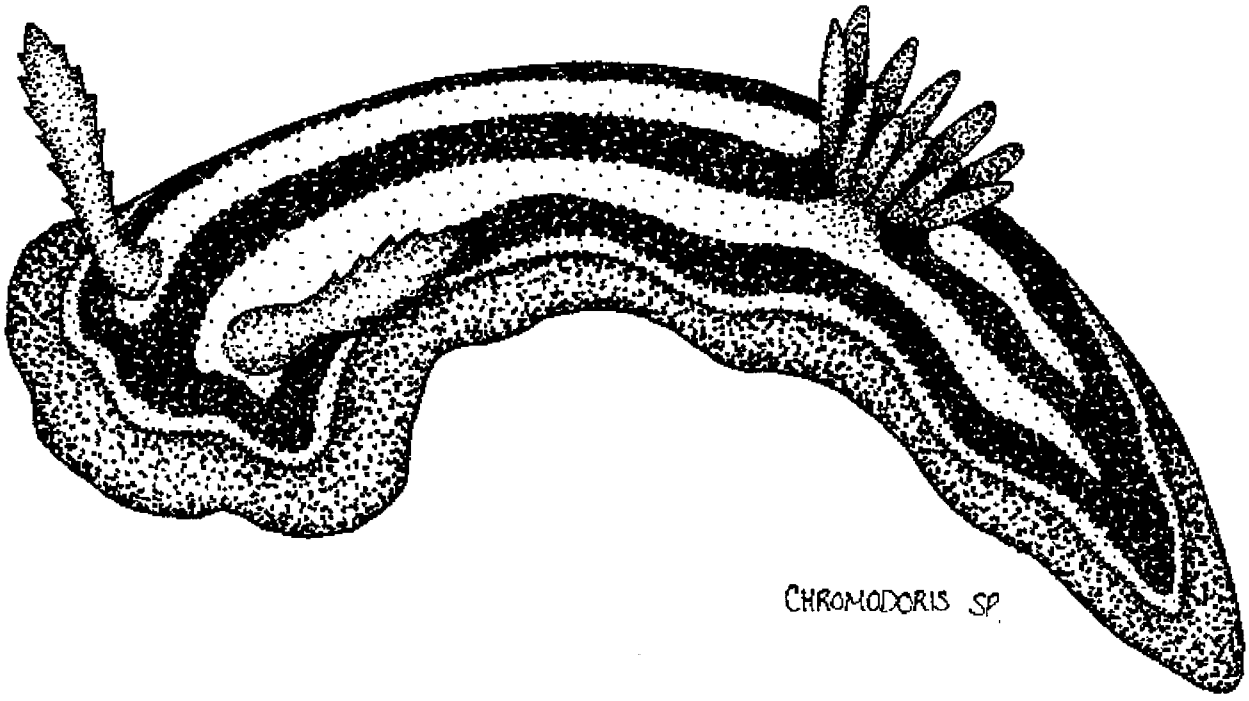
Number 25 July 1999

REEF ENCOUNTER

Newsletter of the International Society for Reef Studies



ISSN 0255-2787

REEF ENCOUNTER No. 25 July 1999

Newsletter of the International Society for Reef Studies

Editor Maggie Watson
Associate Editor Kristian Teleki

CONTENTS

03 Editorial
M. Watson, K. Teleki

03 ISRS Comment
From the President—T. Done

04 ISRS News
STAP winner attends NCRI meeting. *B. Brown, G. Multer*
Expanding horizons: a Brazilian student's first conference abroad. *B. Segal*
Financial assistance for potential **ISRS** members.
1999 ISRS/CMC Fellowship Award Announcement.
ISRS Financial statement & membership report 1998.
Nominations for the Darwin Medal.

08 Upwellings
Role of *Vibrio* in *Oculina* bleaching. *E. Rosenberg, Y. Loya*
How many species of *Acropora* in the Caribbean? *E. Gischler*

12 News
Reefs in Recession: economic crisis affects remote Indonesian islands. *P. Surjadi, C. Hutabarat, K. Anwar*
Maps for Colombian reefs. *J. Diaz*
SIMAC: a new program to monitor reef condition in Colombia. *J. Garzón-Ferreira*
Shoals of Capricorn Programme underway in the Republic of Seychelles. *B. Burnett, K. Teleki*
GBR research news updates on Web. *D. Alcock*
Landsat launched. *F. Muller-Karger*

18 Currents
Paper Parks: worse than useless or a valuable first step? *M. Watson*
High sea temperatures along the coast of Abu Dhabi—impact on corals and macroalgae. *D. George, D. John*

23 Compleat Reef Encounter

24 Features
ISRS Statement on Diseases on coral reefs.
First oceanographic expedition to Navassa Island, USA: status of marine plant and animal communities. *M. Littler, D. Littler, B. Brooks*
What are the origins of the modern coral reef ecosystem? *Rachel Wood*

(Contents Continued on Page 55)

COPY DEADLINE FOR REEF ENCOUNTER 26 (due out Dec. 1999) IS OCTOBER 1 1999

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."
In order to achieve its aim, the Society has the following powers:

i. To hold meetings, symposia, conferences and other gatherings to disseminate this scientific knowledge and understanding of coral reefs, both living and fossil.
ii. 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.
iii. To raise funds and invite and receive contributions from any persons whatsoever by way of subscription, donation or otherwise providing that the Society shall not undertake any permanent 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 modelling.

Reef Encounter is produced by Allen Press, Inc., 1041 New Hampshire, Lawrence, KS 66044, USA. Printed on recycled paper.

EDITORIAL

With this issue we say goodbye and thanks to David Obura, Associate Editor since 1996. David, who is based in Mombasa Kenya, will continue to write for the newsletter and is in a strong position to contribute articles on Western Indian Ocean reefs. A diverse geographical range of articles is essential to **Reef Encounter**, and recognizing the gap that David will leave, we propose to call for three contributing editors, from Latin America/Caribbean, Africa, and Asia/Pacific to seek out and encourage contributions from their regions. Please contact Maggie if you feel you can fill this role. We'd also like to hear from you if you feel your particular subject area is under-represented in the newsletter—send us an article!

This time we cover issues from the recession in Indonesia to reef monitoring in Colombia (**News**). **ISRS** is consolidating its stance as a balanced and considered voice on controversial issues such as coral diseases (**Features**). Last issue's focus on bleaching brought us a short review linking these two issues (**Upwellings**). The society is also playing a major role in the 9ICRS—see **Diary** for the second circular. For anyone who thinks things have been a bit fishy recently, we have an article on the evolution of reefs, and for explorers, a full spread on previously undescribed Navassa Island (**Features**). We thank all our contributors, and especially those who sent illustrations including Sue Daly (Cover and inside), Simon Wilson and David Righton.

Maggie and Kristian

ISRS COMMENT

From the President

When John Ogden handed me the helm on January 1st 1999, our ship, this Society, was on a solid, steady tack, on course, ever making progress. My transition from spectator to helmsman makes me appreciate that keeping this forward momentum needs three things: a vision of where we are headed; a good crew; and instinctive small adjustments of the helm.

Vision—well, the first mark is clear enough—it's a buoy just over the horizon coded '9th ICRS Bali October 23–27 2000'. **ISRS** has major responsibilities in helping bring the 9th International Coral Reef Symposium to fruition. Despite uncertain times in Indonesia, things are falling into place, with the Government contracting a Professional Conference Organizer who will turn on a great venue and great logistics. **ISRS** will have a strong guiding hand in the development of the scientific program, and it is not too late for you to volunteer to lead a mini-symposium. One of the major tasks now underway is seeking sponsors so that as many people as possible from developing as well as developed countries can attend. Please see the second circular in **Diary**.

It's also important that we make our own waves—with coral reefs these days we really are on a beat to windward. Reefs at risk, reefs in crisis, action plans, task forces, networks, working groups, initiatives…national, regional, international. Ironically, we make our waves by being the calm voice of reason and light, but never becalmed or afraid to mix it. Our statements on bleaching and disease are a credit to all those who contributed, and they are widely quoted in important places. We now have a seat as the international voice of science in the Coordination and Planning Committee of the International Coral Reef Initiative—a body whose aim is 'action' through management and policy based on knowledge; and that's where we come in (see **International Initiatives**).

A Good crew—yes, that's you—and you have chosen our officers well. To those who prefer a passive role in the Society—we thank you, as your subscriptions contribute to the big cause of coral reefs, and to the opportunities for the up-coming generation of coral reef lovers, users, researchers, managers and policy makers. To those who have had material published in **Coral Reefs** and **Reef Encounter**—congratulations and thanks. You have reached high

standards, and we rely entirely on high standards to be heard. Thanks so much to the Editors and editorial teams—your roles are vital. To our benefactors and sustaining members—a very special thanks for your generosity. Institutions are vital parts of our crew too. Thanks to AIMS and CRC Reef for their support—in particular my participation at ICRI-CPC. And thanks to the US National Coral Reef Initiative, who in supporting my attendance at their recent international conference in Fort Lauderdale, Florida also facilitated a meeting of Council.

Instinctive small adjustments of the helm—well yes—constantly. But there are also some major wind shifts around, which you the crew may see first. Do we need to change tack? When? Where? What buoy lies beyond '9th ICRS Bali October 2000'? In **Reef Encounter**, you have a vessel for your thoughts—we'd like to see them in print.

Terry Done

ISRS NEWS

STAP Winner Attends NCRI Meeting

Ms. Bárbara Segal from the University of Rio de Janeiro, Brazil was the STAP winner at the recent NCRI meeting (see **Meetings**). The award of the STAP marked another successful collaboration between **ISRS** and the meeting conveners at Nova University, with **ISRS** paying airfare costs while Nova University covered local subsistence.

An article on her impressions of the meeting and the abstract of her paper are printed below, together with a photograph of Bárbara and Dr. Terry Done, President of **ISRS**.

Barbara Brown and Grey Multer,
STAP Co-ordinators

STAP winner Bárbara Segal is congratulated by ISRS President Terry Done.

Expanding Horizons: A Brazilian Student's First Conference Abroad

My master's thesis was developed in the Abrolhos National Marine Park, some 1,000 Km from where I study (Rio de Janeiro). I had to deal with methodological aspects of coral reef assessment, as field studies presented time and funding constraints. Therefore, the International Conference on Scientific Aspects of Coral Reef Assessment, Monitoring, and Restoration was directly related to my personal interests and very useful for me. Many of the authors of papers I have studied for my work were present and I had the opportunity to meet them personally.

Some of the most interesting sessions for me were "Science as a Basis for Coral Reef Monitoring Programs", "Comparative Approaches to Coral Reef Monitoring and Assessment", and "New Techniques

and Methods". During these sessions several questions about sampling methods, sampling scales, and analysis were discussed.

Some of the most important "talks" happened during coffee breaks or after the presentations, where I was able to meet and talk with people from different countries all over the world. These conversations yielded a good exchange of information and plans for future collaborations. I also met Brazilian researchers. Brazil is a huge country and sometimes it is difficult to meet coral reef scientists from other regions and institutions. The contributed papers and personal contacts, new ideas and criticisms represent valuable contributions to my doctoral project. The Conference was a very intense, but gratifying experience.

