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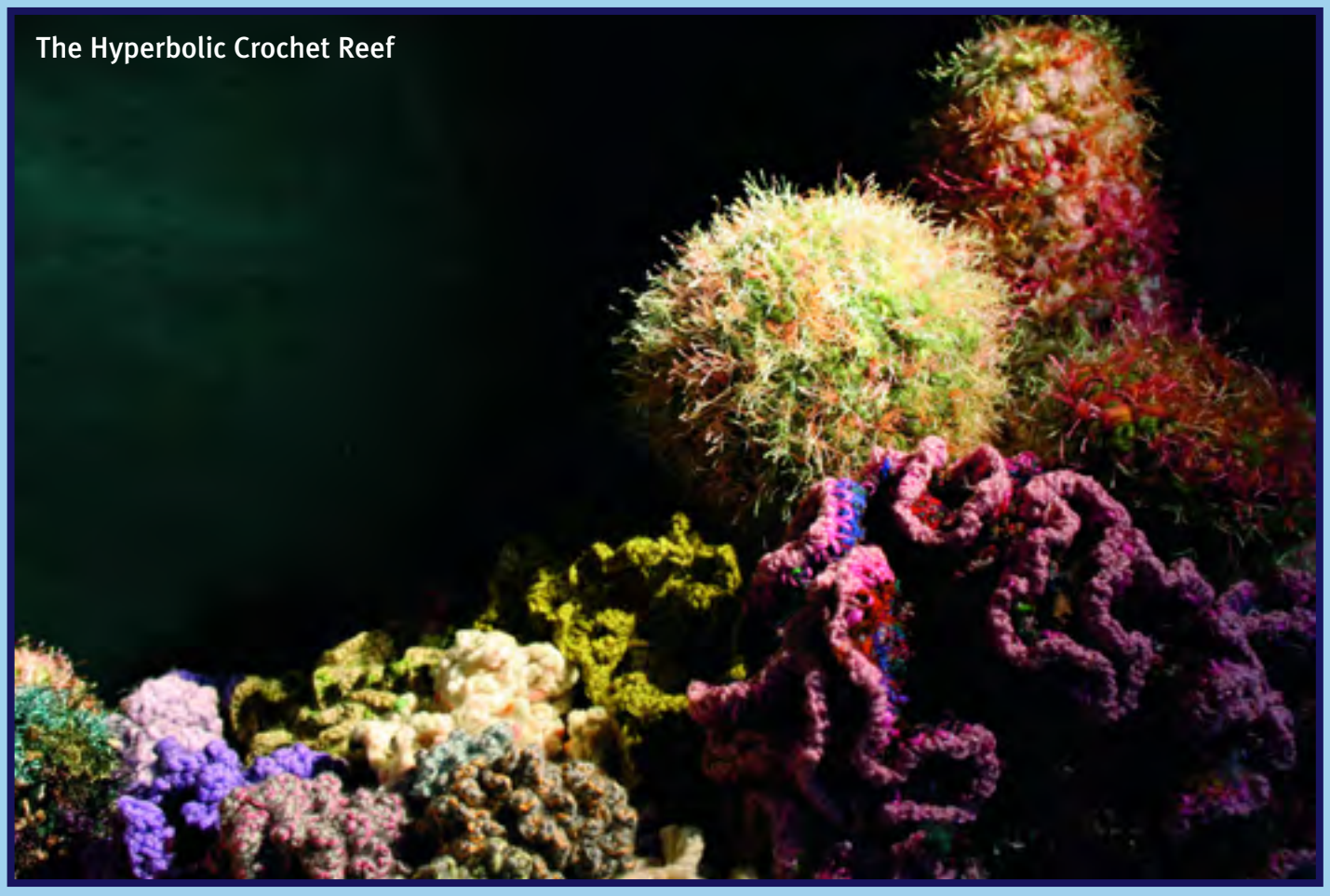
Newsletter of the International Society for Reef Studies



The Hyperbolic Crochet Reef

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Newsletter of the International Society for Reef Studies

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Editorial

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Front cover
The Institute for Figuring Crochet Coral Reef.
Photo Alyssa Gorelick © IFF

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The International Society for Reef Studies was founded at a meeting in Churchill College, Cambridge, UK in December 1980. Its aim under the constitution is to promote, for the benefit of the public, the production and dissemination of scientific knowledge and understanding concerning coral reefs, both living and fossil.

i. In order to achieve its aim, the Society has the following objectives:
ii. To hold meetings, symposia, conferences and other gatherings to disseminate this scientific knowledge and understanding of coral reefs, both living and fossil.
iii. To print, publish and sell, lend and distribute any papers, treatise or communications relating to coral reefs, living and fossil, and any Reports of the Proceedings or the Accounts of the Society.

To raise funds and invite and receive contributions from any persons what so ever by the way of subscription, donation or otherwise providing that the Society shall not undertake any permanent at trading activities in raising funds for its primary objects.
The Society collaborates with Springer-Verlag in producing the quarterly journal Coral Reefs. This large-format journal is issued free of charge to all members of the Society, and concentrates on quantitative and theoretical reef studies, including experimental and laboratory work and modeling.

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EDITORIAL

Past and present Officers and Council Members of ISRS

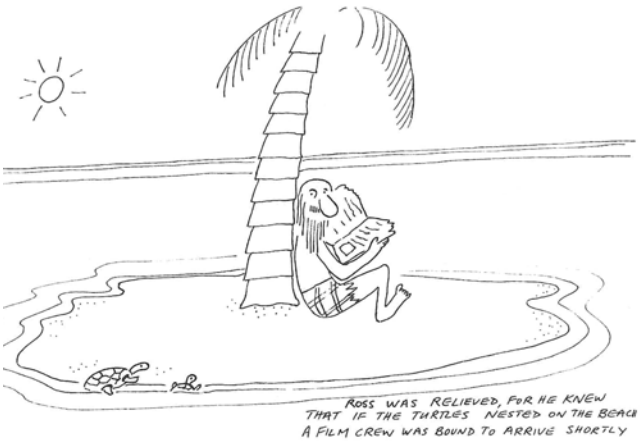
We have another packed issue – thanks so much to all those who have made the contributions (and apologies where we have had to 'butcher' your text to fit everything in!). Many thanks to those of you who came forward at the 11th ICRS and volunteered to help with *Reef Encounter* – we will be calling on your assistance for future issues.

This issue demonstrates the wide range of activities that ISRS is involved in, including the 11th ICRS (p. 5), where ISRS members were much in evidence, the planned new ISRS Briefing Paper on coral reef rehabilitation, and ISRS participation in the new Reefs at Risk project and a research initiative at the University of Cambridge. We have started a permanent section of the newsletter to showcase the Fellowship programme (p. 10), which has now been running for over ten years and has disbursed almost half a million US dollars, thanks to two very generous anonymous donors.

There are reports of reef research programmes underway on the west coast of India, in Oman, and in the Maldives, and of new work looking at the conservation status of sea snakes. As we approach the big Darwin anniversary (2009 is the 200th anniversary of his birth, and the 150th anniversary of the publication of his *On the Origin of Species*) the reflections on progress in coral reef mapping and our understanding of the classification of corals seem very appropriate.

The International Year of the Reef is coming to an end, and has done a tremendous job in promoting a wider understanding of why reefs are important and their uncertain fate to a huge audience: thanks to the Hyperbolic Crochet reef, the message has also reached both the high art world and women's handicraft groups around the world! The new challenge will be to turn this awareness into action – and active ISRS members will be key to this.

Sue Wells, Adel Heenan, Steve Coles



ISRS COMMENT

Message from the President

The 11th International Coral Reef Symposium (ICRS) in Fort Lauderdale, Florida was a resounding success in terms of science and projecting our message to the public. The intellectual tone of the Symposium was superb, and it was good to see us as a group pull away from the depressing attitude that it is game-over for coral reefs. One more time, we all owe Dick Dodge and the Local Organizing Committee (LOC) our thanks for their hard work in putting the conference together.

Bob Richmond and his committee are working to identify the venue for the 12th ICRS, and we expect to make an announcement soon. Several people suggested innovative ways to ease the organizational burden and carbon footprint of the next Symposium. We will pass those ideas on to the new LOC.

On July 1 2008, Rolf Bak took over from Barbara Brown as Editor-in-Chief of *Coral Reefs*. At the same time Betsy Gladfelter took over from Richard Dunne as Editorial Assistant. We thank Barbara and Richard for all they have done for the Society and we look forward to working with Rolf and Betsy. There have also been some changes to the editorial board, so please check the *Coral Reefs* website.

Sue Wells and her editorial team likewise deserve a lot of credit for doing such a professional job in producing *Reef Encounter* on a tight budget. As with so much of the Society's work, they do their jobs voluntarily and without compensation.

ISRS held elections in September (see below). I would like to express the Society's and my own sincere gratitude to retiring Treasurer John Ware, retiring Recording Secretary Rob van Woesik, and retiring Councillors Rolf Bak, Annadel Cabanban, Guillermo Diaz-Pulido, Laurence McCook, Bernhard Riegl, and Yoshimi Suzuki. Rolf will remain on the Council because he is now editor-in-chief of *Coral Reefs*. Congratulations to the successful candidates, whose term will begin 1 January 2009, and thanks to all who ran for office and seats on the Council.

Over the coming months, ISRS will produce a new Briefing Paper (BP) on *Coral Reef Rehabilitation*. BPs are policy statements that are posted on our website and circulated to relevant organizations and the media. Vice President Tim McClanahan is editor of the BPs, and he describes the upcoming paper below.

Membership of ISRS means far more than a subscription *Coral Reefs*, especially considering that many of us can now access the journal electronically through our institutions. The Society serves the community of coral reef scientists, managers and policymakers. It behooves each of us to renew our commitment to coral reef science, management and conservation, and this includes engaging in professional service. Dick Dodge, Bob Richmond, Barbara Brown, Rolf Bak, Tim McClanahan, Sue Wells and their colleagues are good examples. As a proactive start, after we renew our own memberships this fall ***each of us should set a goal of signing up at least one new ISRS member for 2009***. It will require a small effort from each ISRS member, but in aggregate the new memberships will help enormously by providing the means for us to deliver more and better BPs, issues of *Reef Encounter*, fellowships for graduate research, and other products that will advance the science and help save the reefs.

On a very sad note, Gray Multer passed away on October 23, 2008. Gray was recently made an Honorary Member of ISRS. We recognized him at the 11th ICRS for his important scientific achievements and his distinguished service to the Society and the profession generally. Our thoughts and prayers go out to Gray's family. A full obituary will appear soon.

Rich Aronson, President

H. Gray Multer

Coral-reef science has just lost an advocate. Many of us lost a friend, role model, and valued colleague. H. Gray Multer died peacefully at his home in New York State on October 23rd, 2008. But, in character to those who knew him, he did not go quietly. We talked just a week before he passed, and the subject was… coral reefs, coral-reef science, and all that still remains to be done. Not surprisingly, he focused on young scientists and our obligations to support them. Gray spent his 30-year academic career inspiring undergrads at the College of Wooster, Fairleigh Dickinson University and the West Indies Laboratory (which he founded), or exposing the public and young teachers to science through his accessible writings, public lectures and field courses for educators funded by NSF and UNESCO. We will be assembling a retrospective to Gray in the next issue of *Reef Encounter*, so if you have any photos, stories or information, please forward them to: Dennis Hubbard, Dept. of Geology, Oberlin College, Oberlin OH 44074, dhubbard@oberlin.edu.

Realising that he will soon be freed from the trials and tribulations of ISRS's finances, our Treasurer has taken up a new role as the Society's Bard. This is the first of his lyrical contributions:

To all scleractinian corals a warning:
There's a phenomenon called Global Warming!
pCO_2 will increase
Aragonite deposition will cease
And you'll soon be susceptible to storming.

