of DMSP. This research demonstrated that thermally stressed *Pocillopora damicornis* colonies have up to five times more DMSP in their mucus than non-stressed corals. The increase in DMSP concentration in coral mucus not only induced chemotaxis (the ability to direct movement in response to chemical stimuli) by *V. coralliilyticus* towards the mucus of thermally stressed coral, but also chemokinesis, an increase in swimming speed.

This research, which was partly conducted on Heron Island Research Station, highlights for the first time the importance of holobiont produced chemicals such as DMSP as being crucial chemical signals or cues for coral pathogens to locate stressed coral hosts. The findings also emphasise the importance of observing coral-bacterial ecological interactions at the micro-scale to better understand the complex interactions and relationships bacteria form with coral. The research was carried out by lead author Melissa Garren, in addition to Roman Stocker, Kwangmin Son, Roberto Rusconi, Filippo Menolascina and Orr Shapiro from the Massachusetts Institute of Technology (MIT); Justin Seymour and Jessica Tout of the University of Technology, Sydney; and David Bourne and Jean-Baptiste Raina of the Australian Institute of Marine Sciences. Part of this research was funded by the ACRS Terry Walker Award 2012 to Jessica Tout.

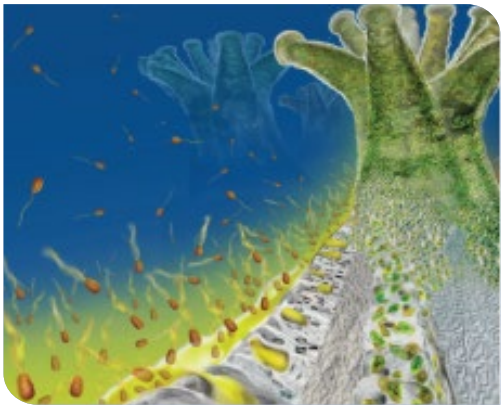


Figure 1 Artist's impression of the microscale world in which coral pathogens can locate a coral (not to scale). The surface of a coral is rich in mucus containing chemicals such as DMSP (yellow) which diffuse through the water column, creating chemical gradients that can act as chemical signals for marine bacteria to locate corals by using chemotaxis. Garren et al. 2013.

How do corals balance light energy?

From the publication:

Elgetti Brodersen K, Lichtenberg M, Ralph PJ, Kuhl M and Wangpraseurt D (2014) Radiative energy budget reveals high photosynthetic efficiency in symbiont-bearing corals. J.R. Soc. Interface. 11(9): 20130997 doi: 10.1098/ rsif.2013.0997

The light field on coral reefs varies in intensity and spectral composition, and is the key regulating factor for phototrophic reef organisms such as corals harbouring microalgal photosymbionts. However, what the actual light use efficiency is in coral tissue and how the light energy budget in corals is affected by increasing light intensities are largely underexplored. In this recent study, we aimed to address how the light energy budget and light use efficiency of the symbiotic microalgae is regulated in the coral tissue and we present the first light energy budget for a symbiont-bearing coral based. Using microelectrode technology we quantified the dissipation of absorbed light energy into photosynthesis and heat within the coral tissue and determined a surprisingly high local photosynthetic quantum efficiency of the photosymbionts in hospite. The majority (>96%) of the absorbed light energy was dissipated as heat, whereas the proportion of the absorbed light energy used in photosynthesis was ~4.0% under an irradiance of 640 µmol photons m-2 s-1. At higher irradiances (and flow velocities), the heat dissipation increased at the expense of photosynthesis. Thus, the light absorption increases the temperature of the coral microenvironment, and thereby has the potential to aggravate the negative response (such as bleaching) to elevated seawater temperatures. Despite the coral's apparent low ability to convert light energy into chemically bound energy (by photosynthesis), we found high gross photosynthetic rates within the coral tissue and local photosynthetic quantum efficiencies reaching ~0.1 O2 photon-1 thereby approaching the theoretical maximum (i.e. 0.125 mol O2 per mol photons, as 8 photons are needed to separate the electrons required to produced one O2 molecule). Corals thus appear as highly efficient light-users and -collectors with optical properties enabling light distribution over the corallite/tissue microstructural canopy, which in turn allows high photosynthetic quantum efficiencies of their photosynthetic microalgae in hospite.

Figure 1. fiber-optic microsensor inserted into the coenosarc tissue of the examined coral species, measuring the amount of light available for photosynthesis within the coral tissue in increments (step sizes) of 100 µm.