After the Conference, I spent a couple of days in Florida and visited the NOVA Southeastern University Oceanographic Center, where I joined a field trip to coral reefs near the coast. I was fortunate to see several "new" marine life forms, and most importantly corals, sea whips, sea fans, and others that do not occur in Brazil. The subject of mass mortality and low recruitment of the genus *Acropora* in the Caribbean was an important matter discussed during the Conference. I had an opportunity to see mapping of some newly discovered *Acropora cervicornis* banks off Fort Lauderdale.

I would like to thank Carol Fretwell, Dr. David Gilliam, and all the staff at the National Coral Reef Institute. Thanks also to my colleagues at the Invertebrate Department of the National Museum in Brazil for helping me prepare my poster. Most importantly I thank **ISRS** for this Travel Award. An event of this magnitude is invaluable for staying up-to-date at the beginning of a scientific career.

Bárbara Segal, Museu Nacional –
Universidade Federal do Rio de Janeiro.
Email < bsegal@acd.ufrj.br>

The Need for Fast, Easy, and Accurate Methods for Coral Cover Assessment: A Case Study in Abrolhos, Brazil

One of the most used methods used to evaluate community coverage is line intercept transects (LITs). However, collection of coral cover data using LITs has drawbacks. Examining the transect taking notes of every centimeter of the line is time consuming, needing divers skilled in underwater handwriting and a lot of effort. The optimization of data collecting would permit to increase the number of replicates, allowing a better quantification of the coral community and comparison among different sites/times. It was here assumed that a LIT is composed of several adjacent data points. It was asked how many data points would be necessary to "describe" a whole line. Several 20 m long LITs were laid down in the Abrolhos Archipelago (17°58' S, 38°42' W), Brazil. The variation of percent cover in relation to a varying number of points drawn from each LIT was evaluated. A relatively stable condition was reached with 500 (out of 2,000) points. The new procedure (point intercept transects—PITs) needed much less effort in two approaches: 1) time per transect (up to 62.5% decrease) and 2) for each point the diver can just tick one mark in a species/category list. Species with less than 5% cover were detected in LITs and PITs. Furthermore, PITs were compared to quadrat samples. No differences were detected in community coverage estimated by five replicates of quadrats or five replicates of PITs. However, PITs detected more species with low cover, presenting a higher resolution than quadrats, as sampled in the current study.

Bárbara Segal, Email <bsegal@acd.ufrj.br>, Clovis B. Castro, Email <cbcastro@pobox.com>

ISRS Financial and Membership Report for 1998

FINANCIAL REPORT

INCOME totaled (US$)	54,618.11
Memberships	49,032.00
Interest	2,642.80
Editorial allowance	2,205.68
Sollins fellowship	737.63
Page charges	0.00
EXPENDITURES totaled (US$)	64,558.78
Allen Press management fees*	12,521.96
Coral Reefs volume 16	12,029.80
Coral Reefs volume 17	13,986.80
Reef Encounter number 22	3,460.16
Reef Encounter number 23	4,364.87
Membership directory	3,366.74
ICRS IX	2,625.84
(Suharsono travel to Boston SICB meeting)	
US meeting - Buddemeier	2,500.00
Editorial allowance	2,208.00
European meeting—Galzin	2,000.00
Postage	1,585.00
Student travel award	1,200.00
Bank charges	1,083.44
European meeting—Camoin	1,000.00
Tax preparation	250.00
Posters	202.23
Ogden meeting for fellowship	173.94

Outgo exceeded income by $9,940.67. Income was almost precisely $1000 more than anticipated, but outgo exceeded expectations by $6000.

* Members have inquired what management fees cover. Services are listed below:

1) Maintaining the membership list.

2) Renewals. Allen Press sends as many as four renewal requests a year. For each notice, **ISRS** pays for paper and printing, and postage (**please renew early to minimize costs**).

3) Costs associated with distributing **Coral Reefs** and **Reef Encounter** (preparing labels, bagging copies and getting them to the distributor). This does not include much of the postage in North America, which is paid directly to the US Postal Service, but does include payment for a service that allows members outside the US to be sent their publications in a rapid but relatively inexpensive manner.

4) Back-issue fulfillments. For people who join or pay after some issues have been sent, Coral Reefs and Reef Encounter are sent first class (**which is very expensive—please renew early**).

5) Storage of back issues—to allow #4.

CASH ON HAND at the end of 1998 $83,712.87

Checking accounts (amount at beginning of year in brackets)

Certificates of deposit

Douglas County Bank	$41,156.18 ($51,591.30)
	$11,134.90 ($10,708.03)
Capitol Federal S&L	$19,880.79 ($20,419.96)
	$11,541.00 ($10,935.10)

1999 BUDGET

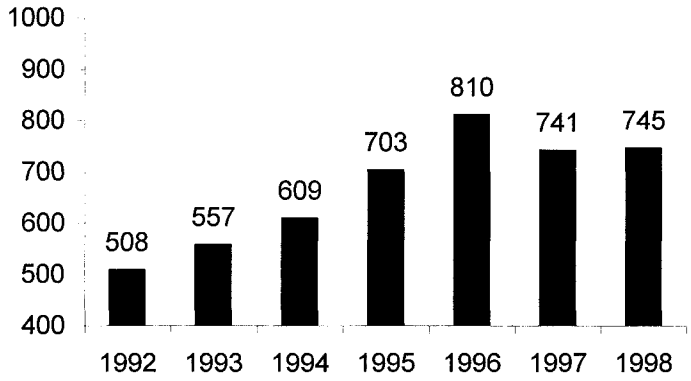
INCOME	$52,800.00
Memberships	48,000.00
Interest	2,500.00
Editorial allowance	2,200.00
Page charges	100.00

A deficit of US$5,700 is projected.

EXPENDITURES	$58,500.00
Allen Press management fees	11,500.00
Coral Reefs volume18	18,000.00
Reef Encounter 24 and 25	8,000.00
ICRS IX expenses	7,350.00
Editorial allowance	2,200.00
Membership directory	3,500.00
Local meetings (×2)	3,000.00
Postage	1,500.00
Student travel award	1,200.00
Bank charges	1,000.0
Audit and tax return preparation	1,250.00

MEMBERSHIP REPORT

At the end of 1998, ISRS members constituted 61 students, 628 individuals, 6 honorary members, 8 sustaining memberships (including 10 members), and 42 family memberships (including 84 family members)



ISRS/CMC Coral Reef Fellowship Award Announcement

The **International Society for Reef Studies** (http://www.uncwil.edu/isrs) and the **Center for Marine Conservation** (http://cmc-ocean.org/) awarded their 1999 Coral Reef Fellowship to Helen Fox (pictured here), University of California, Berkeley. Ms. Fox will work in Indonesia's Komodo National Park where she will assess damage to coral reefs from dynamite fishing, also known as "blast" fishing. She will assess factors that affect recovery of blast sites and she will develop methods to help accelerate recovery of coral reefs damaged by this destructive fishing practice. It is well known that blast fishing causes widespread and devastating damage to coral reefs. Despite being illegal, blast fishing is reported to cause significant reef degradation throughout the South Pacific.

Specifically, Ms. Fox will: 1) evaluate how coral cover at various spatial scales correlates with recruitment; 2) determine how rubble produced at the blast sites affects coral recruitment in various flow regimes; 3) manipulate substrate stability and rugosity to evaluate their effects on coral recruitment rates; and 4) evaluate recovery based on changes in community composition among blast sites of known age compared to nearby unblasted sites. Komodo National Park is located in eastern Indonesia and includes areas where significant blast fishing previously occurred, but has declined dramatically in recent years due to management efforts. This is the third **ISRS/CMC** Fellowship award,

with previous winners working in Belize and the Philippines. The award is for one year and is worth US$14,000.

*For information about the **ISRS/CMC** Fellowship contact: Dr. Steven Miller (Recording Secretary, ISRS) University of North Carolina at Wilmington, 515 Caribbean Drive, Key Largo, Florida 33037 email <smiller@gate.net>*

Financial Assistance for Prospective Members

If you or a colleague would you like to join the **International Society for Reef Studies** and receive **Reef Encounter** and **Coral Reefs**, financial assistance may be available. Prospective **ISRS** members with legitimate needs are invited to request financial assistance with the membership fees. Please send a letter of no more than one page stating the amount of assistance requested and explaining the need to:

Richard Aronson, **ISRS** Corresponding Secretary, Dauphin Island Sea Lab, 101 Bienville Boulevard, Dauphin Island, AL 36528, USA. Email: <raronson@jaguar1.usouthal.edu>

This financial assistance is made possible by private donations. Contributions toward the fund providing support for prospective members will be greatly appreciated. For further details, prospective donors should contact Daphne Fautin, **ISRS** Treasurer, at Email <fautin@ukans.edu>. More details about the society are available on the **ISRS** home page: www.uncwil.edu/isrs

Nominations for the Darwin Medal

This gold medal, the most prestigious award given by **ISRS**, is usually presented every 4 years at the International Coral Reef Symposium. It is awarded to an **ISRS** member who has been recognized as a senior coral reef scientist responsible for major contributions throughout his/her scientific career. Previous recipients have been David Stoddart, Peter Glynn and Ian Macintyre. The next occasion for the presentation of the medal will be the Coral Reef Symposium in Bali in 2000.

Members are invited to send nominations (maximum 500 words) to the **ISRS** Corresponding Secretary Richard Aronson, Email <raronson@jaguar1.usouthal.edu> by 30th September 1999. All nominations will then be forwarded to ISRS Council for selection of a medalist. Each nomination will be judged on its individual merit and a four-fifths majority of Councillors voting must approve a nomination for an award to be made. On presentation of the award in Bali the medallist will give a thought-provoking review of his/her particular scientific field. This talk, following review, will be subsequently published as the Darwin Lecture in the ISRS journal Coral Reefs.

UPWELLINGS

Vibrio shiloi is the Etiological (Causative) Agent of *Oculina patagonica* Bleaching: General Implications

"Exactness cannot be established in the arguments unless it is first introduced into the definitions"
Henri Poincare

Studies that we have carried out during the last few years have led us to view coral bleaching as a bacterial disease affected by environmental factors, especially seawater temperature. To appreciate the difference between this viewpoint and the commonly held position that coral bleaching is a result of stress placed upon the coral (e.g., Brown, 1997; **ISRS** Statement on Bleaching, **Reef Encounter**, 24 Dec. 1998), it is necessary to understand the differences between "cause and causative agent" and between "infection and disease". The consequences of considering coral bleaching as a bacterial disease are

fundamental to the design and interpretations of experiments and may lead in the future to methods for controlling coral bleaching.

In microbiology, the *causative agent* of a disease is demonstrated by applying Koch's postulates:

1. The microorganism must be present in every case of the disease.
2. The microorganism must be isolated from the diseased host and grown in pure culture.
3. The same disease must be reproduced when a pure culture of the microorganism is inoculated into a susceptible healthy host.
4. The microorganism must then be recovered from the experimentally infected host.