John Ware

ISRS 2008 Council Election Results

Recording Secretary
Morgan Pratchett, *ARC Centre of Excellence for Coral Reef Studies, Australia, and Senior Lecturer in the School of Marine Biology and Aquaculture, James Cook University.*
Interests: climate change and ecological and economic consequences of forecast changes in reef systems, development and implementation of targeted management actions.

Treasurer
Donald Potts, *University of California, Santa Cruz, USA; Director of UCSC's Center for the Dynamics and Evolution of the Land-Sea Interface.*
Interests: Ecology and speciation of corals, sustainability of ecologically and latitudinally marginal reefs and organisms under projections (e.g. IPCC) of environmental change.

Councillors
Andrew Bruckner, *Living Oceans Foundation, USA.*
Interests: Understanding the extent and impacts of human and natural threats on reef building corals and processes that enhance coral reef recovery and improve reef resilience during periods of global climate change.

C. Mark Eakin, *National Oceanic and Atmospheric Administration, USA; Coordinator of NOAA's Coral Reef Watch program.*
Interests: Impact of climate change and other disturbance, including El Niño, on coral reef ecology and carbonate budgets of eastern Pacific reefs; thermal stress and coral bleaching, ocean acidification, oil spills, coral palaeoclimatology, and the behaviour of marine organisms.

Ruth D. Gates, *University of Hawaii at MÇnoa, and Hawai'i Institute of Marine Biology. USA.*
Interests: Mechanisms of regulation and de-stabilization of coral dinoflagellate symbiosis, genetics and physiology of dinoflagellates in stony corals. Ruth is the Biology Topic Editor for Coral Reefs.

Kiho Kim, *Biology Department, American University, Washington, USA; member, Ocean Studies Board, National Academy of Science.*
Interests: Population biology and ecology of Caribbean gorgonian octocorals, impact of disease outbreaks of *Aspergillosis* on Caribbean sea fans.

Rupert Ormond, *Save Our Seas Foundation, UK.*
Interests: *Acanthaster* and sedimentation, reef fish behaviour and ecology, reef fisheries and no-take zones, and the management of marine protected areas in the Red Sea and neighbouring regions

Hiroya Yamano, *National Institute for Environmental Studies, Japan.*
Interests: coral reef and reef-island formation and sea level studies in the Pacific, remote sensing studies of coral reefs and terrestrial areas, response of coral reefs and reef islands to global and regional environmental changes

An Olympic coral reef meeting – the 11th International Coral Reef Symposium

Beating the records

The 11th ICRS took place in Broward County Convention Centre, Fort Lauderdale, Florida, 7-11 July 2008, just a month before the Olympic Games themselves, and beat all previous ICRS records: over 3,500 attendees from 75 countries; 1032 oral and 1600 poster presentations; 26 mini-symposia; 3 special sessions; 20 field trips; addresses by 6 distinguished plenary speakers (Malcolm McCulloch, Joan Kleypas, Roberto Iglesias-Prieto, Robert Cowen, Drew Harvell, Daniel Pauley), the Darwin Medalist (Terry Hughes), Rich Aronson (ISRS President), NOAA Administrator Vadm.Conrad Lautenbacher, and also by Florida's governor Charlie Crist, US Congressmen Ron Klein and Brian Baird, and Florida representative Ellyn Bogdanoff; 40 sponsorships from diverse government agencies (including Co-Sponsorships from the state of Florida, NOAA, and DOI), academic institutions, NGOs, and private industry; scores of exhibits; and a fine educational center. The concentration of so many coral reef experts in one location provided an ideal opportunity for extra meetings, workshops and fieldtrips to South Florida's own reefs and further afield in the Caribbean.

The theme was *Reefs for the Future*, a suitably optimistic title for the flagship event for the 2008 IYOR. Despite the potential for the meeting to be a catalogue of doom for reef ecosystems, given the recurring theme of past and present threats to coral reefs, right from the

James Porter with one of his rare coral reef books.

first day the potential to halt further degradation of reef ecosytems was striking and invigorating. With such a large meeting, there was a smorgasbord of coral reef related subjects on offer from geological change in the last Cenzoic to future predictions on coral calcification rates; biological and ecological processes of reef organisms to hydrodynamic mixing; learning about the evolutionary development of reefs using DNA sequence data, to advanced remote sensing technology; integrating fisheries science and socio-economics to coral reef ecosytem management.

Scientific advances

Most important were the many scientific advances that increase our understanding about coral reefs, such as the new genetic techniques showing that reefs are connected primarily at a scale of tens of km, rather than thousands of km as previously thought, and the molecular tools that are revealing the diverse array of microorganisms living in association with reefs that have vital roles in reef health but that, if perturbed, can lead to infection and disease.

Scientists are looking at the genes that corals use to acclimate to surrounding conditions to determine how corals react to their environment. Corals can make their own sunscreen proteins and can customize their protection to light level by up- or down-regulating genes that control the protein production. Other genes are probably involved in the synchronization of spawning, with corals perhaps 'talking' to each other, via chemical messengers. Exciting new work is showing how the coral-symbiont relationship can improve stress resistance, and the buildup of resilience of some reefs from previous hard knocks illustrates that we must protect not only healthy reefs but also those in marginal conditions. These may house the survivors for future generations.

Communicating the message

Notably, the largest mini-symposium was devoted to management, complemented by related mini-symposia on reef restoration, fisheries, and social ecological systems. By 2015, half the world's population will live along a narrow band of coast, putting unsustainable pressures on coastal resources, and it is clear that there will be coral reefs in our future only to the extent that they are valued by people. The Closing Session was therefore designed to develop a synthesis of the Symposium conclusions in a way that will be understandable to all. It took a novel format – a panel of journalists (Tim Radford Guardian, UK; Ken Weiss, Los Angeles Times; Corinne Podger, ABC Australia; Jeff Burnside NBC TV Miami) pitted against a panel of the five symposium super-chairs (Ove Hoegh-Guldberg, Steve Palumbi, Joan Kleypas, Chuck Birkland, Marea Hatziolos).

Moderated by Nancy Baron of the Communication Partnership for Science and the Sea (COMPASS) (a partnership of the Monterey Bay Aquarium, SeaWeb, Island

A gathering of ISRS luminaries during the symposium. L-R back: Charlie Veron, Rick Grigg, Peter Glynn, Ian Macintyre, Yossi Loya; L-R front: David Stoddart, Ken Konishi. (Photo: J. Ogden)

Press, and a Board of Scientific Experts), the Olympian task of each scientific panellist was to summarise in four minutes the highlights from their assigned mini-symposia. In return, each journalist had to explain what they had learnt from the Symposium and how they would spread the message in the media (the RE editor's personal favourite was the headline 'Coral on acid – just say NO!'). This led to animated input from the audience – when various 'elephants in the room' where fiercely debated. Perhaps one take home message was the vital role that ISRS has to play, not with the 'elephants', but with the 'corals on the reef'. The symposium provided a breathtaking overview of what has been learnt about reefs, since their early descriptions as flowers (see Sarah Hamylton's article on page 16) but also revealed the Olympian research effort needed if we are to have the knowledge we need to save them. But as Joan Kleypas said in her plenary talk, we must view this as 'Mission Possible'.

Further information, including the plenary talks and main outcomes of the mini-symposia can be accessed at: www.nova.edu/ncri/11icrs/index.html and a brief overview of the 2632 papers can be found on www.nova.edu/ncri/11icrs/outcomes.html. We end with three short opinion pieces, reflecting the diversity and youth of the 11th ICRS meeting: the coral 'rookie' from Singapore, the 'hybrid' scientist from Puerto Rico and the journalist from Kenya!

A Kenyan journalists view

The 11th ICRS concluded with a resounding warning. A third of reef-building corals around the world are at risk of extinction unless decisive measures are taken immediately. True to the expectations of the conveners, the Symposium lived up to its purpose: to promote the dissemination of knowledge about reef sustainability and resilience. This I felt was vitally important to a country like Kenya that depends on coral reefs for its economy and food supply. It was quite an experience to meet and exchange ideas with so many reef 'stakeholders': scien-

tists, managers, conservationists, students, and journalists, all of whom have a key role to play in reporting on the extreme threat that climate change and other human impacts represent to coral reefs.

The most notable and memorable event for me was the interactive debate between the top journalists and scientists who engaged in a mouth-watering discussion to try and crack the communication dissonance between them. At the end of the session, everyone agreed that the two groups needed each other, one to research, and the other to inform. The 11th ICRS gave a renewed sense of purpose and hope for the future. A consensus emerged that society has both the knowledge and the tools to bring coral reefs back from the brink.

Fort Lauderdale was a very interesting place, especially for a journalist visiting for the first time. Although ICRS was a scientific forum, my journalistic instinct led to broader observations. The empty streets, the scorching sun, the smell of the sea and the pedestrians briskly walking by, kept me thinking about my hometown of Mombasa. This is a place that can be very confusing to negotiate at times, thanks to technology, but the super shuttles and commuter buses were at hand to take us wherever we needed to go. The Convention Center was quite irresistible and its 600,000 square-feet provided us with everything we needed. Not having to worry about moving around the city left far more time to enjoy some of the masses of entertainment on offer.

The closing banquet was a smasher. With refreshments readily available throughout the evening, the mildly messy celebrations led to the old and young, and men and women from all over the world waltzing the Caribbean tango in abandon. As the most organized symposium I have ever attended, with people of different backgrounds and cultures from all over the world, this was surely a learning place not only for me but for others.

Peter Okumu, The East African Standard, Nairobi, Kenya. petokumu2008@hotmail.com

Mixing the sciences – a view from Puerto Rico

As an emerging hybrid scientist (with a background in social and ecological sciences) it was a great pleasure to hear throughout the ICRS the reaffirmation of the need to bridge the natural and social sciences. Historically scientists have been trained to focus on their own discipline, often following a narrow train of thought, and sometimes even considering their discipline superior to others. Many discoveries and advances have indeed been made that way, and a natural science training has often been the soil for the seed of a trait that distinguishes our species in particular: learning about and understanding our own habitat, and then manipulating it to our advantage. At least, that is what we thought.

At a time when new inventions and alternatives are needed so that we can continue living in the way in which we are accustomed, and yet not compromise future generations, we finally recognizing that in union there is strength. We have realized that no single discipline has the solution for the current environmental situation. It is not so much a matter of all working to solve the problem, but rather a matter of all working together to solve it. And we're there. The 11th ICRS made it very clear that the next step in reef management is outreach to social scientists, educators, and media specialists, among others. We need to get the message to everyone: we are doing our part, please do yours. Because in the end, what are we managing? People, not reefs.

I feel very lucky to be part of this era…when we have no choice but to recognize the weakness and vulnerability of our species; a wakeup call of humbleness, so to speak. It has opened doors to reinvent and fix what has proved harmful to us and to our fellow living creatures and habitats. In spite of the overwhelming task we have at hand, I am confident that we are on the right track and that we will discover the way.

Antares Ramos-Alvarez, Puerto Rico (currently University of Oxford, UK) antares@aya.yale.edu

The final plenary with journalists (left) and scientists (right) with conference organisers behind and Dick Dodge at the podium.

A Rookie's Reflections – thoughts from Singapore

Weeks of preparation did not help alleviate the stress of my fast-approaching "P-day" - the day I would give my first presentation in front of an international audience at the first major conference of my academic career. I was scheduled for the morning of the second day. "Perfect slot," said my supervisor, "gets it over with quickly but enough time to acclimatise!" However, being a rookie in the field of coral larval dispersal, I could not help but be engulfed by feelings of inadequacy. To add to my trepidation, the room was packed; I had visions of myself being shredded to bits by all the experts in the audience. In hindsight, at least people turned up. Thankfully, I managed to complete my talk without too much fumbling despite the fact that I was trembling throughout. Jet lag kicked in seriously only after my presentation and if you noticed someone sleeping in one of the conference venue's corners, it was probably me!