Looks can be deceiving - elucidating species boundaries and evolutionary relationships in cauliflower corals

From the publication:

Schmidt-Roach S, Miller KJ, Lundgren P, Andreakis (2014) With eyes wide open: a revision of species within and closely related to the *Pocillopora damicornis* species complex (Scleractinia; Pocilloporidae) using morphology and genetics. Zoological Journal of the Linnean Society 170 (1), 1–33

Summary: In recent years, molecular taxonomy has frequently challenged the skeleton-based classification of scleractinian corals and has significantly contributed to the understanding of their systematics and evolution. In the genus Pocillopora (cauliflower corals) molecular studies have been instrumental for refining species boundaries and revealing hidden species diversity within *Pocillopora damicornis*, one of the most extensively studied species in the genus.

Our manuscript published early this year in the Zoological Journal of the Linnean Society of London now formally revises the taxonomic status of several species within *Pocillopora*. The publication is titled "With eyes wide open: a revision of species within and closely related to the *Pocillopora damicornis* species complex (Scleractinia; Pocilloporidae) using morphology and genetics" and represents the latest in a series of articles published by myself and co-authors in the last two years that aim to elucidate species boundaries and evolutionary divergences within pocilloporids.

In corals, high level of phenotypic plasticity encrypts species boundaries and has promoted taxonomic confusion since the earliest species descriptions in the 18th century. The diversity of gross morphological variants found in *P. damicornis* has made it the "poster child" for eco-morphology, i.e. variations in shape and size exhibited by an organism in response to certain environmental conditions. However, we demonstrate that the growth forms are not only characteristic to certain reef habitats, but also vary significantly along latitudinal gradients (Fig. 1).

Species decisions were made on the basis of genetic evidence, reproductive and new morphometric data, including fine-scale corallite and coenosteum structure, Although high phenotypic plasticity is exhibited by most *Pocillopora* species, our work revealed that mitochondrial molecular phylogenies are congruent with groups based on morphology, therefore reflecting species-level differentiation. Fine-scale morphological variation, particularly the shape and type of columella, was useful for differentiating between genetic clades and provides an excellent signature of the evolutionary relationships among genetic lineages.

The integrative approach applied in this work further assisted to elucidate the evolutionary history of species within the genus *Pocillopora*. Some species lack sharp nuclear divergence although their differences in morphology, symbiont association and reproduction were distinct. Occasional introgressive hybridization at evolutionary time scales is therefore assumed in the genus and may likely represent an important evolutionary source of genetic variation useful for adaptation. However, this mechanism together with incomplete lineage sorting complicates the delineation of species within the genus on the basis of a single species concept. The Unified Species Concept applied in this study has proven to be an alternative yet suitable approach in revising coral taxonomy.

Following the description of *P. aliciae*, a new species characteristic of the subtropical waters of Eastern Australia, in early 2013, this recent work describes eight species (*P. damicornis*, *P. acuta*, *P. aliciae*, *P. verrucosa*, *P. meandrina*, *P. eydouxi*, *P. cf. brevicornis*), including a novel taxon identified at Lizard Island in the Northern Great Barrier Reef – *Pocillopora bairdi* (Fig. 2). A taxonomical key, citation synonyms, type materials and molecular reference sequences are presented. Being aware of the taxonomic debate within the genus *Pocillopora*, this publication provides guidance to correct species identification and delivers solid taxonomical units to ecologists and conservationists, which is an essential tool for accurate biodiversity research.

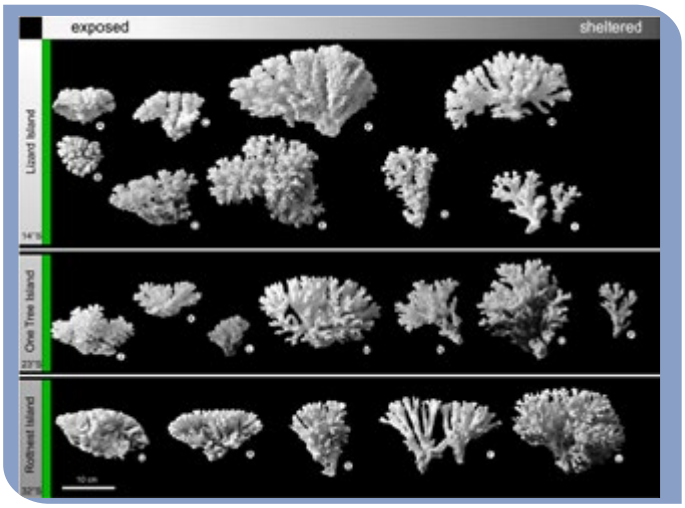


Figure 1. Morphological plasticity exhibited by *Pocillopora damicornis* skeletons in environments from exposed to sheltered at different geographical locations/latitudes (Schmidt-Roach et al. 2014).