It is important to keep in mind that certain pathogens have the capacity to cause disease only in a host under special conditions that favor the microbe. Many diseases, e.g., the flu, occur in the winter when conditions favor the infectious agent, but the etiological agent of the disease is the microorganism, not the winter. In the case of coral bleaching, increased seawater temperature can "cause" or "trigger" bleaching by inducing the microbe to be more virulent or the host more susceptible.

Disease and infection are not synonymous. Disease is defined as a process resulting in tissue damage or alteration of function, producing visible physiological or microscopic symptoms. Infection is the invasion of tissues (including skin or surface mucous) by microorganisms with or without producing disease. Our research shows coral bleaching in *Oculina patagonica* to be a disease, and it should be referred to as such.

Our research shows coral bleaching in *Oculina patagonica* to be a disease, and it should be referred to as such.

Applying Koch's postulates, it has been demonstrated that *Vibrio shiloi* is the causative agent of the coral bleaching disease of *Oculina patagonica* (Kushmaro *et al*., 1996; 1997; 1998). Furthermore, the disease is blocked by antibiotics. Elevated seawater temperature is a critical environmental factor for this bacterial disease. From 16–20°C the disease does not occur even when a large number of the pathogens are applied to the coral, whereas from 25–30°C (summer seawater temperatures off the Mediterranean coast of Israel) even a few *V. shiloi* can cause the disease. The increased temperature without the bacteria is insufficient to cause bleaching because antibiotics prevent the bleaching even at elevated seawater temperatures. The first step in the infectious process is the adhesion of *V. shiloi* to *O. patagonica* via a β-galactoside receptor on the coral surface (Toren *et al*., 1998). The bacterial adhesin that recognizes this receptor is not produced at low temperature. Thus, the elevated seawater temperature triggers the production of the bacterial adhesin and allows infection to proceed. In essence, the elevated seawater temperature causes the bacterium to become virulent.

Two key questions are: (a) What is the mechanism of *O. patagonica* bleaching, i.e., how does the bacterium cause the loss of the algae? (b) How general is the phenomenon, i.e., are bacterial pathogens responsible for bleaching other corals in other parts of the world? Progress has been made in answering the first question. After adhesion to the coral surface, *V. shiloi* penetrates into the coral tissues and produces toxins which can inhibit photosynthesis, bleach and lyse the algae (Rosenberg *et. al*., 1998; Ben-Haim *et. al.,* 1999). These toxins are currently being isolated, chemically characterized and their mode of action studied.

Although there is no direct data for or against bacteria being the etiological agent of bleaching any corals other than *O. patagonica*, the following circumstantial evidence suggests to us that bacterial bleaching of corals maybe widespread. First, the pattern of *O. patagonica* bleaching closely resembles coral bleaching in other parts of the world in patchiness and spreading nature, loss of pigments and endosymbiotic zooxanthellae and reversibility when temperature drops. By analogy with well-known animal and plant diseases, identical symptoms often suggest similar pathogens. Second, the frequently observed patchiness and spreading nature of coral bleaching is more typical of an infectious agent rather than a stress phenomenon. One would expect adjacent corals in the sea to be exposed to the same conditions.

Are bacterial pathogens responsible for bleaching other corals in other parts of the world?

Currently, we are trying to isolate coral bleaching bacteria from bleached corals in different parts of the world. Again, by analogy with other animal and plant diseases, one would expect each coral

pathogen to be species specific. We would like to encourage coral biologists (either by themselves or in collaboration with microbiologists) to attempt to isolate coral pathogens from bleached corals that they are studying. We recommend TBS agar (Difco) for primary isolation of *Vibrio*. To test the pathogenicity of the isolates, it is important to use healthy corals of the same species from which the potential pathogens were isolated, and elevated seawater temperatures.

References

Ben-Haim Y, Banin E, Loya Y, Rosenberg E (1999) Inhibition of photosynthesis and bleaching of zooxanthellae by the coral pathogen *Vibrio shiloi*. Environ. Microbiol. (in press)

Brown, BE (1997) Coral bleaching: causes and consequences. Coral Reefs 16: Suppl. S129-S138.

Kushmaro A, Ben-Haim Y, Fine M, Rosenberg E, Loya Y (1998) Effect of temperature on bleaching of the coral *Oculina patagonica* by *Vibrio* AK-1. Mar. Ecol. Progr. Ser. 171: 131-137.

Kushmaro A, Loya Y, Fine M, Rosenberg E (1996) Bacterial infection causes bleaching of the coral *Oculina patagonica*. Nature 380: 396

Kushmaro A., Rosenberg E, Fine M, Loya Y (1997) Bleaching of the coral *Oculina patagonica* by *Vibrio* AK-1. Mar. Ecol. Progr. Ser. 147: 159-165.

Rosenberg E, Ben-Haim Y, Toren A, Banin U, Kushmaro A, Fine M, Loya Y (1998) Effect of temperature on bacterial bleaching of corals. In: Microbial Ecology & Infectious Disease. E. Rosenberg (ed) ASM Press 242-254.

Toren A, Laundau L, Kushmaro A, Loya Y, Rosenberg E (1998) Effect of temperature on the adhesion of *Vibrio* AK-1 to *Oculina patagonica* and coral bleaching. Appl. Environ. Microbiol. 64: 1379-1384.

Eugene Rosenberg and Yossi Loya, Departments of Molecular Microbiology & Biotechnology and Zoology Tel Aviv University, Ramat Aviv, Israel 69978 Email: <eueqene@post.tau.ac.il>

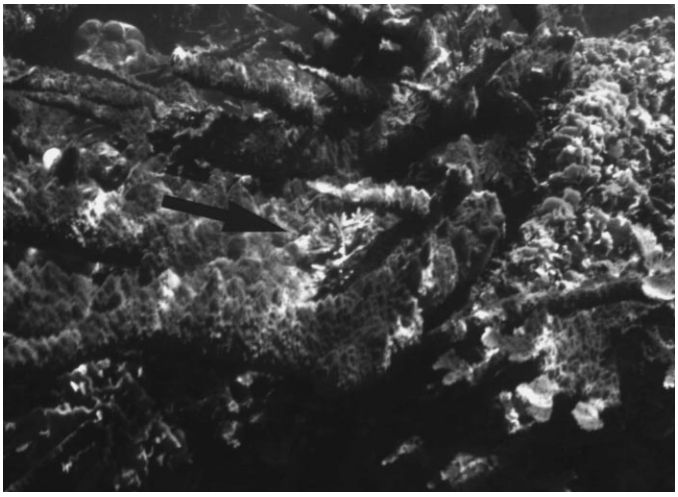
How Many Species of *Acropora* in the Caribbean?

In the Caribbean there are three described species of *Acropora*: the elkhorn coral *A. palmata*, the staghorn coral *A. cervicornis*, and the rare fused staghorn coral *A. prolifera*. All three species have been constituents of Caribbean coral reefs since the Pliocene (Frost 1977; Budd *et al*. 1994; McNeill *et al*. 1997) and were first described by Lamarck in 1816. A crucial characteristic is their growth potential which is higher than all other Caribbean reef corals. *A. palmata* dominates the high-energy zones of Caribbean reefs in water between zero and five meters depth where it usually forms a breakwater. *A. palmata*, owing to its restricted depth range, has been successfully demonstrated as an indicator of Holocene sea level (Lighty *et al.* 1982). *A. prolifera* also occurs in rather shallow areas of surge, whereas *A. cervicornis* is characteristic of shallow to moderate depths down to 20 m.

A. prolifera growing on *A. palmata* with tissues fusing

Here I report on an occurrence of *A. prolifera* growing on *A. palmata* with tissues fusing (see photos). This occurrence was observed in the shallow fore reef in front of Tobacco Cay, southern Belize Barrier Reef, where *A. palmata*, *Agaricia* spp., and *Millepora* spp. form a high-relief spur and groove system (James *et al.* 1976). There are two possible explanations for this occurrence. First, elkhorn and fused staghorn corals are indeed two species and tissue fusion is possible between these two genotypes. Second, *A. palmata* and *A. prolifera* are morphologies of one species and the described example simply shows the maximal morphological variation within different parts of the same colony. In fact, gel electrophoresis of 12 common species of Caribbean reef corals showed that the *Acropora* spp. were the least readily separable and among the genus, *A. palmata* and *A. prolifera* showed some striking similarities (Ohlhorst 1984).

To my knowledge Bak and Criens (1982) have made the only systematic study on fusion in *Acropora* species in the Caribbean where they experimentally tried to fuse intracolony and intercolony fragments of *A. palmata* and *A. cervicornis*. Interestingly, only



tissues of intracolony fragments fused. Yet, when fusing fragments of different species, *A. palmata* overgrew *A. cervicornis*.

Further information on the fusion of Caribbean *Acropora* species includes observations from various colleagues who observed *A. palmata* and *A. cervicornis* or *A. palmata* and *A. prolifera* intergrowing. I would welcome comments and further observations from other reef scientists on this topic.

References

Bak RPM, Criens SR (1982) Experimental fusion in Atlantic *Acropora* (Scleractinia). Mar. Biol. Letters 3: 67-72.

Budd AF, Stemann TA, Johnson KG (1994) Stratigraphic distribution of genera and species of Neogene to recent Caribbean reef corals. J. Paleont. 68: 951-977.

Frost SH (1977) Miocene to Holocene evolution of Caribbean province reef-building corals. Proc. 3rd Int. Coral Reef Symp. 2: 353-359.

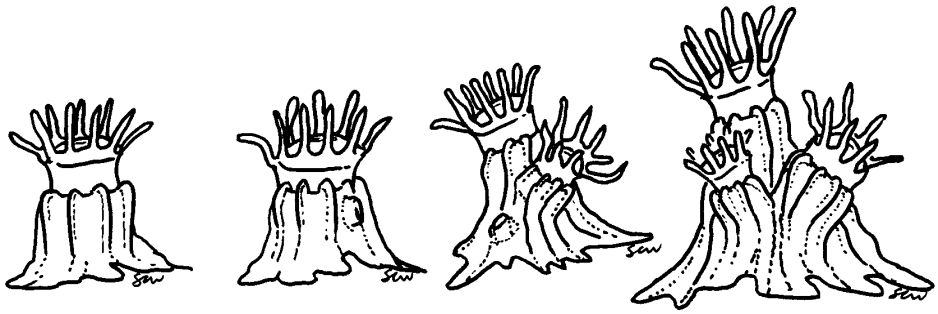
James NP, Ginsburg RN, Marszalek DS, Choquette PW (1976) Facies and fabric specificity of early subsea cements in shallow Belize (British Honduras) reefs. J. Sed. Petrol. 46: 523-544.

Lighty RG, Macintyre IG, Stuckenrath R (1982) *Acropora palmata* reef framework: a reliable indicator of sea level in the western Atlantic for the past 10,000 years. Coral Reefs 1: 125-130.

McNeill D, Budd AF, Borne PF (1997) Earlier (late Pliocene) first appearance of the Caribbean reef-building coral *Acropora palmata*: stratigraphic and evolutionary implications. Geology 25: 891-894.

Ohlhorst SL (1984) The use of polyacrylamide gel electrophoresis in coral taxonomy. Palaeontogr. Amer. 54: 45-48.