With P-day over, the conference suddenly seemed much more fun! I could finally concentrate on listening to others' talks (well I *tried* very hard to, while fighting the jet lag). The most memorable one was by a friend who appeared quite relaxed about her pending presentation, yet turned out to be even more distressed than me. She was so tense during her talk that she apologised a total of three times for her nervousness! In between rushing to and from the different rooms, or dozing off only to wake up and find that I'd missed the talk I'd been waiting for, I had the opportunity to speak with lots of researchers in my field. It was particularly exciting to finally meet in person the authors of the papers that have inspired me most, such as Andrew Baird, Paul Sammarco and Jim Underwood. And then there were the games of hide-and-seek with friends who were tucked away in various nooks quaffing coffee, deciphering the program book, or preparing frantically for their presentations! There was hardly a dull moment. Even the posters session held surprises – such as Yoko Nozawa's wonderful creation and the beguiling bottles of Land Shark.

Motivated by the encouragement and knowledge garnered from my first international conference, I am back in Singapore and ready to face the challenges that lie ahead. So, I must finish writing this, stop daydreaming about what I might be presenting at the 12th ICRS, and get on with my research!

Tay Ywee Chieh (PhD candidate), Marine Biology Laboratory, National University of Singapore, Department of Biological Sciences, Faculty of Science, 14 Science Drive 4, Singapore 117543.
g0601117@nus.edu.sg

Call to Action

One of the outcomes of the 11th ICRS was a 'Call to Action'. This has been published in Science 322 (10 October 2008) as follows:

We have a real - but rapidly narrowing - window of opportunity in which to take decisive action. We must immediately:

Cut CO2 emissions by lowering our carbon footprint and ask our policymakers to commit to low carbon economic growth.

Eliminate open access fisheries in coral reef ecosystems. Establish and enforce regulations on user rights, total allowable catch, individual catch quotas, non-destructive gear and other sustainable fisheries regulations.

Protect coral reef herbivores, including parrotfish. Ban the harvesting of these species for sale and commercial consumption.

Establish and strictly enforce networks of Marine Protected Areas that include No-Take Areas. Consult with local communities and authorities on design and benefit sharing to maximize returns and build sustainability into the process in order to protect marine biodiversity and restore vital fish stocks.

Effectively manage the waters in between Marine Protected Areas. The enforcement of coastal zoning, environmental impact assessments and "polluter pays" regulations can help control marine and land-based sources of pollution, while strategic environmental assessment can effectively manage coastal development and tourism.

Maintain connectivity between coral reefs and associated habitats. Mangroves, sea grass beds and lagoons contribute to the integrity of reef ecosystems and their continued production of ecosystem services.

Report regularly and publicly on the health of local coral reefs. Include assessments of the effectiveness of management and conservation measures.

Recognize the links between what we do on land and how it affects the ocean. We live on a blue planet - our health depends on ocean health.

Bring local actors together to develop a shared vision of healthy reefs and a road map for getting there. Engage members of industry, civil society, local government and the scientific community to set ambitious targets and performance indicators.

Work for change with management to produce desired outcomes.

The Call for Action is on the web as a petition. As of 24 November 2008, this has 841 signatures, but the target is 500,000. To add your signature, go to www.thepetitionsite.com/1/11th-international-coral-reef-symposium-call-to-action

ISRS NEWS

Coral Reefs – Best Paper Award 2007

Each year the Editorial Board and Topic Editors of the journal *Coral Reefs* nominate an award for the "Best Paper of the Year". For 2007, the paper: 'Real-time PCR reveals a high incidence of Symbiodinium clade D at low levels in four scleractinian corals across the Great Barrier Reef: implications for symbiont shuffling' by J.C. Mieog, M.J.H. van Oppen, N.E. Cantin, W.T. Stam, J.L. Olsen, in *Coral Reefs* (2007) 26:449-457, was chosen out of 59 articles. The award, of 1000 euros donated by the publisher, Springer, with a certificate and engraved paperweight, was presented to the lead author, Jos Mieog and two of his co-authors, Madeleine van Oppen and Neil Cantin, at the 11th ICRS in July 2008.

We are very pleased that the award should have been made to a young scientist. Jos, a PhD student at the University of Groningen (the Netherlands), completed his MSc degree in 2002 at the University of Nijmegen, studying giant clams on the Great Barrier Reef. He then returned as a volunteer to the Australian Institute of Marine Science (AIMS) and participated in the research of Dr Madeleine van Oppen and Dr Ray Berkelmans. His PhD, a collaborative project between AIMS and the University of Groningen, was completed in late 2008 and Jos now plans to move to Australia to continue his research.

Barbara Brown, Emeritus Professor of Tropical Marine Biology, ex-Editor in Chief, Coral Reefs

R-L; Barbara Brown, Martine van Bezooijen (Springer representative), Jos Mieog, Madeleine van Oppen, Neil Cantin.

New Briefing Paper on Coral Reef Rehabilitation

The next ISRS Briefing Paper (BP) will be on Coral Reef Rehabilitation, and its production will be led by Dr Alasdair Edwards at the University of Newcastle on Tyne, UK. Managers in industry, government, and NGOs are often being forced to make difficult decisions in relation to issues of reef restoration and artificial reefs, generally with little, or only promotional, information. Good judgment and objectivity, as well as high quality information, are badly needed in this subject area and the Society has, therefore, resolved to provide a consensus statement. It will include an evaluation of the role of artificial reefs. The BP process involves five stages, 1) the selection of topics and authors by the ISRS Council, 2) the production of a draft statement by the lead author, 3) review and revision by the Council members, 4) review and revision by the ISRS membership, and 5) final publication for the general public. This briefing paper is in stage 2 and we expect to make it available to the ISRS members for comment by April and to publish it by July 2009. If you have new or useful information that you think is relevant to this BP, please contact Dr Edwards A.J.Edwards@newcastle.ac.uk.

Tim McClanahan, ISRS Vice President

ISRS support to Reefs at Risk

The World Resources Institute (WRI), the International Coral Reef Action Network (ICRAN) and the UNEP World Conservation Monitoring Centre (UNEP-WCMC) are leading a major collaboration to produce a map-based analysis of threats to the world's coral reefs, called *Reefs at Risk Revisited*. This update of the 1998 analysis, *Reefs at Risk – A Map-Based Indicator of Threats to the World's Coral Reefs*, will provide a detailed examination of human pressures on coral reefs, implications for reef condition, and projections of associated economic impacts in coastal communities. Using recently developed, high resolution data, the analysis is being implemented at twenty times the level of detail of the 1998 analysis. It will include the same local and regional threats as previous *Reefs at Risk* analyses (coastal development, land-based sources of pollution, marine-based threats, overexploitation), but indicators of thermal stress to coral reefs, resistance to coral bleaching, and risk from ocean acidification are important additions.

Reefs at Risk Revisited will raise public awareness of the location and severity of threats to coral reefs, and catalyze targeted, responsible, and informed decisions to protect them. The effort will show decision-makers, politicians and the public where to focus energy and resources, and will inform bilateral, regional and international bodies as they seek ways to help coordinate and finance conservation activities. ISRS will support the project as a scientific advisor by:

- Providing guidance and ensuring that the analysis is informed by the best and most up-to-date science possible

- Providing peer reviews of the analysis method and validation of results; and
- Disseminating and promoting the publication.

See www.wri.org/project/coral-reefs
or contact Lauretta Burke for further information,
(Lauretta@wri.org) or
Katie Reytar (kreytar@wri.org)

100 Important Questions for Global Conservation

ISRS was invited to contribute its expertise to identifying the 100 research questions of greatest importance at the global level for conservation policy makers and practitioners, as part of a project led by Bill Sutherland at the University of Cambridge, UK. The questions had to be internationally relevant, important for policy and/or on-the-ground conservation, and answerable by scientists. ISRS managed to offer over 200 questions to the exercise (ah, you say, that's what that flip chart at the Society's ICRS booth was about!), and while Rich battled Hurricane Gustav, I attended the 2-day workshop in Cambridge in November 2008 along with some 30 other assessors, representing scientists, international NGOs, professional societies, research councils and policy makers from virtually all continents.

We started with over 2200 questions and on the first day eliminated about 85% in each of 15 topic-specific sets. The Marine Section – perhaps surprisingly the largest – started with 260 questions, reduced at the end of two exhausting hours, to 32. On the second day, questions from related sections were combined to form three main groups, each with 90-100 questions. It took each group 5 hours to select, through voting and (sometimes heated!) discussion, its top 30 questions and 10 shortlist questions. Finally, the top questions from each group were pooled, reviewed and combined as appropriate. This intense process resulted in 100 questions considered critical to conservation policy and action. While there is no doubt that different assessors would come up with a different list, I feel that the issues addressed would still, in general, be represented. We will reveal the marine and coral reef issues that made it into the top 100 as soon as the full results have been published.

Isabelle Côté, ISRS Corresponding Secretary

ISRS FELLOWSHIP PROGRAMME

Introduction

Finding funding to support graduate research can be very difficult: coral reef research does not come cheap. One of ISRS's most important activities, therefore, is its fellowship programme, run jointly with the Ocean Conservancy (OC) and a brainchild of the late Gray Multer, an ardent supporter of young coral reef researchers. A total of 36 fellows have been supported since 1997, when Melanie McField – now a Council Member – was the first successful applicant. Since then about four fellowships have been awarded annually, the number varying according to the funds available (see table).

	No.	University affiliation	US $
1997	1	USA	13,500
1998	1	Philippines	13,500
1999	1	USA	14,000
2000	2	Brazil, USA	15,000
2001	1	USA	14,500
2002	4	Brazil, USA, New Zealand	30,000
2003	4	UK, Australia	28,125
2004	4	Australia, USA, Cuba	35,478
2005	4	Australia, USA	45,000
2006	6	Australia, USA	90,000
2007	2	Australia	15,000
2008	6	USA	90,000
Total	**36**		**404,103**

Over US$400,000 has been disbursed, most of which has been provided by two anonymous donors, one supporting the programme from 1997-2000, and the second providing funding since then. ISRS has contributed about US$25,000 of the total. Both ISRS and the reef-research community owe an immense debt of gratitude to the two donors.

Fellowships are available to students worldwide, who are already admitted to a graduate program at an accredited university. The aim of the programme is to help Ph.D. students develop skills and address problems related to relevant applications of coral reef ecosystem research and management. The funding can be used to support salary, travel, fieldwork, and laboratory analyses, and typically comprises about 30% of the student's total research budget. The student can work entirely at the host institution, or can split time between developed and developing country institutions. The proposals are reviewed, and winners selected, by a committee of 3-4 ISRS Council members, and in 2008, also by Jack Sobel, OC's previous Director of Strategic Conservation Science and Policy, who has been facilitating the programme. The evaluation criteria include a) scientific merit, b) feasibility, c) support letter from major professor, and d) relevance to the Fellowship guidelines.

A diverse array of research topics has been supported in the following subject areas (figures in brackets are the number of fellowships awarded since 2003 in this subject): connectivity (3), coral biology (2), coral microbial communities and disease (3), coral recovery and resilience (4), community-based management (2), fish / coral dynamics (3), historical reef ecology (2), larval settlement processes (2), reef organism diversity (2), and

the effects of marine protected areas (3). Awardees have tended to be affiliated to universities in Australia and the USA, but their nationalities and the countries in which they have carried out their research have a much broader geographical distribution: research has been supported on reefs worldwide including American Samoa, Belize, Brazil, Indonesia, the Cook Islands, the Galapagos, the Philippines, the Yucatan Peninsula, the Florida Keys and the Bahamas. ISRS and the OC will nevertheless be looking at ways to improve the geographic distribution of the awardees.

2008 Fellowship Awards

For 2008, six fellows were selected and the winners were announced at the ISRS General Meeting at the 11th ICRS in Fort Lauderdale Florida.