Figure 1. Colony consisting of *Pocillopora bairdi* (left half), *P. meandrina* (top right) and *P. damicornis* (bottom right) (Schmidt-Roach et al. 2014).

Experimental sites in Orpheus Island

Australian Coral Reef Society

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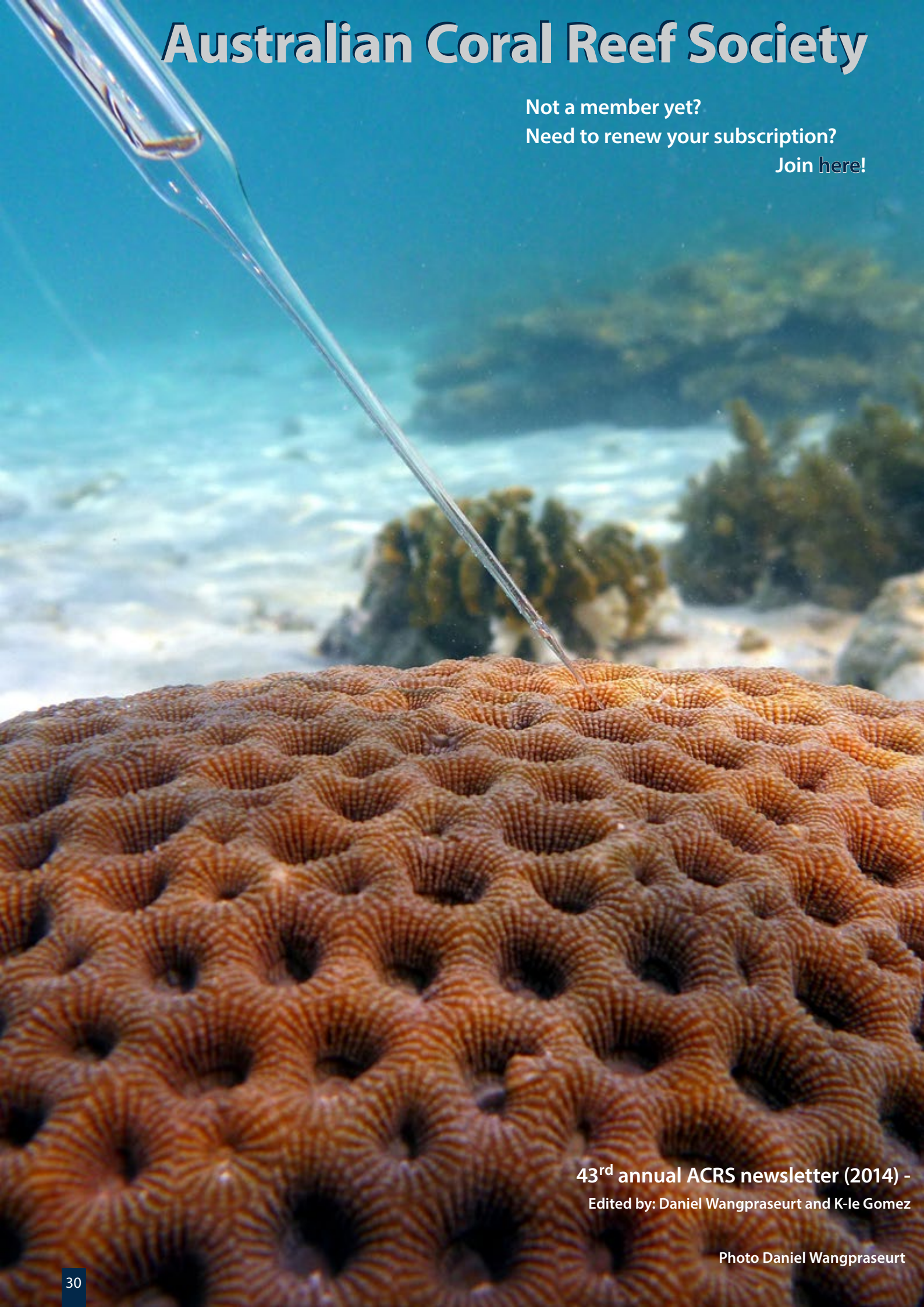

43rd annual ACRS newsletter (2014) -
Edited by: Daniel Wangpraseurt and K-le Gomez

Photo Daniel Wangpraseurt