Eberhard Gischler, Geologisch-Paläontologisches Institut, Universität Frankfurt am Main, Senckenberganlage 32-34, 60054 Frankfurt am Main, Germany, Tel: 49-69-798 25136, Fax: 49-69-798 22958, Email: <gischler@em.uni-frankfurt.de>



Reefs in Recession: Economic Crisis Affects Remote Indonesian Islands

The economic crisis in Indonesia began in late 1997 and the effects were widespread by early 1998. Hardships were first felt in cities as food disappeared from supermarket shelves. Some experts predicted the crisis would not effect rural areas where food is grown locally, but in the remote Togean Islands, about 24 hours by bus and boat from Palu (capital of Central Sulawesi), economic and political instability has penetrated everyday life, crossing sea boundaries and impacting natural resources.

The Togean Islands occupy approximately 60,000 ha of land and 108,000 ha of sea in Sulawesi's Gulf of Tomini. The remote archipelago is part of the "coral triangle", the area of highest coral diversity, approximately bordered by the Philippines, Indonesia and Oceania/Melanesia. Here, fisheries are extremely productive. The Tomini bay where the Togeans are located hosts some of the country's most productive tuna fisheries. Both national and regional government recognize the importance and high diversity of the Togeans, where many endangered species breed including dugong, hawksbill and green sea turtles. Conservation International recently undertook a Marine Rapid Assessment Program (MRAP) survey, and found high numbers of marine species, some of which may be exclusive to the Togean Islands.

Economic and political instability has penetrated everyday life, crossing sea boundaries and impacting natural resources

Approximately 30,000 people representing six ethnic groups (Togeanese, Bajau, Bobongko, Buginese and Gorontalonese and Javanese transmigrants) inhabit the seven major Togeans Islands. There are 37 villages, each with distinct characters and livelihoods. In some of the villages, such as those of the Bajau, nearly everyone fishes. In other villages, there are very few full time fishers and farming is the main activity, although nearly all Togean Islanders are part time fishers to some extent. A growing number of people are employed in the tourism industry and associated businesses. From 1995 to 1996, visitors to the Togeans increased 150%, reaching approximately 4000 in 1996 (nearly 20% of the visitors to Central Sulawesi). But recently the recession has hit tourism hard. Most tourists (often back-packers) came from Europe. When riots and political instability spread outside the big cities some governments advised their citizens not to travel to Indonesia. Losmen and community guest houses were suddenly empty. Those who had left fishing and farming to become entrepreneurs had no option but to go back to their traditional way of living.

Poverty is the main issue in the Togeans, and 29 out of 37 villages are categorized "poor", meaning average annual per capita income is below Rp. 700,000 (US$ 100). Prices in the Togeans are normally 20% higher than those in the mainland even without recession. Prices gradually increased further from mid 1997, and are thought to have induced bombing and cyanide fishing by local fishers seeking quick cash. When economic crisis really took hold, prices increased by approximately 250%. Although local fishers use cyanide, the driving force behind cyanide fishing remains live fish traders from Hong Kong and the large cities of Indonesia (primarily Ujung Pandang and Jakarta), who have been operating in the Togeans since 1992. By contrast, dynamite fishing is mostly carried out by local fishers for quick cash. Fish caught using bombs are usually salted and sold outside the Togeans for increasingly high prices.

Researchers heard bombing up to 10 times in a day

YABSHI (Yayasan Bina Sains Hayati Indonesia / The Indonesian Foundation for the Advancement of Biological Sciences), a Jakarta based NGO started research in Malenge island in 1990. Surveys in April 1995 and June 1997, suggested that reefs to the north of Malenge were already severely degraded, with hard coral down by about 22% in the later survey. Almost every week in 1997 YABSHI researchers heard bombing on Malenge reefs. Instances increased in

November and December 1998 to 10 times in one day. A researcher in Kabalutan village, one of largest Bajau communities in the Togeans (and one which has often been accused of dynamiting) listed at least 3 factors: socio-psychological, economic, and inadequate law enforcement. The Bajau community, like other fishing communities in Indonesia gain respect through conspicuous consumption. New clothes, boats, and foods are wealth indicators. The economic crisis made it hard to meet even basic needs, but weak law enforcement in the Togean provides opportunities to make money. There has never been a sea patrol to monitor dynamiting or cyanide fishing, and even when several bombers were caught by locals, punishment was not severely enforced to provide an example. The desire for quick cash also impacts the terrestrial ecosystem. Conservation International's recent survey investigated people's livelihoods. Some community groups confessed they had opened up more forest lands for crop plantation, mostly cacao and cloves which are increasing in price. Forest just behind YABSHI's research station in Malenge island (home to many endemic terrestrial species) has been cleared for the same reasons. Sedimentation from logging activities also affects reefs in this interdependent system. Conserving the forest habitat is as much a priority for Conservation International's program in the Togeans as are the islands' marine environments.

P. Surjadi, Conservation International, Haji Samali 51, Pejaten Barat, Jakarta 12510, Indonesia Email <CI-indonesia@Conservation.org>; C. Hutabarat & K. Anwar The Indonesian Foundation for the Advancement of Biological Sciences (YABSHI), Tanah Baru 98, Depok 16421 Jawa Barat, Indonesia. Email: <yabshi@jkt.mega.net.id>

Maps for Colombian Reefs

Coral reefs and associated environments in the Colombian Caribbean occupy approximately 1125 km^2. Three main areas are: (a) the mainland coast with fringing reefs along rocky shores, (b) offshore reefs on the continental shelf, and (c) oceanic reefs on the lower Nicaraguan Rise, around 700 km off the Colombian continental coast. Morphological, biological, ecological, and environmental information for most of these reef areas is fragmentary or lacking, but a five-year baseline study, started in 1994, is now producing results. Data provide general descriptions, inventories of characteristic biota, ecological and geomorphologic zoning, habitat mapping, and assessments of coral health. The program operates under the auspices of INVEMAR with the cooperation of biologists and geologists from the Universidad Nacional de Colombia and the University of Bern, Switzerland. Studies involve undergraduate and postgraduate students from several Colombian universities. A total of 14 reef areas out of 18 have been surveyed since 1994. Seven oceanic reefs (two reef complexes and five atolls or pseudo-atolls), five offshore reefs on the continental shelf, and two mainland coast areas have been investigated. Preliminary geomorphological and ecological (habitat) maps were produced from aerial photography available at the Colombian Geographical Institute. However, dates of photographs ranged from 1944 to 1991, and quality varied with cloud cover, sea state, sun angle as well as blobs and smudges. More detailed complementary information was obtained from aerial color slides taken from a chartered aircraft at altitudes of 200 to 600m. Information has been digitized directly into a Geographic Information System for storing and processing. Topographic, morphological and habitat maps have been generated and used to guide field studies of bottom types, depth, distribution and relative cover of dominant sessile biota.

Information has been digitized directly into a geographic information system

Final thematic maps (topography, geomorphology, bottom habitats, living and dead coral cover) were produced using standardized criteria for habitat classifications. The maps will be arranged in a comprehensive atlas of the coral reef areas of Colombia, which should go to press this year. Such an atlas will be a useful tool for both environmental managers and scientists.

Juan M. Díaz, Instituto de Investigaciones Marinas y Costeras, INVEMAR, A.A. 1016, Santa Marta, Colombia. Email: <jmdiaz@invemar.org.co>

SIMAC: A New Program to Monitor Coral Reef Condition in Colombia

Considerable coral reef decline has occurred in Colombia throughout the last two decades, both in the Pacific and the Caribbean coasts (for example see Garzón-Ferreira and Kielman 1994; Zea *et al* 1998). But without a broad monitoring program, the reef degradation processes have not been well documented and their causes are poorly understood. Long term studies in Colombia only began in 1992, when INVEMAR, a marine research institution, joined the CARICOMP program and implemented a permanent monitoring site on the Caribbean coast. Since then, water quality and bottom community measurements have been taken without interruption at two stations in Chengue bay.

With the aim of developing an expanded nationwide program for Colombia, INVEMAR prepared a monitoring proposal with the support of several other Colombian institutions (CORALINA, CEINER, Universidad del Valle, and Universidad Nacional). The Colombian science funding institution (COLCIENCIAS) approved financial aid at the end of 1997. Later, the United Nations Environment Program (UNEP-RCU/CAR) joined this initiative, providing additional funds.

Monitoring was immediately expanded to four important reef sites

Initial Efforts

Although an optimal monitoring system was still being designed, monitoring was immediately expanded to four important reef sites (Chengue bay, 11°20' N 074°08' W; Rosario islands 11°11' N 075°48' W; and San Andrés island 12°32' N 081°43' W all in the Caribbean, and Gorgona island 2°58'10" N 078°11'05" W in the Pacific) in a two year basic program. We adopted a sampling protocol based on the CARICOMP Level 1 methodology (CARICOMP 1994). Measurements of water quality, yearly surveys of benthic reef cover, coral disease incidence, fish diversity and abundance were undertaken. The water quality protocol includes at least weekly measurements of surface temperature and salinity, and transparency of the water column, as well as a continuously recording bottom temperature logger. In Chengue bay, (near our laboratory facility), we take weekly measurements of chlorophyll, suspended solids and nutrients in surface waters, as well as sedimentation rates at the reef bottom. Benthic cover and coral disease is estimated on permanent transects distributed at three depth levels (3–6, 9–12 and 15–19 m). Fish communities are monitored using methods similar to the AGRA program (Ginsburg 1998), including two types of visual censuses: a rover diver census to estimate fish species richness and a belt transect to estimate abundance of selected important species.

SIMAC hopes to develop community level monitoring

Designing SIMAC

Meantime, we reviewed reef monitoring programs around the world to help design a national reef monitoring system for Colombia (SIMAC: Sistema Nacional de Monitoreo de Arrecifes Coralinos en Colombia). At the end of a three day workshop in Santa Marta (October 1998) a protocol was agreed, similar to Level 1 CARICOMP monitoring, but with additional surveys for important mobile invertebrates, like lobsters, conch, octopuses, crabs and urchins. We tried to get international participation at the workshop by inviting reef scientists from other countries, but only one foreign scientist and 27 people from Colombia attended. The results and conclusions of the workshop have been compiled in a written report which will be distributed soon. The SIMAC has already promoted Reef Check during 1998 and hopes to develop community level monitoring to help educate the public about the values and problems of coral reefs. Colombia also recently joined the Global Coral Reef Monitoring Network (GCRMN).

We are planning a second workshop in August 1999, in Santa Marta to review the protocol and select strategies for maintaining and developing the SIMAC. Participants will come from Colombian institutions which manage and protect coral reef areas, as well as from research and funding agencies. We hope to obtain a clear promise of collaboration from all interested institutions. Based on the

results of both SIMAC workshops, on the experience from CARICOMP Level 1 monitoring, and on some international assessment obtained through workshops, conferences, the internet and expert advice, we will prepare a final proposal including an optimal monitoring structure and a strategic development plan for SIMAC. A database for SIMAC will be developed at INVEMAR with the technical support from the National System of Marine Environmental Information of Colombia. The SIMAC database structure will be compatible with other international databases like CARICOMP and ReefBase.