Suzanne Arnold, University of Maine
The role of herbivory and productivity potential on reef resilience.
Michael Holcomb, Woods Hole Oceanographic Institution
Coral calcification and environmental change: an investigation of interactions between temperature, CO_2, nutrients, and symbiosis.
Kelton McMahon, MIT-WHOI Joint Program in Biological Oceanography, Woods Hole Oceanographic Institution
Tracking coral reef fish migration with compound specific-stable isotope analysis: connectivity between juvenile nursery habitats and coral reefs.
Malin Pinsky, Hopkins Marine Station, Stanford University
Effects of low population density on reef fish connectivity.
Hollie Putnam, Hawaii Institute of Marine Biology, University of Hawai'i at Manoa
Larval response to forecast climate conditions.
Jada-Simone White, Department of Zoology, University of Florida
Scaling up our understanding of mechanisms constraining coral recovery.

Reports of the 2006 Fellowships

Reef Encounter 36 carried three reports from the 2006 fellows. We report here on the remaining three.

Do predator-dominated coral reefs have higher fish biomass and potential harvest due to changes in growth rates?

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Fishing has caused dramatic declines in the top predators that probably once dominated fish community biomass on coral reefs[1, 2, 3, 4], to the extent that many are now ecologically extinct on most reefs[5]. This dramatic change has prompted numerous studies of the consequences of predator removal on prey abundance. Surprisingly few examples of trophic cascades have been documented on coral reefs[6]. This lack of population-level prey responses suggests that individual-level effects may be more important, although few studies have examined this.

Here we examine a key life history trade-off for a reef fish community: somatic storage and reproduction. We expect that the removal of predators by fishing will shift prey energy allocation at the individual level from reproduction to somatic storage. When predators are removed, prey mortality rates are lower and somatic storage will likely lead to greater future reproduction. In contrast, when prey mortality rates are high, reproduction cannot wait. In order to test this hypothesis, we surveyed and collected representative species from each trophic level at sites representing high and low fishing pressure within and across islands and estimated metrics of somatic storage (total weight, liver weight) and reproduction (gonad weight, size at sex change).

Palmyra Atoll and Kiritimati Island in the Northern Line Islands provide a natural experiment to test the effect of predator removal on reef fish community life history traits, while controlling for fish population genetic differences. No fishing occurs on Palmyra Atoll because it is a U.S. Fish and Wildlife Refuge. In contrast, Kiritimati Island has a human population of over 5000 concentrated on the leeward side, while the windward side is unpopulated. In order to estimate fishing pressure and differences in fish community structure, both household and ecological surveys were conducted.

Individuals of five fish species representing each major trophic group (herbivore, zooplanktivore, omnivore, benthic invertivore, and predator) were collected on Palmyra and on the windward and leeward sides of Kiritimati. Each individual was weighed, measured, dissected and its liver and gonad weighed following sexing. Ordinary least squares were used to estimate site specific differences in length-weight, liver-weight, and gonad-weight relationships. The size at sex change for the sex changing herbivores was estimated using logistic regression on size-frequency distribution data from ecological surveys.

Prey fishes showed greater somatic storage under low predator conditions both within and across islands as indicated by total weight and liver weight, whereas predators showed no difference. Prey fishes also showed less energy allocation to reproduction under low predation conditions as indicated by gonad weight and size at sex change. Previous results showed similar results for size at sex change across Palmyra and Kiritimati[7].

Both metrics of somatic storage and reproduction

provide evidence supporting the hypothesis that prey fish shift energy toward somatic storage and away from reproduction when predation pressure is low. This is the first study to show community-wide individual-level effects of predator removal on prey fishes. These findings are an important first step to understanding the relationship between fishing, fish community structure and productivity. The net impact of fishing predators on fisheries productivity will depend on the relative contribution of individual somatic growth and population growth. If predators enhance fish community productivity, restoring predators may be a win-win for fisheries and conservation.

Acknowledgements: I would like to thank my collaborators, Stuart Sandin, Ben Ruttenberg, Scott Hamilton, and Mary Donovan, and my advisor, Nancy Knowlton. I would also like to thank ISRS/TOC for funding the field work and other expenses that were necessary to complete this work.

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Aspergillosis in sea fans: phylogenetic relationship among Aspergillosis strains and patterns of prevalence.

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Sea fan aspergillosis is a fungal infection, characterized by necrotic tissue surrounded by a purple halo[1]. It can lead to death of the colony or may decrease rates of reproduction and recruitment[2], affecting population dynamics[3]. Aspergillus is generally understood to be terrestrial fungi[4], and indeed many fungi reported in marine organisms are common in terrestrial habitats[5, 6]. However very little is known about their ubiquity in the marine environment[7].

Since the 1990s many populations of *Gorgonia ventalina* throughout the Caribbean have been reported with symptoms of aspergillosis but few studies have monitored colony status through time[3], or shown whether aspergillosis is still a principal cause of sea fan mortality. We have isolated and identified several fungi, including eight species of *Aspergillus* species, common to both healthy and diseased colonies of *G. ventalina* in Puerto Rico, suggesting that aspergillosis can be caused by several species of opportunistic fungi[6]. This report presents data on the mycoflora associated with healthy and diseased *G. ventalina* colonies, focusing on the spatial variation in the composition of the fungi community on six reefs and surrounding seawater in Puerto Rico. I also measured the spatial and temporal variation in the incidence and prevalence of aspergillosis on these reefs and determined the causes of mortality of colonies of *G. ventalina* for a period of one year.

Twenty six species of cultivable fungi were identified from seawater and sea fan tissue from six reef sites. The mycoflora was more diverse in seawater (23 species) than in sea fans (18 species). The most common species in seawater and sea fan colonies were *Aspergillus flavus* and *Penicillium citrinum*. Healthy colonies showed more species (15) than diseased colonies (10). Healthy and diseased colonies shared 53% of the species, with the genera *Aspergillus* and *Penicillium* common to both healthy and diseased colonies of *G. ventalina*. The most frequent isolates for healthy colonies were *A. flavus* and *A. sydowii*; while *A. flavus*, and *Penicillium citrinum* were frequent for diseased colonies. Surprisingly, *A. sydowii* was not isolated from diseased colonies at any reef.

The ANOSIM analysis indicates significant differences among sites between the mycoflora associated with healthy colonies ($R=0.174$, $p=0.004$) and diseased colonies ($R=0.383$, $p=0.003$). However, the mycoflora from near shore and offshore seawater did not vary significantly ($R=0.088$, $p=0.244$). Spatial comparison of mycoflora composition in diseased colonies (SIMPER analysis) showed significant dissimilarities for Jobos Bay, while the same analysis for healthy colonies showed more places with dissimilarities (Icacos, Humacao, Luis Peña, Escambron, Jobos and Culebrita).

These results suggest that local factors are influencing the fungal composition especially for fungal diversity in healthy colonies, while diseased colonies showed more similarities among sites and lower diversity. Jobos Bay, a site with significant differences in composition of diseased colonies, is an estuary historically impacted by agricultural runoff and a major sugar cane mill, and more recently by warm waters from a thermoelectric plant. The lack of significance dissimilarity between seawater and sea fans mycoflora suggests low specificity of sea fans, and suggests surrounding seawater as the source of sea fan fungi. Studies that have related the bacterial community of hard corals to seawater have found more differentiation[8, 9]. Octocorals may be less selective than scleractinian corals, or fungi more successful colonizers than bacteria.

Our data supports the hypothesis that aspergillosis

may be caused by several opportunistic fungi, and not only by *A. sydowii*. Our data also dispels the idea that fungi are foreign to marine ecosystems, and pathogenic when present. Most species found in seawater were also present in sea fan tissue (healthy or diseased). This suggests that *Aspergillus* and *Penicillium* have high affinity for marine hosts, and that marine hosts are generalist with respect to these genera. Thus, these fungal groups successfully colonize different hosts and are important elements of the natural mycoflora of these marine organisms.

Healthy and diseased sea fan colonies were followed between September 06 and September 07. A total of 448 colonies were marked and photographed. Sea fan lesions were classified as type 1: necrosis surrounded by purple halo[2] and type 2: Lesion of unknown origin colonized by fouling organisms[10]. The incidence of aspergillosis (new cases per visit) was very low in all sites (0-4). No significant difference was observed in prevalence of the disease among sites (X^2=8.54; *df*=5, P=0.12), nor among colony size classes (X^2=12.11; *df*=9, P=0.20). Colony death by aspergillosis was rare for all sites (<1%). Detachment was the highest cause of death (14.3%) and significantly varied among sites (X^2=31.72; *df*=5, P=0.00). Small colonies were more susceptible to detachment than larger ones (X^2=19.218; *df*=7, P=0.007). These results suggest that the principal cause of mortality in sea fans (especially small colonies 1-20cm) is detachment related to high energy events. Aspergillosis was present in all sites but at a low prevalence, and was not a significant source of mortality.

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Fungal community associated with diseased and healthy Gorgonia ventalina: the role of temperature stress and demographic consequences of aspergillosis to G. ventalina colonies

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Sea fan aspergillosis was first reported in the mid 1990s throughout the Caribbean Basin, and since then much effort has been devoted to its study. The first studies described the disease manifestation (purpling, necrotic tissue surrounded by a dark purpling ring), the pathogenic agent (the saprophytic fungus *Aspergillus sydowii*)[1] and its incidence and prevalence in the Caribbean[2]. Subsequent studies have covered a wide range of topics.

Our study had surprising results[3, 4], in that we found that the mycoflora of sea fans is much more diverse than previously thought. Thirty five fungal species were isolated through culture techniques, the majority of which are new reports for sea fans; the two most common genera were *Aspergillus* and *Penicillium*. The study also showed that (1) the fungal community of healthy sea fans was distinct from and more diverse than, that of diseased fans and (2) within afflicted colonies, the fungal community of lesions was different and more diverse than that of healthy tissue. We proposed three reasons to explain the latter: 1) The reduction of fungal diversity in diseased fans is caused by an increase in dominance of the fungal pathogen; 2) Environmental changes may reduce microbial diversity making the host more susceptible; and 3) Colonies may have a general physical response to a local infection which might affect commensal microbes as well as pathogens. Our most striking result was that *A. sydowii*, the pathogen causing aspergillosis, was exclusively isolated from healthy fans which casts doubt about the role of this species as a primary pathogen. Moreover, since no single fungus was exclusively associated with healthy or diseased fans, pathogens other than fungi might be causing aspergillosis. Given that it is not clear that Aspergillus, or any fungus, is the sole pathogen, calling this disease aspergillosis is an oversimplification. Aspergillosis of sea fans thus turns out to be highly complex, with the implication

that other coral diseases may be similarly so.

Our second study looked at growth and mortality rates of sea fans in different size classes (small <500 cm^2, medium 500-1000cm^2, and large >1000cm^2) and in healthy and diseased individuals. Detachment, not aspergillosis, was the main cause of death of the 150 colonies followed for one year (68% vs. 32%). Surprisingly, mortality due to aspergillosis was recorded only in small fans. Lesions associated with aspergillosis in medium and large fans did not increase in size, although no diseased colony recovered. Aspergillosis also reduced colony growth, especially in small ones. This suggests that smaller fans are more susceptible to aspergillosis than larger fans, contradicting previous studies5 that state that the former should be more resistant (although this result is based on aspergillosis prevalence rather than mortality). If mortality in small fans is as fast as our data suggest (about three months), a small healthy fan may die without being counted as diseased if censuses are carried out at intervals of over three months, giving the erroneous impression of a low prevalence of aspergillosis among small fans. High mortality among small fans, combined with slow growth rate among the diseased fans, and the low capacity of recovery from aspergillosis among adult colonies indicates that aspergillosis may have serious repercussions for sea fan populations.