REFERENCES

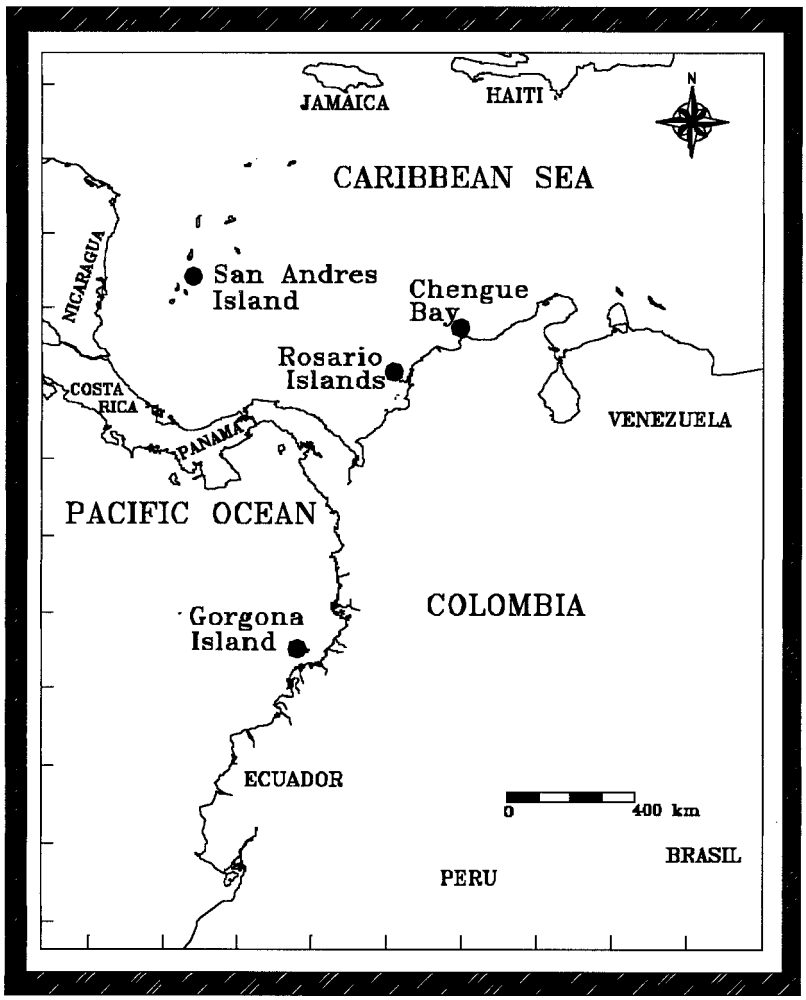
CARICOMP (1994) CARICOMP methods manual, Level 1. Centre for Marine Studies, Univ. West Indies, Kingston: 54 p.

Garzón-Ferreira J, Kielman M (1994) Extensive mortality of corals in the Colombian Caribbean during the last two decades. Proc. Colloq. Global Aspects Coral Reefs, Univ. Miami, U.S.A.: 247-253.

Ginsburg R (1998) Atlantic and Gulf Reef Assessment (AGRA). Revised rapid assessment protocol (RAP). RSMAS, Univ. Miami (or http://coral.aoml.noaa.gov/agra/).

Zea S, Geister J, Garzón-Ferreira J, Díaz JM (1998) Biotic changes in the reef complex of San Andrés Island (Southwestern Caribbean Sea, Colombia) occurring over nearly three decades. Atoll Research Bulletin 456: 1-30.

Further information from Jaime Garzón-Ferreira, SIMAC Project Leader, Instituto de Investigaciones Marinas y Costeras (INVEMAR), A.A. 1016, Santa Marta, Colombia.
Tel: (575) 4214774. Fax (575) 421377.
Email: <jgarzon@invemar.org.co>



Shoals of Capricorn Programme Underway in Republic of Seychelles

November 1998 saw the commencement of field operations for the Royal Geographical Society (with the Institute of British Geographers and in collaboration with the Royal Society) *Shoals of Capricorn Programme* in the Republic of Seychelles. A nineteen-member multidisciplinary team of marine scientists formed the Seychelles Baseline Project (SBP) for a one month expedition.

Based primarily at the Shoals field station on Ste. Anne Island, the team conducted various tasks including side-scan sonar surveys, investigations of the extent of coral bleaching, as well as benthic and fish community dynamics. Samples of zoanthids were also collected widely for population genetic studies. Permanent monitoring stations were established at four sites on Ste. Anne, Praslin, Curieuse and Cerf Islands. A tide gauge and current meter were deployed at Ste. Anne and will continue to log data under the care of the Marine Parks Authority (MPA) and Shoals permanent field staff.

It became immediately obvious that the reported large-scale coral bleaching across the Indian Ocean (Wilkinson 1998) had caused massive mortality. Most reefs were extensively colonized by filamentous and coralline algae, suggesting that mortality occurred in the first half of 1998. This relates well to information from local diving operators who first noticed the coral 'turning white' at the very end of 1997. Apparently they were pleased at first because the snowy white *Acropora* looked so pretty!

Dive operators were pleased at first because the snowy white *Acropora* looked so pretty!

By the time the SBP team arrived, there were few areas of living *Acropora*, healthy or bleached. Live coral cover was estimated to have fallen by 50-95% and surviving corals were predominantly massive *Porites* and *Goniastrea* species. Repeat visits by SBP team members and routine monitoring by Shoals and MPA staff will study the recovery process at the four permanent sites.

In March 1999, a four-member *Shoals* team conducted further biological surveys of the outer Seychelles aboard *Thalassi*, revisiting sites of the 1998 *Southern Seychelles Atoll Research Programme*. Effects of bleaching on coral mortality, algal overgrowth and animal communities were assessed for reefs on Cöetivy, Alphonse and St. Pierre. The team made similar observations to the SBP, but were encouraged by the number of coral recruits observed and by the partial recovery of previously bleached massive species. Together with the intact reef architecture and apparently unaffected fish communities, these observations suggest grounds for cautious optimism if the present trend of recovery is maintained.

Grounds for cautious optimism if the present trend of recovery is maintained

In addition to the scientific programs of both expeditions, the *Shoals* Darwin Initiative training objectives were achieved during practical seminars held for staff from the Seychelles Natural History Museum and MPA. Various skills were covered including monitoring methods, taxonomy, sample preparation and habitat mapping. Local training is an important facet of the Shoals ethos, which seeks to promote ongoing, locally-run science, monitoring and education efforts after the initial phase winds up in 2001.

The *Shoals of Capricorn Programme* now has field stations in Seychelles, Mauritius and Rodrigues. The success of these stations and of the SBP and *Thalassi* expeditions owes much to generous local support and funding provided by the Royal Society and the Darwin Initiative.

Further details of Shoals, and information on how to participate, can be obtained from http://www.rgs.org/ex/5expesho.html or the Director, Iain Watt, Email: <shoals@rgs.org>.

Reference:

C. Wilkinson (1998). Status of coral reefs of the world: 1998. Australian Institute for Marine Science, Townsville.

Bill Burnett, Department of Marine Science and Coastal Management,
University of Newcastle upon Tyne,
Newcastle NE1 7RU,
Email: <W.J.Burnett@newcastle.ac.uk>: and
Kristian Teleki, Email: <kat1003@cus.cam.ac.uk>

GBR Research News Updates on Web

Access to research on Australia's Great Barrier Reef World Heritage Area has been made easier following the launch of an information service on the Internet. Regular news updates on the current state of research about corals, dugongs, seagrass, coastal sediment, fishing and bleaching is now available as a free service for anyone with Internet access and an email address.

The Great Barrier Reef Cooperative Research Centre recently launched the service on its popular website, increasing public access to contemporary coral reef research, education and training programs to Australia and the world. The news service was launched to 270 international delegates attending the International Tropical Marine Ecosystems Management Symposium in Townsville last November.

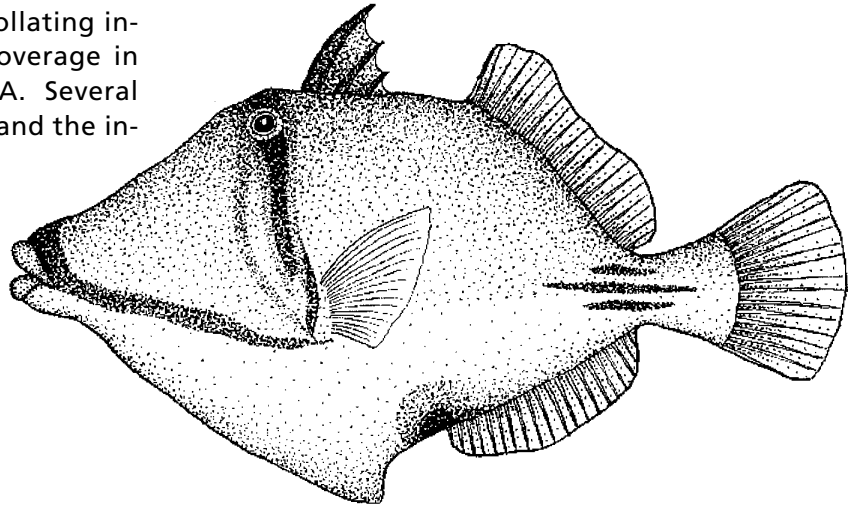
Mr. Simon Woodley, Director of the Centre, said that 'CRC Reef Research Centre Online' adds a new dimension to the growing number of marine environment and science websites published on the Internet. "It's a much faster way for reef researchers to communicate their news and scientific progress—such as coral bleaching updates—to interested politicians, students, colleagues, reef user groups and the media."

Subscribe to the free news service at www.gbrmpa.gov.au/~crcreef in the news section.
For further information contact: Don Alcock,
CRC Reef Research Centre,
Tel: + 43 (07) 4781 5247 Fax: + 43 (07) 4781 4099
Email:<don.alcock@jcu.edu.au>
Web: http://www.gbrmpa.gov.au/~crcreef

LANDSAT Launched

The Landsat-7 spacecraft, carrying the Enhanced Thematic Mapper (ETM+) sensor, was launched April 15, from Vandenberg airforce base in California. The ETM+ is capable of collecting multispectral 30 m pixel images and also has a 15 m panchromatic band. Frank Muller-Karger and the Landsat Science Team are planning to collect data over major coral reefs as part of the Long-Term Acquisition Plan for the ETM+ data. Interested investigators, particularly those with active field programs in coral reefs, are invited to email a brief description of their research objectives, dates of field programs, and long-term requirements for remote sensing data to see if Landsat can provide coverage. The team is collating information on the need for coral reef coverage in order to draft a set of priorities for NASA. Several test images have already been collected and the in-flight calibration process has been started. It looks like a healthy system operating up there!

Contact Frank Muller-Karger,
Remote Sensing/Biological Oceanography,
Department of Marine Science,
University of South Florida, 1407th Ave. South,
St. Petersburg, FL 33701
Tel: (727) 553-3335 / (727) 553-1186
Fax: (727) 553-1103
Email: <carib@carbon.marine.usf.edu>
Web page ht.//paria.marine.usf.edu



Paper Parks—Worse Than Useless or a Valuable First Step?

Marine protected areas (MPAs) are a necessity for effective conservation, and an increasingly popular management tool. But when new sites are designated, politicians and managers often forget the lesson they should have learnt from many of the earliest parks: that effective enforcement is essential in order to reap benefits for conservation or fisheries enhancement. Too often, MPA's are set up without the means to enforce their own rules. More commonly, protected areas simply lack appropriate regulations. In both cases the result is a park on paper but not in practice. So should conservationists push for protected area status, or wait until management guidelines are in place?

A park on paper but not in practice…

Why Paper Parks?

In many cases, legislation is not in place to support protected areas. For example in Puerto Rico, there is nothing in the legislative framework which can be used to designate a 'no take zone'. At the moment, the best conservationists can do is push for a 'natural reserve' but without exploitation restrictions. For the last two years an administrative order which would prohibit fishing and hence effectively create a protected area in Culebra, Puerto Rico, has been sitting on the desk of the Secretary for the Department of Natural and Environmental Resources, awaiting a signature. This is despite strong public support for the measure. Similarly, in the Dominican Republic there is currently no ministry with responsibility for the environment, so conservation misses out on the top level governmental negotiations and treaties.

Frequently, the political will to enforce protection doesn't exist; or lack of local involvement means regulations are unenforceable. The Horseshoe Reef off Anegada in the British Virgin Islands was designated a no fishing zone, but almost immediately the Chief Minister bowed to public pressure and issued fishing permits to his Anegadian constituents. In other cases, designating a marine protected area or tightening regulations is a long process, going through several changes of ministers, each time setting the process back to square one. Often, the root cause of poor political will is poor public support. Managers around the world tell stories of threats and harassment. Lack of local support and involvement makes enforcement very difficult even for countries that can afford policing. The USA enforcement authorities estimated three million dollars set up costs to effectively police the proposed Tortugas Ecological Reserve in the Florida Keys, with a further 1.1 million a year running costs. Governments, particularly in small island states, take a lot of convincing that without securing a long term funding source for enforcement, education and maintenance they will lose out on tourist income as well as shore protection and the food supply that their reefs provide.

Worse Than Useless?

So are paper parks just ineffective, or does poor enforcement actually make matters worse? Having an area recognized on paper can give a false sense of security to policy makers. The Parque Marino Isla Bastimentos in Bocas del Toro, Panama was declared to protect coral reefs. Ten years later a survey showed there were almost no corals, soft corals or sponges there. Many of the sites protected under the United States Marine Sanctuary Program have been criticized as paper parks. It's said that the only new regulation in the Monterary Sanctuary was to prohibit research without a permit! In California, only 0.14% of the combined area of 104 MPAs is set aside as 'no take' (where all fishing and extraction is banned). Similarly, in Western Australia MPAs are open to recreational and commercial fishing and some level of oil exploration. Only a small area within these parks (usually less then 10%) is a 'no take' zone, whereas all terrestrial parks are protected from exploitation. Many protected areas (including marine parks on the Kenyan coast) attract visitors just because of their designation. More visitors means more pressure on fragile ecosystems, some-

times destroying the very environment which was supposedly protected. A common aim of MPAs is to enhance nearby fisheries, but a very little poaching (recreational or commercial) can wipe out potential benefits, leading to loss of local support. Protected areas can also exacerbate conflicts. Early attempts to set up MPAs in St. Lucia (Eastern Caribbean) failed because fishers saw MPA's as playgrounds for tourists created at the expense of local people. Ironically, well-managed protected areas are often touted as a means of conflict resolution, where zoning schemes can separate antagonistic activities (Australia's Great Barrier Reef is the classic example).

Any protected area, no matter how well defended, is a paper park if its defenses fail to address the most significant threats.

Any protected area, no matter how well defended, is a paper park if its defenses fail to address the most significant threats. Patrolling to prevent poaching won't stop reef degradation from land based sediment plumes or nutrient enrichment. Protected reefs without tourist education, mooring buoys and a policing program with real teeth simply serve the tourism dollar in the short term. And without local cooperation, particularly from fishers, many protected area regulations are unenforceable. Protecting a resource may even 'flag' it for potential poachers. Researchers mapping grouper spawning grounds in the Bahamas for possible inclusion within protected areas worry that unless education and enforcement go hand in hand with legislation, identifying the spawning grounds will be their downfall.

A Useful First Step?
From Paper to Practice

On the other hand, protected areas are difficult to set up from scratch, particularly the 'no take' areas that reef conservation desperately needs. Advocates have to start somewhere. If lack of enforcement means getting designations is relatively easy, at least all potential MPAs can be listed. Priorities can be shuffled later. Protected areas, even on paper can act as a rallying point for further action. And where the main threats are external, such as sedimentation, their very failure can be a tool pressing for better upstream management.

Protection often evolves over time

More importantly, protection often evolves over time to a higher level. An excellent terrestrial example is Yellowstone National Park in the United States, widely considered the crown jewel of the National Park System, but which did not restrict hunting, felling or other exploitation for the first 30 years after creation. For a marine example, consider the Exuma Land and Sea Park, established in the Bahamas during the 1950s. Protection was added gradually, going from no restrictions to 'no take'. In this case, legislation had local backing, as demonstrated by one elderly lady who gave chase to anglers in the days before patrols by uniformed rangers. Similarly, it has been a battle to get 'no take' zones established within the Florida Keys National Marine Sanctuary, USA (see **Bookshelf**). The originally proposed six percent was whittled away to a mere 0.5, but even that is a step in the right direction. On the north coast of Jamaica, the Montego Bay marine park was established in 1974, but didn't get offices until 1989. Full legal recognition came in 1992, with a spear fishing ban and the installation of mooring buoys in 1993. All the same, there's a long way to go. A fishing ban hardly addresses the major problem of eutrophication from the nearby coastal developments. On a cynical note, paper parks, which are gazetted but fail through lack of management, at least document that failure. They may help lead to a change in approach and counter the oft-heard complaint: "but you didn't work through the system".

Paperless Parks

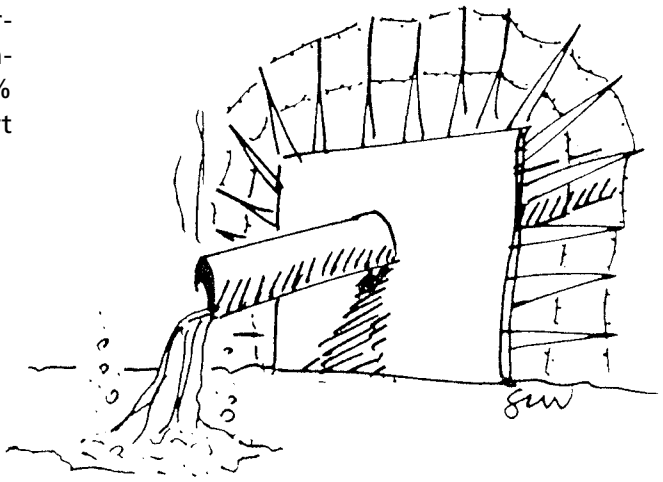
If an area is special it should be declared. If unmanaged parks attract increasing user pressure, why not spread that pressure with more designated areas? If enough people agree an area is special, you may even end up with a rare 'paperless park' by default. The Curaçao Underwater Park (Netherlands Antilles) does not exist on paper, but is in effect subsidized by government, through support for a NGO which manages the area. Legislation was drafted but never finalized, and if the area has any legal foundation, it is only in customary law. Park staff implement Curaçao's rudimentary regulations on coral harvesting and spear fishing. Ironically, local people now think these legal prohibitions only apply in the paperless park since that's the only area where they are enforced. In other places, there are some encouraging

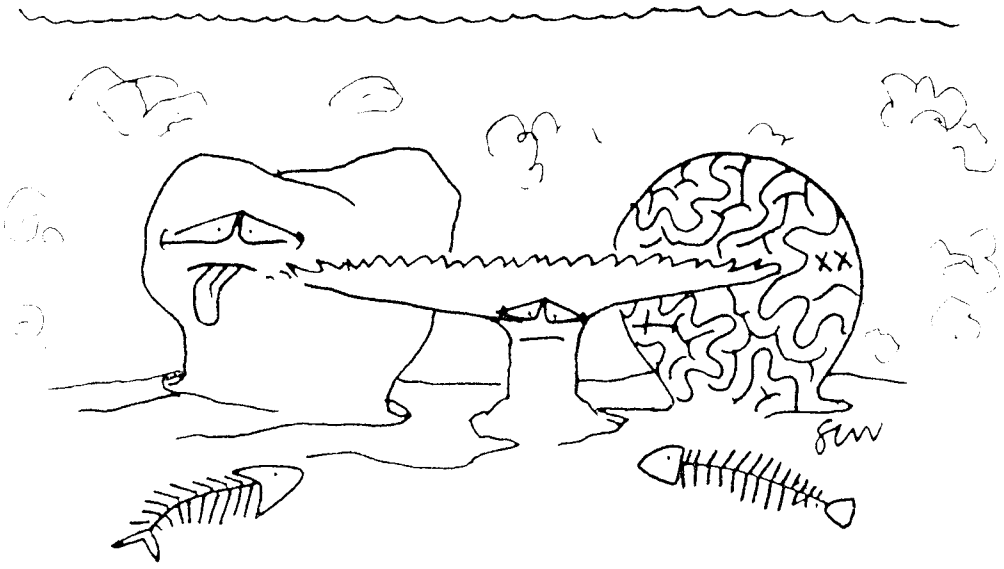
signs. In Culebra, Puerto Rico fishermen have been pushing the government for a restricted area since 1980 because they believe it would bring benefits. Virtually all the local eco-tour businesses have also backed the idea, as have the last two local municipal administrations from different parties. Similarly, at Discovery bay on the north coast of Jamaica, fishermen recently asked for a meeting to discuss extending the existing voluntary reserve.

Protected areas need a strong rational for designation (usually high biodiversity or potential fisheries enhancement), a legal framework and effective management. Encouraging policy makers to designated parks without deciding on a proper management strategy is unrealistic and usually counterproductive. Conversely, protection has often evolved without much scientific basis, and as the science of management improves, the process may accelerate. Perhaps most importantly, conservation is a slow battle. Marine protected areas, including paper parks, only cover approximately 0.5% percent of the world's oceans. Managers must start with what's available.

Maggie Watson,
Email <habari@candwbvi.net> or
<iclarm@candwbvi.net>

The question, Paper parks, worse than useless or a valuable first step?' was raised at the IUCN sponsored workshop on Marine Protected Areas, held in St. Croix, US Virgin Islands, November 1998. The following people contributed ideas and information either through comments at the workshop, email discussions or published work (errors remain the responsibility of the compiler): Jim Bohnsack, Craig Dahlgren, Lloyd Gardner, Hector Guzman, Lorna Innis, Les Kaufman, Mary Ann Lucking, Mike Mascia, D. McArdle, Malden Miller, Gray Multer, John Ogden, Laurie Jeanne Raymundo, Tony Rouphael, Riviere Sebastien, Jeff Sybesma.