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CURRENTS

Coral Reef Mapping

A Brief History of Motivations and Methods

The history of coral reef mapping reflects both the changing demand for information on reef systems and technical innovations in marine cartography. On early navigational charts, reefs appear as incidental features, and their distribution was recorded because of the need for traders to avoid such navigational hazards. Marco Polo noted use of such charts by seamen in Ceylon in the Indian Ocean as early as the late fourteenth century. In the sixteenth century, boat-based island mapping techniques combined astronomical determination of location with close monitoring of ship movements and relied on accurate knowledge of observer location. Imprecise measurements of ship speed led to characteristic skewed coastline orientations in maps from this period. Notable reef maps were produced by Christopher Columbus (Caribbean), James Cook (Pacific) and, later, Charles Darwin.

A chart of the West Indian Ocean from the late Seventeenth Century. Map scan courtesy of the Royal Geographical Society

Throughout the Second World War, surveys of islands and reefs using conventional film and low flying aircraft, were undertaken for military purposes. These led to maps produced from mosaics of detailed aerial photos, reef coverage being visually interpreted and sketched onto tracing paper overlays. In 1967, the introduction of a computer, digitiser and plotter at the Royal Society Cartography Unit in the UK substantially advanced the development of cartographic databases, marking the early development of Geographical Information Systems. The first earth observation satellites were launched in the 1970s, the US Landsat Programme of 1972 being a notable development for coral reefs. Such a wide perspective of the planet highlighted the finite nature of the Earth and its resources.While expanding the techniques available for reef mapping, this facilitated the growth of conservation as a discipline and reefs began to be mapped in recognition of their intrinsic value and the need to manage their condition.

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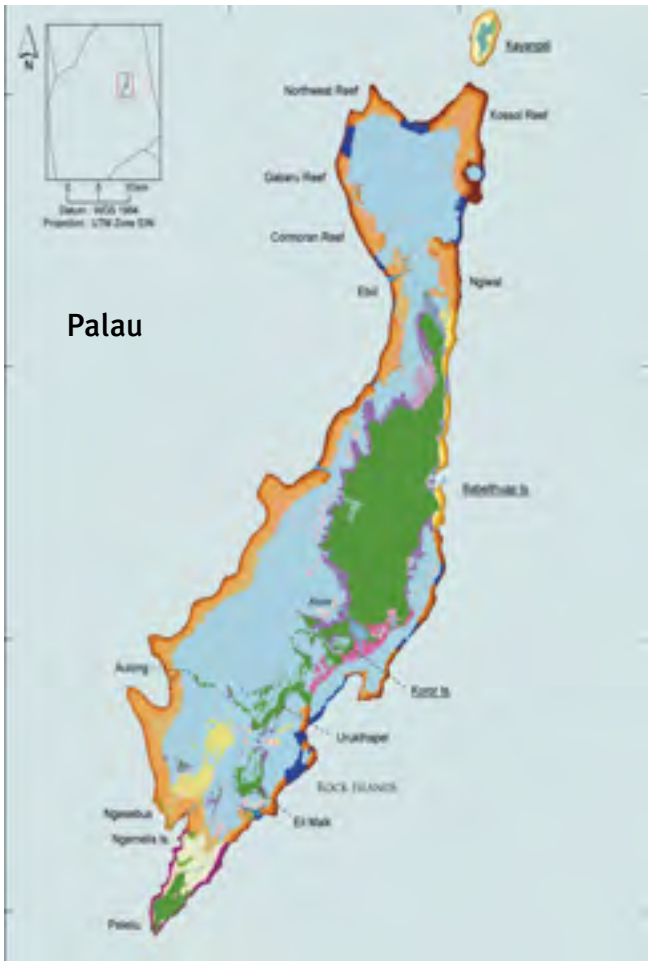
The Millenium Mapping project - mapping Pacific Ocean coral reefs

The Millennium Coral Reef Mapping Project (MCRMP) has just completed the compilation of detailed geomorphological maps and statistics on reefs in American Samoa, Clipperton, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawaii and all US minor outlying islands, Kiribati (Gilbert, Phoenix, Line groups), Marshall Islands, Nauru, New Caledonia, Niue, Palau, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna, and the Australian Coral Sea reefs and Lord Howe Islands.

The resulting electronic Atlas is a joint effort between the French Institut de Recherche pour le Développement (IRD), MCRMP (initially funded by NASA through the Institute of Marine Remote Sensing at the University of South Florida, USA, and the French Coral Reef Initiative in the South Pacific (CRISP). The Nature Conservancy has provided support for the Solomon Islands products. A prototype was demonstrated at the 11th ICRS, and the final product is to be released in early 2009. The Atlas offers the possibility of navigating through a series of linked pdf files and requires only Acrobat Reader®. This type of easy-to-access, user-friendly product will suit those unable to use the GIS formats usually provided by MCRMP, although the latter are still available for customized skilled work.



The maps are based on Landsat satellite images from 1999-2003, and new principles and approaches allowing large scale work and mass production have been used[1, 2]. The thematic richness and satellite-imagery based surface areas offer a spectacular improvement to previous databases, at regional level and also frequently at national and island levels. The Atlas will permit either directly (such as a study on food security[3]) or indirect (e.g. a seamount study[4]) analyses. In New Caledonia, the MCRMP atlas is the only comprehensive data source for the sites nominated for UNESCO World Heritage listing. Most Pacific Island countries and territories already have access to the GIS products, which are being used by national technical services, international developmental organisations (e.g. South Pacific Applied Geosciences Commission, Secretariat of the Pacific Community), NGOs and scientists (e.g. for fisheries research[5]).

The atlas has been made possible thanks to Céline Chauvin (IRD, atlas assemblage), Christine Kranenburg (USF, data management), Damaris Torres-Pulliza (USF, mapping), Alan Spraggins (NASA/USF, mapping), Julie Robinson (NASA, PI), Frank Muller-Karger (USF, PI) and Serge Andréfouët (IRD, PI, MCRMP design, mapping, validation, scientific applications).

See the following two pages for the keys to the maps.

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OCEANIC ISLAND - ILE OCÉANIQUE

Island lagoon
Lagon d' île

67, deep lagoon
lagon profond

Barrier land
Ilot

72, land on reef
caye, îlot, motu

Outer barrier reef complex
Complexe de récif-barrière externe

81, forereef
front

85, reef flat
platier

86, shallow terrace
terrasse peu profonde

87, shallow terrace with constructions
terrasse peu profonde avec constructions

76, deep terrace
terrasse profonde

88, subtidal reef flat
platier infratidal

78, enclosed basin
bassin enclavé

83, pass
passe

Coastal barrier reef complex
Complexe de récif-barrière côtier

120, forereef
front

125, reef flat
platier

126, shallow terrace
terrasse peu profonde

117, enclosed basin
bassin enclavé

123, pass
passe

Imbricated barrier reef complex
Complexe de récif-barrière imbriqué

107, forereef or terrace
front récifal ou terrasse

111, reef flat
platier

112, shallow terrace
terrasse peu profonde

109, pass
passe

Barrier-fringing reef complex
Complexe de récif-barrière avec frangeant

135, forereef
front

137, reef flat
platier

138, shallow terrace
terrasse peu profonde

129, channel
chenal

Inner-lagoon patch-reef complex
Complexe de massifs coralliens lagonaires

166, deep terrace
terrasse profonde

179, reef flat
platier

180, shallow terrace
terrasse peu profonde

Shelf patch-reef complex
Complexe de massifs coralliens de plateau

218, subtidal reef flat
platier infratidal

Lagoon-exposed fringing reef
Récif frangeant de lagon

235, channel
chenal

237, enclosed lagoon or basin
lagon ou bassin enclavé

240, reef flat
platier

241, reticulated reef flat
platier réticulé

Inner-seas exposed fringing reef
Récif frangeant de mer intérieure

230, forereef
front

232, reef flat
platier

229, enclosed lagoon or basin
lagon ou bassin enclavé

Ocean-exposed fringing reef
Récif frangeant océanique

222, forereef
front

224, reef flat
platier

223, pass
passe

Diffuse fringing reef
Récif frangeant diffus

244, diffuse fringing reef
récif frangeant diffus

Fringing reef of coastal barrier reef complex
Récif frangeant de complexe de récif-barrière côtier

245, diffuse fringing reef
récif frangeant diffus

Fringing reef of barrier-fringing reef complex
Récif frangeant de complexe de récif-barrière

252, reef flat
platier

Main land
Terre émergée

1000, main land
terre émergée

1001, aquatic land features
lac, lagune, embouchure

ATOLL - ATOLL

Atoll rim
Couronne d'atoll

11, forereef
front

12, pass
passe

14, reef flat
platier

16, shallow terrace
terrasse peu profonde

Atoll lagoon
Lagon d'atoll

26, shallow lagoon
lagon peu profond

Atoll rim land
Ilot d'atoll

21, land on reef
caye, îlot, motu

BANK - BANC

Drowned bank
Banc ennoyé

40, drowned bank
banc ennoyé

OCEANIC ISLAND - ILE OCÉANIQUE

Outer barrier reef complex
Complexe de récif-barrière externe

- 73, barrier reef pinnacle or patch
  pinacle de récif-barrière
- 76, deep terrace
  terrasse profonde
- 78, enclosed basin
  bassin enclavé
- 79, enclosed lagoon
  lagon enclavé
- 81, forereef
  front
- 83, pass
  passe
- 85, reef flat
  platier
- 86, shallow terrace
  terrasse peu profonde
- 88, subtidal reef flat
  platier infratidal

Barrier land
Ilot

- 72, land on reef
  caye, îlot, motu

Coastal fringing patch
Massif corallien côtier ou frangeant

- 160, reef flat
  platier

Inner-lagoon patch-reef complex
Complexe de massifs coralliens lagonaires

- 164, land on reef
  caye, îlot, motu
- 168, enclosed lagoon
  lagon enclavé
- 179, reef flat
  platier
- 180, shallow terrace
  terrasse peu profonde
- 182, subtidal reef flat
  platier infratidal

Ocean-exposed fringing reef
Récif frangeant océanique

- 222, forereef
  front
- 223, pass
  passe
- 224, reef flat
  platier
- 226, shallow terrace
  terrasse peu profonde

Lagoon-exposed fringing reef
Récif frangeant de lagon

- 238, forereef
  front
- 240, reef flat
  platier
- 242, shallow terrace
  terrasse peu profonde

Diffuse fringing reef
Récif frangeant diffus

- 244, diffuse fringing reef
  récif frangeant diffus

Fringing reef of barrier-fringing reef complex
Récif frangeant de complexe de récif-barrière

- 254, shallow terrace
  terrasse peu profonde

Barrier-fringing reef complex
Complexe de récif-barrière avec frangeant

- 135, forereef
  front
- 136, pass
  passe
- 137, reef flat
  platier
- 138, shallow terrace
  terrasse peu profonde

Inner-seas patch-reef complex
Complexe de massifs coralliens de mer intérieure

- 186, enclosed basin
  bassin enclavé
- 192, forereef
  front
- 197, reef flat
  platier
- 198, shallow terrace
  terrasse peu profonde
- 200, subtidal reef flat
  platier infratidal

Shelf patch-reef complex
Complexe de massifs coralliens de plateau

- 218, subtidal reef flat
  platier infratidal

Inner-seas exposed fringing reef
Récif frangeant de mer intérieure

- 229, enclosed lagoon or basin
  lagon ou bassin enclavé
- 230, forereef
  front
- 232, reef flat
  platier
- 234, shallow terrace
  terrasse peu profonde

Main land
Terre émergée

- 1000, main land
  terre émergée

Island lagoon
Lagon d' île

- 67, deep lagoon
  lagon profond

Corals are animals: why the confusion?