High Sea Temperatures Along the Coast of Abu Dhabi (UAE), Arabian Gulf—Their Impact Upon Corals and Macroalgae

Introduction

During 1997 and 1998 critical threshold temperatures for corals were exceeded in many parts of the tropics resulting in coral bleaching followed by appreciable mortality. There is a strong correlation between such episodes of coral bleaching and sea surface temperature anomalies ('hotspots'). The Indian Ocean has been one of the most severely affected tropical regions (see Strong *et al.* 1998) with the seasonal maximal sea-surface temperatures (SST) exceeded for prolonged periods in many areas. The coral reefs of the Arabian Gulf have undergone similar catastrophic bleaching and two major episodes have been observed during a long-term research program on the marine biotopes of Abu Dhabi, sponsored by the Abu Dhabi Company for Onshore Oil Operations (ADCO).

Many corals are almost at the edge of their ecological range.

Corals along the Abu Dhabi coastline occur as a veneer on pre-Cretaceous limestone, sandstone or on 'fasht' and their growth is insufficient for appreciable coral accretion. In this coastal region, conditions are harsh and many corals are almost at the edge of their ecological range. Often the SST (18-35°C) and salinity (40-55 ppt) are close to or exceed the tolerance limits of such corals in most other parts of the tropics. Coral diversity in the southern Arabian Gulf is low (ca. 50 hermatypic species) and it is assumed they have acclimated to the temperature extremes to be found in the region (see Coles 1988). In 1996 and 1998 there were widespread coral bleaching episodes along the Abu Dhabi coast and these correlated with SST anomaly conditions, the first episode being less severe than the second.

SST remained at 34(C or above for almost 14 weeks

Coral Bleaching and Death

The first phase of coral bleaching affected several species of *Acropora*, one of which (cf. *A. horrida*) formed thickets over large areas of shallow offshore platform until a SST anomaly took place between July and September 1996 when the sea remained at or above 34°C for 10 weeks (35°C for at least 4 weeks). By March 1997 over 95% of *Acropora* was dead on all reefs examined along the Abu Dhabi coast. Dead branches remained *in situ* or were beginning to disintegrate on some more exposed reefs where mounds of *Acropora* debris formed. An orange/red sponge (as yet unidentified) bored into many branches, making them very brittle and leading to the breakage and eventual collapse of the coral framework that provided refugia for many reef fish.

The second phase of temperature-related bleaching involved the boulder corals (primarily *Porites*, *Platygyra* and faviids) and took place between July and October 1998 when the SST remained at 34°C or above for almost 14 weeks and at 35°C or above for almost 9 of those weeks. The average weekly SST was well above 35°C for 3 consecutive weeks along a significant length of the Abu Dhabi coast. These sea surface temperatures exceeded the mean maximum annual value (over an 18 year period excluding 1996) by at least 1°C. This episode was more severe than the one encountered in 1996 in terms of both maximum sea temperature and duration. During the 1996 SST anomaly the boulder corals suffered only a relatively small amount of damage. It was estimated that by March 1997 less than 10% of the surface area of such corals were overgrown by well-established mats or turfs of algae. The second episode bleached 80-95% of coral on all reefs examined in October 1998. Boulder corals will remain *in situ* for some considerable time following their death unlike the *Acropora* skeletons that disintergrate in a relatively short period. The same seasonal succession of macroalgae observed on the dead acroporids also takes place on the dead boulder corals.

Coral Recovery

Although the majority of the acroporids (95-100%) apparently died following bleaching in 1996 there were some signs of regeneration in 1997

when sea temperatures did not rise above the seasonal norm. The recovery was severely set back by the STT anomaly of 1998 although a few isolated clumps of live *Acropora* were observed in April 1999. As of now the recovery of the acroporids is very limited with no more than two or three regenerating individuals or new colonies observed in areas of 100 m^2 or more of old Acropora-dominated reef.

The boulder corals have not been so severely affected as the acroporids. Despite suffering 70-80% bleaching during the SST anomaly of 1998 there has been reasonable recovery. Surveys in April 1999 estimated 20-30% of the surface area of boulder corals had died on reefs lying to the east of Abu Dhabi City. Often recovery is very patchy with adjacent areas either completely recovered or dead whereas nearby boulder corals are only partially damaged. Reefs examined to the west of Abu Dhabi city were worse affected, showing a greater proportion of dead boulder coral (50-60%) in April 1999 than those to the east. This was not entirely unexpected since sea temperatures are generally higher for longer time periods of the summer in the western region of Abu Dhabi.

Before the 1996 episode of temperature-related coral bleaching and death, acroporids and boulder corals dominated shallow rocky offshore platforms. Most macroalgae were confined to the shallows where coral cover was low with many of the more conspicuous brown algae disappearing during months (usually July-October) when the sea temperature was 32°C and above. The most noticeable change to take place immediately following the death of *Acropora* was its rapid over-growth by mat and turf-forming red algae. These algae readily entrap silt particles and probably account for the siltation of reefs reported by divers. By March 1997 clumps of grazing-resistant fleshy macroalgae developed on these branches (e.g., *Lobophora variegata, Colpomenia sinuosa, Laurencia* spp.), together with crustose coralline red algae (principally *Lithophyllum kotschyanum*), as well as encrusting invertebrates (principally sponges, hydroids, bryozoans and tunicates). Algae also grew on newly exposed primary surfaces left when rough seas swept the dead *Acropora* branches off the rocky platforms.

Many of the reefs of Abu Dhabi are now increasingly dominated by algae

The crustose coralline red algae are gradually becoming more noticeable and now grow over dead *Acropora* in areas where a framework of dead branches persists, or cover shallower areas of platform formerly occupied by acroporids. Many of the most conspicuous macroalgae are distinctly season-

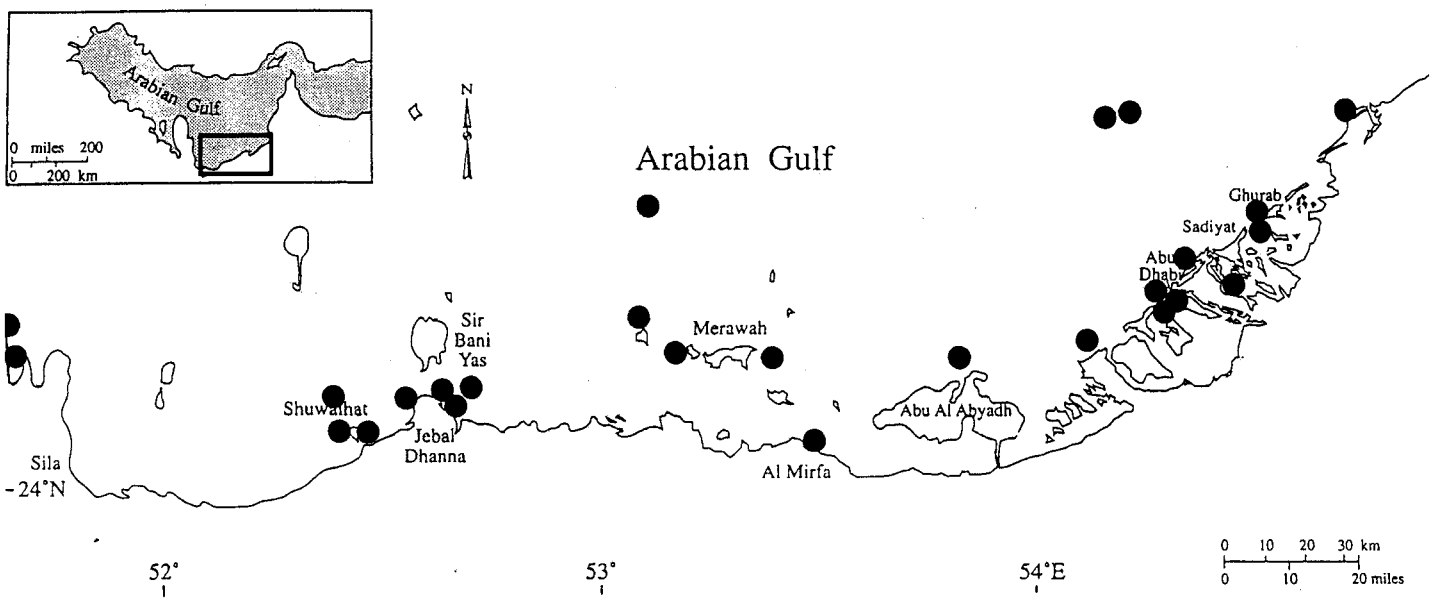


Figure 1. The Abu Dhabi coastline and offshore islands showing position of sites examined where there are areas of recently killed and/or living coral. Insert shows position of the area in relation to the rest of the Arabian Gulf.

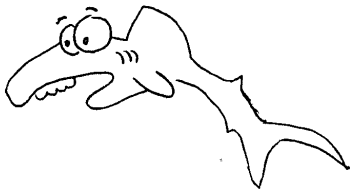
al unlike the majority of mat or turf-forms and crustose coralline algae that persists throughout the year. It is too early to know whether algae will increasingly dominate areas of damaged boulder coral reef, although mat and turf forms have already overgrown dead or damaged parts of boulder corals. The slower growing crustose coralline algae may gradually increase in cover, especially where sea urchins are abundant enough to reduce the cover of other competing algal growth forms significantly.

References

Coles, SL (1988) Limitations on reef coral development in the Arabian Gulf: temperature or algal competition? Proc. 6th Int. Coral Reef Symp. Townsville, Australia 3: 211-216.

Strong AE, Goreau TJ, Hayes RL (1998) Ocean hotspots and coral reef bleaching. January-July 1998. Reef Encounter 24: 20-22.

David George and David John,
Departments of Zoology and Botany,
The Natural History Museum,
Cromwell Road, London SW7 5BD, UK
Email: < D.George@nhm.ac.uk > and
< D.John@nhm.ac.uk >



Compleat Reef Encounter

Entrepreneur Bill Warren last year attempted to sue the government of the United States, hoping to gain permission to exploit guano on the tiny island of Navassa. However, biological surveys have found rare plants and an endangered ground dove as well as a spectacular reef (see **Features**), persuading the Department of the Interior to foil Mr. Warren's plans.

Under the United States' Guano Act of 1856, any uninhabited land containing guano and not under control of another nation may be claimed in the name of the U.S. America staked its claim to Navassa in 1857 and mined until tools were downed in a slave revolt.

Mr. Warren attempted to force the U.S. government to set a purchase price for the island, and became suspicious of the timing of the surveys. The U.S. Department of the Interior and the Center for Marine Conservation declared plans were already well underway when the lawsuit was filed. Warren responded to the results of the survey: "In a way I am kind of happy that they did that because it shows how greedy the government is and ridiculous, caring more about some plants….than people having jobs and good fertilizer for the things we eat".

Abstracted from an article by Andrew Shulman, Washington Times, August 6th 1998.

ISRS Statement on Diseases on Coral Reefs

Diseases of corals and other organisms are having significant, negative impacts on the structure and appearance of coral reefs. On some reefs, the effects of disease have been of a similar magnitude to more familiar disturbances, such as outbreaks of the crown-of-thorns starfish in the Indo-Pacific and coral bleaching associated with elevated sea temperatures. A new scientific awareness of diseases on coral reefs leads to a host of questions about the novelty of recently discovered syndromes, the importance of observed trends toward increasing infection rates, and the extent to which human activities are responsible. This statement, issued by the **International Society for Reef Studies (ISRS)**, summarizes current knowledge on the subject. It was compiled by an ad hoc group of scientists in **ISRS**, composed of individuals who are directly or indirectly considering disease as part of their research programs.