Corals are animals. This fundamental natural order causes a lot of confusion. Foliose growth forms and hackneyed comparisons of their diversity to rainforests compound our sense of their being closely related to the plant kingdom, and Linnaeus famously failed to distinguish between our beloved Cnidaria and Plantae. During a recent visit to the Dutch West Indies, I found it easy to see why he lumped the two together. Saba is a volcanic island that rises out of deep sea to the rainforest-covered peak of Mount Scenery at 2631m. The two principal activities for island visitors- diving and walking- enable intimate observation of reef and rainforest environments in close proximity. It is hard to miss the morphological similarities between corals and plants here. In fact, they were so striking that I was prompted to remind myself why we insist on differentiating the two at all.

John Ellis, a PhD student of Linnaeus, championed the idea that corals are animals, and in 1754, invoked a classical structural argument to demonstrate this. He spent a day collecting coral samples from oyster beds at Brighthelmstone, Sussex, UK. In a letter published in the *Philosophical Transactions of the Royal Society*, Ellis describes the specimens he viewed under the microscope, comparing numerous structural features of corals with their various plant counterparts. He christened what we know today as *Antipathes* the "Pomegranate flowering coralline" on account of the resemblance of its closed polyp vesicles to the double flower of a blossoming pomegranate. He also noted the manner in which smaller branches of lobster horn coral join the main stem at equal distances, like the perennial horsetail plant.

However, Ellis' letter is the earliest recorded suggestion of physiological links between coral polyp tentacles, the central mouth, stomach cavity and network of connecting tubes between the principal stem and sub branches. Uniquely, in terms of energy supply among marine animals of the photic zone, corals have managed to create uninterrupted conditions of peace and stability. This did not go unnoticed by Ellis, who commented on their numerous and varied faculties for suspension feeding. But with the benefit of hindsight, we now know that this utopia has primarily been achieved through their symbiotic relationship with photosynthetic zooxanthellae. Despite missing a key piece of the jigsaw puzzle, Ellis was commenting on a critical adaptive mechanism that distinguishes corals from plants.

The trump card for those in favour of separating corals and plants was Darwin's theory of Evolution. Although naturalists had been classifying living organisms hierarchically for hundreds of years, the rationale for doing so only emerged relatively recently. Cladistic taxonomists classify organisms on the basis of their evolutionary relationships. Corals belong to the phylum Cnidaria, made up of some 9000 aquatic species with the unifying characteristic that they possess nematocysts (stinging cells). Fossil records suggest that Cnidarians diverged from other animals in the Precambrian (between 4500-542 million years ago), yet the earliest known plant fossils originate from the Cambrian (542-488 million years ago). So it is likely that corals, the most primitive form of animals, had already diverged by this point. Any classification system that grouped the two together and also accounted for evolutionary processes would have to include a host of other organisms in the same group.

So why do corals and plants look similar? The structure of two species can often be similar because of independent adaptation to common environmental pressures, a phenomenon known as convergence. Coral growth form depends ultimately on polyp character and size, growth rate and reproductive strategy, but there is much variation due to adaptation to environmental conditions as in plants. Light availability and wave action are dominant controls of coral structure, whereas light intensity, temperature, humidity, and wind speeds influence leaf shape and size in plants. Coral response to humidity is fairly cut and dry, in that submersion in a marine environment is essential. This leaves the matter of wind speeds and wave action, which seems to be a question of particle dynamics. Linear wave theory suggests that energy at depth is a function of surface waves, which in turn are reliant on wind strength and frequency, so terrestrial and marine organisms could easily have adopted common survival solutions in a hot, light and exposed environment, as in Saba.

Regardless of whether energy, evolution, or the environment underpins these similarities, they demonstrate the dynamic nature of taxonomy. Relationships and similarities have historically been explored and, where science hasn't offered up the justification for doing so, distinctions have been drawn that reflect our understanding of the fundamental basis of natural order. In the case of the corals and plants at Saba, it is certainly worth remembering that there is more to this than meets the eye.

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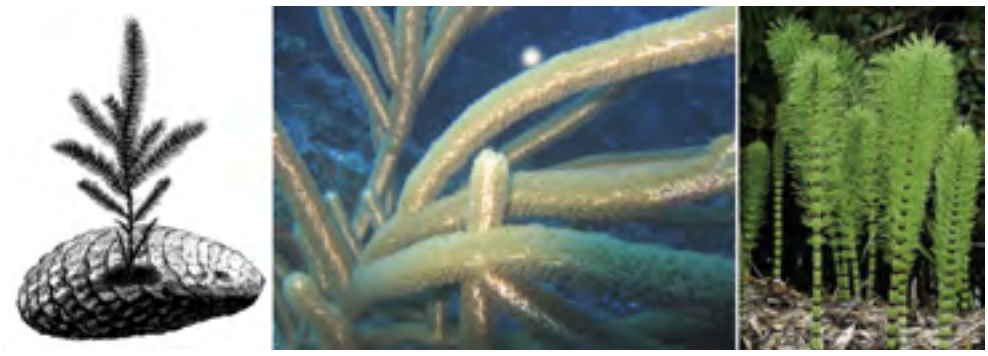


L-R: Lobster horn coral in John Ellis' field book; underwater scene in Saba; horsetail.

NEWS

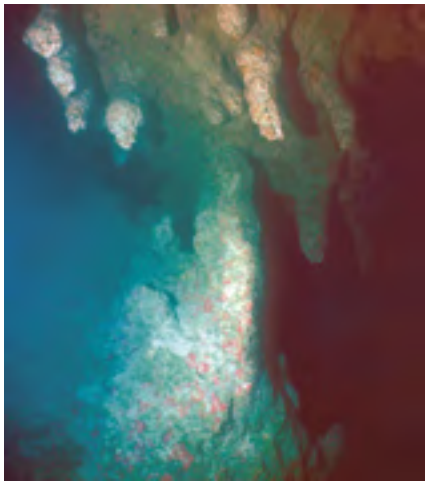
Italian research in the Maldives

Over the last three decades, the Maldives has become a favourite holiday destination, to the point that international tourism now equals or even surpasses traditional sources of income such as fisheries. Many tourists come from Europe, particularly from Italy, which now has a special relationship with the Maldives, both commercially and scientifically. In 1989, Italian scientists began to study Maldivian coral reefs[1, 2] and, since 1997, the group has undertaken annual scientific cruises with Albatros Top Boat, an Italian tourist operator[3].

Perhaps the most interesting and unexpected result of our work has been the discovery of a "blue hole" in the lagoon of Faanu Mudugau, a peripheral reef on the eastern rim of Ari Atoll[4]. Blue holes are water filled karst features that, through a vertical opening, lead to complex cave systems below sea level. They are known in the Bahamas and other Atlantic reef localities, but had not been recorded in the Indian Ocean. The blue hole of Faanu Mudugau opens at the bottom of a large bowl-shaped depression, and has a roughly circular entrance with a diameter of about 70 m. Its walls overhang an irregular bottom covered by fine carbonate loose sediments at 7083 m depth. Hydrogen sulphide is found in water deeper than 4550 m.

Finding speleothemes, such as stalactites and stalagmites, at about 50 m depth provided the ultimate proof of the Quaternary emersion of the Maldivian archipelago and of its karst origin, showing that modern coral growth is only a thin living veneer over older coral rock[2]. This is of great significance for the Maldives, a nation that lives on coral, not only economically but also literally, since the land is formed exclusively by coral islands. Every event, whether climatic or anthropogenic, that might reduce the natural accretion of coral reefs must be considered as a serious threat to the continued existence of the country.

One such threat was the coral mortality following the bleaching event of 1998. Data collected on before, during and after this showed that, as early as 1999, coral recolonization had started with many newly settled colonies. New recruits were dominated by Agariciidae, but dominance then shifted to Acroporidae and Pocilloporidae. By 2002, although coral diversity had not decreased, some previously abundant species had become rare and the hydrocoral *Millepora* has not been recorded. Maldivian reefs did not undergo a phase shift towards dominance by fleshy algae, sponges, or corals other than *Acropora* and *Pocillopora*, but instead, reef recovery seems to be following a predictable ecological succession toward the pre-existing situation. However, cover is still very low, and the three-dimensional structure of the reef is largely lost as dead colonies were reduced to rubble[5].



The blue hole in Faanu Mudugau lagoon (Photo C. N. Bianchi)

The Sumatra-Andaman tsunami of 2004 hit the easternmost atolls, causing, in addition to human fatalities and damage to infrastructure, the submersion of low islands, erosion and displacement of sand and coral cays, and resuspension of sediment. Sand, rubble, detritus and wrecks were driven to shallow bottoms and eventually deposited on reef slopes. Although coral colonies were hit and partially broken, and sand and rubble covered the epibenthic biota, no widespread reef damage was reported. The results allow for cautious optimism about the recovery potential of the Maldivian reefs after major disturbances

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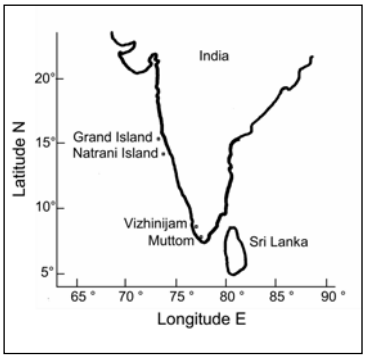
The reefs of India's west coast

Most of the research on India's coral reefs has focused on the Andaman and Nicobar Islands, Lakshadweep Islands (see last issue of *Reef Encounter*), Gulf of Mannar, and Gulf of Kutch. The west coast of the mainland has received much less attention. The Center for Applied Science from Millennium Relief and Development Services, USA, and the Indian NGO, Institute for Environmental Research and Social Education, have developed a collaborative partnership to study these reefs and associated fish communities. Fringing coral reefs surround Grand and Natrani Islands, with coral cover of 31% and 15%, respectively, although 34% of the corals at Grand Island in September 2002 were bleached. The sites south of Vizhinjam had little coral cover (<1%), but high sponge, barnacle, and mussel cover. All sites on the west coast were dominated by turf algae (22-60% cover) and subjected to high sedimentation. Two hundred fish species were recorded along this coast, excluding cryptic and pelagic species which were not surveyed. New distribution records were found for many sponge, octocoral and fish species.

Post-tsunami studies indicated that there was no damage to the reefs of Grand and Natrani Island. However, at Muttom, there was a clear shift in taxonomic abundance with a decrease in sponge and barnacle cover matched by an increase in fine turfing algae and rubble. Lack of data from before the tsunami means that changes cannot be conclusively attributed to tsunami damage, although they are consistent with this.



Map of study sites. Several reefs were studied between Vizhinjam and Muttom.

Studies of the humphead wrasse (*Cheilinus undulatus*), a species targeted in the live fish food trade, revealed that this species is rare on this coast. The grouper assemblage was dominated by species that are found more often in the silty and estuarine habitats that are typical of the coast of the Indian subcontinent. Many sites were littered with plastic and waste cloth. Other threats included untreated effluent being discharged into the sea, and intense artisanal fishing, including the use of dynamite fishing. Many of the reefs had nets and/or traps that were caught among the rocks and continued fishing. The tourism industry in the area provides scope for the development of snorkelling tourism.

Typical coral patches found offshore of Grand Island, Goa.

Ten publications have so far resulted from this partnership, and reprints and photos are available at www.mrds.org/Regions/southasia/india/INDIA.HTM

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Call for information: extinction risk of sea snakes to be assessed

Sea snakes comprise almost 90% of extant marine reptile species and are a unique component of the marine biodiversity of South East Asia and northern Australia; there are no sea snakes in the Caribbean or Atlantic. There are five extant sea snake lineages: the Acrochoridae (file snakes); Homalopsinae (mud snakes) and Natricinae (salt-marsh snakes), both subfamilies of the Colubridae; and the marine hydrophiines ('true' sea snakes) and genus *Laticauda* (sea kraits) in the family Elapidae. By far the largest group is the marine hydrophiines with approximately 60 species[1].

Aipysurus laevis – *olive sea snake (Photo: Vimoksalehi Lukoschek)*

Most sea snakes occupy relatively shallow benthic coastal habitats, such as estuaries and brackish waters, and coral reef environments, all of which are experiencing severe habitat degradation. This, as well as incidental (bycatch) and directed take for their meat, skin and internal organs (sea snakes are not currently listed in CITES), combined with their low reproductive outputs and dispersal capacities, make all sea snake species highly vulnerable to localised extinctions. Most species form large aggregations at some locations but not in other apparently ecologically suitable areas, perhaps because of low reproductive output and potentially low juvenile dispersal. These life-history characteristics suggest that recovery of locally extinct sea snake populations would be extremely challenging. Recent genetic data indicate limited connectivity among populations[2], particularly over intermediate and large distances, suggesting that populations need to be managed as separate entities.

Emydocephalus annulatus – *turtleheaded sea snake (Photo: Nigel Marsh).*

For example, the Australian reefs in the Timor Sea are home to some 20 'true' sea snake species and are regarded as the sea snake 'capital of the world'. Ashmore and Cartier Reefs are Marine Protected Areas (MPAs) and illegal fishing and collecting is controlled, but some of the many endemic species have disappeared and others have declined in abundance. In the late 1990s sea snakes were surfacing at average rates of 20 snakes an hour at Ashmore Reef but in 2007 only seven snakes were seen in ten days of intensive surveying[3]. There has been a similar reduction in sea snake populations on protected reefs in the southern Great Barrier Reef over the last 30 years suggesting that the cause of the decline is something that cannot be halted by MPAs[3,4].

A thorough assessment of sea snake conservation status is needed in order to design, target and implement effective protection and conservation strategies. A workshop will therefore be held to look at the extinction risk of all sea snake and mud snake species under the International Union for Conservation of Nature (IUCN) Red List Criteria in February 2009 in Brisbane, Australia, funded by Conservation International, and supported by the Great Barrier Reef Marine Park Authority (GBRMPA), the International Sea Turtle Society (ISTS) and the Queensland Environmental Protection Agency. Please send any data or observations of sea snake population declines, along with information on distribution or abundance for particular sea snake species to suzanne.livingstone@iucn.org for incorporation into the IUCN Red List assessments. Thank you. For more information on marine Red List assessments see: www.sci.odu.edu/gmsa/

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Cyclone Gonu in the Gulf of Oman

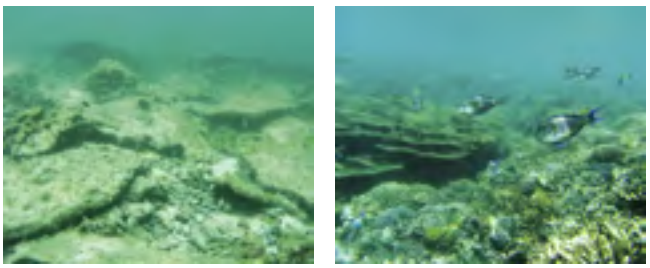
Upwelling and associated oceanographic features within the Gulf of Oman prevent oligotrophic conditions by reducing water temperature and light penetration, and by bringing nutrients into the euphotic zone. The net result is a near absence of true coral reefs from much of the coastline1, although some occur, typically in shallow water embayments where light penetration is high and the effects of upwellings are limited, as at Barr Al Hikman (a large mono-specific *Montipora* reef), Ras Sawadi, and Goat Island in Musandum[1, 2, 3]. However coral communities growing on exposed rocky substrates or other dead coral colonies (e.g. *Porites*) are widespread, typically comprising mixed hard and soft coral assemblages at depths above 18m. Hard coral cover in mixed assemblages is usually low, ranging from 5-30%, but mono-specific stands of *Acropora* and *Pocillopora* can exceed 90% total coral cover over areas of 50m^2 or more (pers. obs.).

Cyclone Gonu in June 2007 was the strongest cyclone on record in the Arabian Sea, and equal to the strongest on record for the northern Indian Ocean. It reached peak wind speeds of 240km/h (information courtesy of the India Meteorological Department), before winds declined to 150km/h prior to landfall on the eastern most tip of Oman. Between 2005 and June 2007, data had been collected at 141 sites, and after the cyclone, 101 of these locations were resurveyed. The immediate impact was significant destruction of coral communities primarily due to intense wave action and storm water runoff, the extent of this dependent mainly on location, coral morphology, depth and exposure. Sites at depths of less than 8m bore the brunt of the waves, and suffered very high coral mortality from abrasive and attritional forces. Exposed (and even semi-exposed) landward and island sites showed reductions in coral cover of 30-99%, particularly those dominated by mono-specific stands of *Pocillopora damicornis* and mixed *Acropora*. *Acropora* stands showed very large declines in structural heterogeneity. More resistant and resilient growth forms (e.g. those of *Porites*, *Symphyllia*, *Favites* and *Platygyra*) were also affected in the most exposed locations, physically moved by wave action or suffered large declines in cover due to 'sand blasting'.

The Gulf of Oman and study area (inset)

More sheltered coral communities suffered less direct physical damage, although freshwater lens effects and sedimentation associated with wadi discharges caused significant mortality. The former affected shallow water coral communities within Bandar Khiran and Khawr Yenkit, where mortality rates of up to 100% were recorded above 1.5m depth. Sedimentation effects appeared to have been less severe. In intermediate areas the nature of the impact was largely predictable with fast growing branching and tabular species suffering higher mortality than boulder corals (e.g. *Platgyra*, *Favites* and small poritids).

One year on, coral communities are recovering at varying speeds. Semi-exposed and sheltered sites exhibit the most obvious re-growth with branching *Acropora* and *Pocillopora* very evident at island locations. This re-growth is not, however, obvious at most mainland locations where oceanographic conditions are thought to be less suitable and sources of fragments are low. More exposed locations show less sign of recovery and, in a few instances, no sign, although recruitment is apparent in several areas and genera, particularly where a good proportion of communities are still intact, inferring the importance of localised recruitment. The outlook for long term recovery is largely positive, although recovery of habitats to their approximate condition prior to the cyclone may take decades[4]. These coral communities may nevertheless exhibit greater resilience and recovery than the more widespread and well-studied coral communities in the Indo-Pacific and wider Caribbean.



An Acropora *dominated coral community at the Daymaniyat Islands in February 2007 and in March 2008 following the cyclone. Coral mortality exceeded 80%. In the months since considerable new recruitment has been observed directly onto dead coral rubble.*

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BOOK REVIEWS

A Reef in Time

J.E.N.Veron
Harvard University Press 2008,
ISBN-13:978-0-674-12679-7 RRP £24/US$35

A Reef in Time: The Great Barrier Reef from Beginning to End makes a strong and frightening argument that the world's coral reefs are on the brink of extinction due to the uncontrolled human production of greenhouse gasses. Veron points out mass extinction events are not something new for corals; these organisms have experienced mass extinctions at least five times throughout Earth history and have taken a staggering amount of time, tens of millions of years, to recover from these events. The difference this time, Veron argues, is that natural processes and random events (bolides, supervolcanoes, and sea level changes) are not the catalyst for extinction; we are.

Veron is no Cassandra, he is the former Chief Scientist at the Australian Institute of Marine Science and his previous books include *Corals in Space and Time* and *Corals of the World*, the definitive textbook on zooxanthellate scleractinian corals. Veron has dedicated his life to the study of corals and coral reefs, but has now shifted his focus to the plight of coral conservation and climate change. Veron states, "The immediate threat greenhouse gasses pose to coral reefs and all of mankind made me realize that I must write this book. Action to drastically curtail greenhouse gas emissions must begin in earnest if we are to reverse what could potentially be the onset of a sixth mass extinction event".

A Reef in Time is Veron's call to arms and one that is written in such a way that anyone can readily understand. The Great Barrier Reef and many other reefs throughout the world's oceans are experiencing mass coral bleaching events with increasing frequency and are particularly susceptible to ocean acidification, the process whereby the oceans are absorbing anthropogenic carbon dioxide, which results in surface ocean conditions that are less favourable for coral growth. Unlike coral bleaching, which is an acute and visible threat, acidification is a chronic and largely invisible stressor. "The long-term outlook is that reefs will be

committed to a path of destruction long before any effects are visible," he says. If global atmospheric CO_2 levels reach 650-700 parts per million, as they are forecast to do by the latter part of this century, traces of human-produced carbon dioxide will still be present in 30,000 years time, contributing to acidification. Veron says, "The lag time in the carbon system makes it perfectly clear that greenhouse gas emissions must be reduced by 70-90% if we hope to avoid environmental disaster, 10% will not do. The common denominator that all five mass extinction events had in common was a disruption in the carbon cycle, which is exactly what we are doing by burning vast quantities of fossil fuels."

A Reef in Time is well written, understandable to the layperson, and disturbing, but does not leave the reader hopeless. The solution to the CO_2 dilemma is achievable, but we need political will and all the technological ingenuity we can muster to solve the problem. Veron did his homework and the result is a thoroughly researched book that spans many disciplines of earth science and presents a big picture wakeup call we all should heed.

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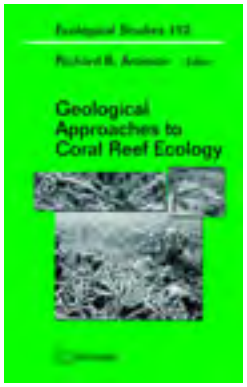
Geological Approaches to Coral Reef Ecology

Richard B. Aronson (Ed)
Springer. ISBN: 978-0-387-3538-4 RRP £100/US$129



One of the major issues that we, as coral reef scientists, currently face is the need to put into context the scale and extent of ongoing coral reef ecosystem change. Have ecosystem changes, on the scale reported at present, occurred in the past? Which of the varied range of contemporary stressors are without precedence in the past? Which disturbance events are increasing in frequency and intensity? Such questions are often difficult to answer using contemporary data but the sub-Recent and Quaternary fossil record of coral reef development has the potential to provide a wealth of information. The absence of human impacts on pre-Holocene reefs also means that the Quaternary fossil record provides an invaluable baseline for examining natural reef ecological states and cycles of change.

Geological Approaches to Coral Reef Ecology provides an excellent overview of the important contribution that palaeoecological studies can make to the ongoing debate about late Holocene reef ecosystem change, and these long-term perspectives have much to offer to reef managers. As the title suggests this is a book that will be of interest not only to reef geologists but also to reef ecologists. There are four main sections.

Part 1 - *The changing fate of coral reefs* (Chap 1 by Wood) outlines the relevance of reef palaeoecological data to modern ecological questions, flagging up some of the inherent problems that exist in terms of data resolution in the fossil record and in recognising past causes of coral mortality and ecological turnover.

Part 2 - *Detecting critical events* looks at how the fossil record can reveal information about past disturbance events. Greenstein (Chap 2) reviews the potential of coral reef taphonomic studies for interpreting past ecological conditions on reefs and aiding the interpretation of reef framework depositional events. Aronson and Ellner (Chap 3), demonstrate the value of the centennial to millennial timescale coral community records that can be derived from reef cores, drawing on examples from Belize. De Vantier and Done (Chap 4) show how past scarring patterns on massive, long-lived corals can be used to determine the timing and spatial extent of *Acanthaster* outbreaks, revealing that these occurred prior to direct human impact on the marine environment but that the frequency and extent of outbreaks may be increasing. Deslarzes and Lugo-Fernández (Chap 5) discuss the influence of seasonal fluvially-derived terrigenous sediments inputs on the submerged, offshore reefs of the Flower Garden Banks in the Gulf of Mexico, and suggest that the historical absence of branching corals may have helped to maintain coral community stability here. Halley and Hudson (Chap 6) show how fluorescent and density banding records can be used to reconstruct past records of coral bleaching, concluding that there is no evidence of major bleaching over the period 1878-1986.

In Part 3 - *Patterns of reef development and their implications*, Macintyre (Chap 7) reviews, through core records, reef response to post-glacial sea-level rise in different shelf and shelf-edge settings in the Caribbean, and shows the impressive capacity of reefs to respond positively even to this. Pandolfi and Jackson (Chap 8) emphasise the use of the pre-Holocene record for developing ecological baselines against which recent community shifts can be compared. Precht and Miller (Chap 9) focus specifically on the Holocene record along the Florida Reef Tract and suggest that the current paucity of *Acropora* corals may have more to do with longer-term environmental constraints than recent disturbances.

The final section, Part 4 - *Coral reefs and global change* considers reefs in the context of global environmental change. Riegl (Chap 10) and Wellington and Glynn (Chap 11) review the role of extreme climatic events, the interaction between such events and disease outbreaks and other disturbances, and possible geomorphic, ecological and geochemical indicators of past ENSO activity. Kleypas (Chap 12) considers past and predicted changes in global environmental conditions that have most direct relevance to coral reefs - sea surface temperatures and seawater chemistry - flagging up the considerable uncertainties in our understanding of the future of reef ecology and geomorphology. In summary, this book contains a very useful set of contributions that provide a long-term perspective on issues directly rele-

vant to many contemporary reef ecological questions, as well as a valuable source of reference material.

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Deep-sea coral ecosystems: biology and geology

Robert Y. George and Steven D. Cairns. 2007. Proceedings of the Third International Symposium on Deep-Sea Corals. *Bull. Mar. Sci.* 81(3):309-559. US$50.

Conservation and adaptive management of seamount and deep-sea coral ecosystems.

Robert Y. George and Steven D. Cairns. 2007. Rosenstiel School of Marine and Atmospheric Science, University of Miami. Miami, 324 p. US$50.

Both volumes available from Editorial Office, Bulletin of Marine Science, RSMAS, University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149-1031, USA.

The third international symposium on deep-sea or cold-water coral biology was attended by nearly 300 participants from 21. As with the first symposium, the proceedings have been published in two parts: the *Bulletin of Marine Science* volume deals with science while the second volume is devoted to management and habitat mapping of deep water corals and sponge beds on continental slope and seamount areas.

In the *Bull. Mar. Sci.* volume, Cairns provides a much needed review of the word 'coral' noting that it can be used to describe members of seven higher level taxa within the Cnidaria comprising over 5,000 species of which almost 66% are found at depths of over 50 m. There are at least 34 common names, 23 of which are binomens with the word coral modified by a qualifier. Three papers on systematics deal with genetic analyses. Papers in the geology and climate section show how scleractinians and bamboo octocorals can be used to glean information about ocean conditions over the past 200 thousand years. However, Thresher *et al.* note that specimens collected at different sites can have quite different elemental compositions, and Matsumoto shows that Mg/Ca ratios could be strongly affected by *in situ* temperatures. The coral biology and natural history section covers topics as diverse as isotope data from antipatharians (perhaps more relevant to the previous section), effects of bottom trawling on *Oculina* communities (not a happy story), effects of symbionts on black coral morphology (worms wreak havoc on characters of taxonomic importance), reproduction in hydrocorals and precious corals, and the use of a deep gorgonian as a catshark nursery.

In the second volume, the first section has a largely U.S. perspective, although H. Thiel urges deep-sea researchers to become "stakeholders" in the management process and advocate for "science protection areas" which are not currently provided for under the Law of the Sea Convention. Three papers look at the link between fish and coral communities, but none show much of an obligate relationship between these. Sulak *et al.* suggest one microcarnivore might be strongly associated with *Lophelia* reefs in the Gulf of Mexico, but both Auster and Edinger *et al.* note that sampling methods (either submersibles or trawls) are severely limited when it comes to understanding possible functional links between deep-sea corals and deep-sea fish. The last two sections cover a wide geographic area. For the first time details about hard and soft coral faunas from Chile, India, and Brazil are presented. The precious corals of Hawaii, ancient sponge bottoms of British Columbia, and deep *Madracis* communities off the Caribbean coast of Colombia are reviewed. Management measures to protect cold-water corals communities off Nova Scotia and the Darwin Mounds off Britain are discussed. Biogeographic analyses of the eastern North Atlantic and Japan are presented, both areas where the taxonomy of the non-scleractinians is best known.

The two volumes illustrate the development of this still relatively new field. Much of the early work emphasized *Lophelia* reefs and the need for their protection from destructive fishing practices. Recent work shows that knowledge of the taxonomy of non-scleractinians is slowly advancing and will help us to understand deep-sea coral communities, both modern and ancient.

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Bookshelf

Seafaring Scientist: Alfred Goldsborough Mayor, Pioneer in Marine Biology

Lester D.Stephens and Dale R. Calder. 2006. University of South Carolina Press, Columbia, South Carolina. ISBN: 13 978-1-57003-642-2
RRP £17/US$25

This readable paperback tells the tale of the founder of the first tropical marine biological lab in the Western Hemisphere – the Tortugas Laboratory on Loggerhead Key in the Gulf of Mexico. Alfred Mayor was an expert on jellyfish and coral reefs, and had travelled round the world before establishing the Dry Tortugas research station in 1904. There are over 30 illustrations, including some of Mayor's own scientific drawings and photographs of his beautiful, devoted and long suffering wife, Harriet, who he married in 1900 and the correspondence with whom provided much of the information for the book. The politics, rivalry and stresses of running a lab, fundraising, and regular long trips away from home will be familiar to many coral reef researchers today. And the cumulative impact that Alfred Mayor had over his lifetime should provide encouragement to those who still today struggle to keep tropical research going in what are often trying circumstances.

The Hyperbolic Crochet Coral Reef

IFF bleached coral reef, Hayward Gallery, London (Photo S. Wells)

Who would have thought that IYOR 1008 would get one of its biggest communication boosts from the unlikely combination of geometry and crochet? But this is exactly what Margaret Wertheim, founder of the Institute for Figuring (IFF – www.theiff.org), has engineered with her wild and whacky, winsome and wonderful, world of the hyperbolic crochet coral reef – which has now been seen by millions and exhibited in major galleries in New York, Los Angeles, Chicago, and London.

The IFF is an organization "dedicated to the poetic and aesthetic dimensions of science, mathematics and the technical arts". As a quick glance at its website will show, the interests of the IFF in figuring – that is problem solving involving numbers - are wide ranging, from the physics of snowflakes and the hyperbolic geometry of sea slugs, to the mathematics of paper folding, the tiling patterns of Islamic mosaics and graphical models of the human mind. The connection with corals is via 'hyperbolic space'. Until the 19th century, mathematicians knew about only two kinds of geometry: the flat – or Euclidean - plane and the sphere. But there is a third form: hyperbolic geometry. On a regular Euclidean plane, if you have a series of circles around a point, the circumference of the larger circles increases linearly. On a hyperbolic plane, the circumference of the circles increases exponentially, so that both the perimeter and the area of the circles get bigger much faster. For a long time people thought that hyperbolic space was just a mathematical abstraction, but it is now known that many things in nature exhibit this geometry - lettuce leaves, kelp, and various kinds of sea creatures, especially sea slugs, flat worms, and corals. And in 1997, Daina Taimina, a mathematician at Cornell University, found that you could model hyperbolic space using crochet – just by adding new stitches to each row.

IFF crochet corals, Hayward Gallery, London (Photo S. Wells)

Margaret Wertheim was so enthused by this that she and her twin sister, Christine (professor at the California Institute of the Arts), started crocheting. With the realisation by Christine that the resulting shapes resembled coral colonies, the idea of a woolly Great Barrier Reef was born. Just as living organisms have evolved from simple protoplasmic forms into a wide diversity of species today, so the simple original crochet patterns of Dr Taimina have morphed and evolved into hundreds of different and more complicated "species" of crochet forms. New contributors add their own embellishments and elaborations, in a process that Margaret describes as "almost Darwinian". Christine and Margaret are finding this fascinating to watch, as it demonstrates that the whole really is greater than what any individual could produce. The Bleached Reef is the most popular exhibit, with the finest and most delicate work, produced largely by Sarah Simons (a handmade-book artist and writer in Los Angeles), and Heather McCarren (completing a PhD in geoscience at UC Santa Cruz).

The exhibitions have been accompanied by workshops where people from all walks of life have discovered the fun of creating their own coral structures, and at the same time learnt about the perilous state of the world's reefs. Those involved include a science fiction writer in Seattle (Vonda MacIntyre), a physics and mathematics teacher in Australia (Helen Bernasconi), a Texan housewife (Evelyn Hardin), and an industrial designer in Pennsylvania (Kathleen Greco). A local reef is beginning in Sydney, Australia, one will be made in Arizona for inclusion in the Scottsdale show, and interest has been shown in Latvia. So just as living reefs send out spawn to produce new reefs, so also the Crochet Reef is spawning around the world.

For those wanting to see the woolly reefs, the following are on display:
IFF Crochet Reef: Los Angeles, Track 16 gallery, 10 Jan – 20 Feb 2009; Scottsdale Arizona, Scottsdale Cultural Center, April 12 to July 2009; Museums in Washington DC and Michigan – potential shows in 2010.
UK Reef touring to four cities in 2008 – see http://www.theiff.org/exhibits/iff-e18.html
NY Reef and Chicago Reef, Staten Island. http://www.showhownyc.com/ and http://www.theiff.org/reef/sister.html

IFF crochet coral reef and anemone garden. Urchins by Christine Wertheim; Sea slug by Marianne Midelburg. (Photo Alyssa Gorelick © IFF)

MEMBERSHIP

The annual ISRS membership subscriptions for individuals is US$80, and for families is US$90, provided payments are made by 1 March. Individual and Family Members receive the journal *Coral Reefs*, the newsletter *Reef Encounter* and other periodic mailings. Student membership costs US$25 and benefits include all of the above except the journal *Coral Reefs*. Patron Members are those who support the society with an annual subscription of US$200 and, in addition to the standard benefits, they will see their names printed in each issue of *Reef Encounter*. Renewals received between 1 March and 30 April cost US$30 for students, US$90 for individuals and US$100 for family membership. Renewals received after 1 May cost US$32, US$100 and US$110 respectively. New members can join at the base rate of US$25, US$80 and US$90 at any time of the year. Financial assistance may be available to prospective members with legitimate needs. Please contact ISRS Corresponding Secretary Dr Isabelle Côté at imcote@sfu.ca. Institutional subscriptions to *Coral Reefs* must be placed directly with Springer-Verlag. Subscriptions to the Society should be addressed to: International Society for Reef Studies, P.O. Box 1897, Lawrence, Kansas 66044-8897, USA.

NOTES FOR CONTRIBUTORS

Reef Encounter is ISRS's newsletter and is published twice a year. It aims to complement the Society's journal, *Coral Reefs* by providing:

- news on all aspects of reef science, including meetings, expeditions, book reviews;
- brief reviews of recent trends and developments that bear on reef research;
- discussion and debate on issues concerning reefs or the ISRS (letters to the editor are welcome);
- information on student opportunities.

Reef Encounter has an informal and journalistic style. Articles should range between 200 and 1000 words. If you are planning a substantial contribution, please contact the Editor first. References should be kept to a minimum, and each one should be numbered in the text using superscript, and listed at the end of the article in the order in which they are cited. Avoid the use of *op.cit*. or *ibid*, and use World List abbreviations. In all other aspects, references should follow the style prescribed for *Coral Reefs*. Please send your full address and email details which will be published with your article.

We particularly welcome artwork and photographs to help us illustrate the magazine. Images can be sent as hard copy or electronically. Electronic images should have a resolution of 350 dpi and must be a size appropriate for the newsletter format. In particular, we cannot enlarge small electronic images and retain publishable quality. Where images are included in the article, please send legends and/or captions separately (not in the image file). Explain all symbols, abbreviations, shading patterns, etc. Maps should have a scale and indicate orientation. Please use either metric units or imperial with metric units.

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