Disease is a natural process that has been poorly studied in the oceans because of its ephemeral nature. Epidemics in animal populations, called epizootics, are a serious threat to the health of coral reefs worldwide. Recent observations of epizootics affecting sea urchins and scleractinian corals show that diseases on reefs can devastate their target populations and act as agents of rapid and dramatic community change. Marine pathologists and microbiologists are attempting to identify the causes of infection, but the pathogens responsible for most diseases affecting reef organisms remain elusive. These difficulties are complicating efforts by scientists and managers to study outbreaks and decide if control measures are warranted. It is becoming clear, however, that human activity is at least partially responsible for disease outbreaks on coral reefs over the past decade.

Diseases on reefs can devastate their target populations and act as agents of rapid and dramatic community change

Pathogens responsible for most diseases affecting reef organisms remain elusive

Corals are colonial invertebrates related to sea anemones. They lay down the limestone foundations of coral reefs, protecting tropical shorelines and providing habitat for the many fish and invertebrate species that feed a substantial proportion of the world's population. Like all living organisms, corals are prone to diseases of various sorts. The incidence of disease on coral reefs may be on the rise, but without historical, baseline data it is difficult to determine if the observed increase is real or simply a reflection of increased research activity. Recent scientific reviews list four to six confirmed coral diseases in the Caribbean region alone; other estimates, based only on observed symptoms, run as high as fifteen. Bacteria, fungi, and cyanobacteria ("blue-green algae") are known to cause diseases in corals. Sick and dying corals are cause for concern, because coral death slows the rate of reef construction. Reefs devastated by disease (or by other causes of coral mortality) may not be able to keep up with sea-level rise, which is naturally slow but may be accelerating due to global warming. And as reefs degrade, fish and other seafood resources decline as well.

a disease carried by ocean currents killed more than 95 percent of the *Diadema* throughout the Caribbean

Three coral diseases—"white-band," "black-band," and "plague" — were first reported in the Caribbean in the 1970s. The first documented, regional-scale epizootic, however, affected the black-spined sea urchin, *Diadema antillarum*. In 1983–84, a disease carried by ocean currents killed more than 95 percent of the *Diadema* throughout the Caribbean. This epizootic clearly demonstrated that diseases can have major impacts on reef ecology. Before its mass mortality, *Diadema* was an important herbivore: it ate fast-

growing fleshy algae (seaweeds), keeping space free for corals to survive and grow. After the urchins died, algae increased dramatically on many Caribbean reefs. They colonized corals that had been killed by hurricanes and by white-band disease.

Although the infective agent of white-band disease remains unknown, there is some evidence that it is bacterial. White-band disease infected populations of staghorn and elkhorn coral (*Acropora cervicornis* and *Acropora palmata)* throughout the Caribbean region in the 1980s and 1990s, inflicting enormous losses. Because *Diadema* also disappeared, seaweeds rapidly colonized the dead coral skeletons, and as a result large areas of Caribbean reefs have been covered with fleshy algae for over a decade. Paleontologists working in Belize recently uncovered evidence that the epizootic of white-band disease is without historical precedent. Staghorn coral has not died off before on a regional basis in at least several thousand years. Staghorn and elkhorn corals are major constructors of reef framework, and their loss could slow the rate of reef growth in the Caribbean.

the epizootic of white-band disease is without historical precedent

Many marine scientists suspect that human activities, such as pollution and changing patterns of land use, promoted the spread of white-band disease in Florida and the Caribbean. There is little evidence for a human connection, however, other than the historical novelty of the outbreak. Eutrophication, the enhanced input of nutrients by humans, may be an important source of stress to reef organisms. Eutrophication may compromise disease resistance, allowing opportunistic infections to take hold and new diseases to emerge. A fungal infection of sea fans appears to provide a link to human activity. The fungus, *Aspergillus sydowii*, has infected large populations of sea fans in the Florida Keys and throughout the Caribbean. *Aspergillus sydowii* is thought to be a land-based fungus that has invaded the marine environment via the sediment in terrestrial runoff.

Aspergillus sydowii is thought to be a land-based fungus that has invaded the marine environment

Reliable information exists for two other diseases: black-band disease and "plague type II." Black-band disease, caused by a consortium of bacteria (including cyanobacteria) attacks and kills massive, head-forming corals. Black-band disease could pose a serious threat to populations of brain corals and star corals, which, like the Acropora species, are important components of reef framework in the Caribbean. Plague type II attacks head corals in Florida, but it has also been observed elsewhere in the Caribbean. In this case, rigorous microbiological work showed that the disease is caused by a single bacterium, a new species of *Sphingomonas*.

Other epizootics are killing corals and many other important species on reefs of the Pacific, Indian and Atlantic Oceans. Black-band disease and white-band disease have now been identified on reefs throughout the tropical Indo-Pacific, including the Red Sea, Mauritius, the Philippines, Papua New Guinea, and the Great Barrier Reef of Australia. In the Arabian Gulf, the newly discovered yellow-band disease is affecting up to 75 percent of the coral colonies in local populations. In addition, diseases of algae, sponges, and fish have been and continue to be identified.

Reefs throughout the world were stressed by unusually high sea temperatures in 1997-98, and the worldwide episode of coral bleaching that resulted may render corals more susceptible to disease. In the Mediterranean, bacterial infections are associated with bleaching, and disease outbreaks have been linked to predation by coral-eating snails in the Red Sea. The causal connections among bleaching, predation, and disease remain obscure, however.

Plague type II is caused by a single bacterium, a new species of *Sphingomonas*

The role of disease on coral reefs and possible interactions with environmental influences should be a research priority over the next several years. Despite the frustrating inability to identify pathogens in most cases, reef scientists have detected symptoms that could represent over a dozen new diseases. Diseases are now recorded as part of standardized reef monitoring programs throughout the world, including the Caribbean Coastal Marine Productivity

(CARICOMP) Program, the worldwide Reef Check, the Atlantic and Gulf Reef Assessment (AGRA) Program, and a variety of government and private programs in Australia.

Because corals grow slowly, live for decades to centuries, and reproduce sporadically, today's epizootics will probably have consequences that reach far into the future. Multidisciplinary efforts, combining microbiology, coral physiology and pathology, ecological monitoring, and paleontology, will be necessary if we are to understand what is happening and devise management strategies in response. The **International Society of Reef Studies** endorses existing government and private funding of multidisciplinary programs to promote research on the changing nature of coral reefs. The Society recognizes the need for an increased level of support if the many threats to reefs worldwide are to be understood and mitigated.

This statement was released to the press and over the Internet on February 4 1999.

The First Oceanographic Expedition to Navassa Island, U.S.A.: Status of Marine Plant and Animal Communities

Navassa Island is one of America's most isolated and hostile island habitats, located approximately in the geographical center of the Caribbean (18° 25' N, 75° 01' W), 300 km from the continental U.S.A. More precisely, Navassa lies about 58 km west of La Hotte Peninsula, Haiti, 142 km east-northeast of Morant Point, Jamaica, and 167 km south of Guantanamo Bay, Cuba. The Island is roughly a right triangle with a surface area of about 5.6 km^2. It rises abruptly from a concentrically triangular, submerged bank (30 m deep at the island and extending about 1 km offshore to 50 m at the outer drop-off) to form a raised, two-tiered terrestrial escarpment (Fig. 1).

… one of America's most isolated and hostile island habitats

The island has no beaches and is isolated from boat traffic by overhanging, 9 to 15 m-high sea cliffs that completely encircle the Island. Behind the sea cliffs is a rather barren, flat to undulating, rocky shelf of pot-holed, but extremely hard, fossilized limestone. Extensive patches of mound-like bushes and trees (*Ficus*) which provide roosting sites for numerous sea birds (including abundant boobies, frigate birds and terns) also characterize this area.

In June 1998 Dr. Michael Smith, Senior Scientist with the Center for Marine Conservation (CMC), contacted our group regarding a proposed expedition to Navassa Island. He initially invited our team

Figure 1. …a raised two-tier terrestrial escarpment

to join a multidisciplinary land-based expedition of eight scientists that would be camping near the center of the Island. After considerable discussion and effort, a concurrent, ship-based, marine biological expedition was organized (funded by CMC and U.S. Department of the Interior) through Dr. Carlos Rodriguez, Director of the Museo Nacional de Historia Natural in Santo Domingo, Dominican Republic. Dr. Rodriguez arranged the local logistics, as well as the charter of the ship *R/V MAGO DE MAR*, thereby launching the first marine expedition to Navassa Island. Accompanying the marine team were Nina Young (CMC coordinator), Ian Griffith (remote operated vehicle (ROV) pilot), Llena Sang (fish specialist from the Dominican Republic) and the ship's crew of four.

As reviewed by Proctor (1959), several botanists have visited Navassa Island. The first to record any plants was the Swedish botanist Olof Swartz, who recorded two plant species during his voyage to Jamaica (1784–1786). Almost a century and a half later, a second Swedish plant collector, E. L. Ekman, spent two weeks on the Island in October 1928. He reported 102 species of vascular plants (Ekman 1929), of which he considered 44 to be indigenous. Following Ekman, H. A. Rehder of the Arnold Arboretum collected about two dozen plants on Navassa Island in January 1930, and then in June 1956, G. A. Proctor (1959) collected 38 species during a four-day visit. Before the present study, the last plant collector was S. Kiem, of the Fairchild Tropical Garden, who gathered seeds of the two endemic palms in January 1958. To our knowledge no marine biological collections or related studies have been reported for Navassa Island.

… no marine biological collections or related studies have been reported for Navassa Island.

Figure 2. Walls reach depths of 22–35 m all around the island.

The cruise (23 July–6 August 1998) was arduous, but highly successful, with a total of 78 SCUBA dives (to 35 m) at 13 collection sites (all video documented). We collected 318 individual wet algal specimens, 34 mixed bulk collections and 65 samples for molecular analysis. Additionally, we characterized 6 deepwater ROV transects (on videotape) and took 1,620 underwater photographs (color transparencies) to document Navassa Island's invertebrate, fish and marine plant life. We have also produced an algal checklist and are developing a field guide to the common marine macrophytes of Navassa Island as a CMC website (www.cmc-ocean.org/navassa.html). Some of the more noteworthy observations/interpretations we made are outlined here.

General current drift, consistently observed throughout the study, tended to split northeastward and southeastward (from the northwest point), moving along the north and west coasts respectively. However, wind direction and predominant seas were primarily from the east. Terrestrial cliffs, of an unusually hard calcareous rock (phosphate/carbonate?), plunge subtidally to depths of 22–29 m all around the island.

Spectacularly colorful, mixed communities of sponges, coralline algae, tunicates, bryozoans, hydroids and low-growing iridescent algae (e.g., *Dictyota* spp.) were prominent along the undercut walls that reach depths of 22–35 m all around the island (Fig. 2). In our opinion these submerged overhanging ledge and cave systems rank among the most impressive of the tropical Unites States continental and insular coastal dive sites that we have

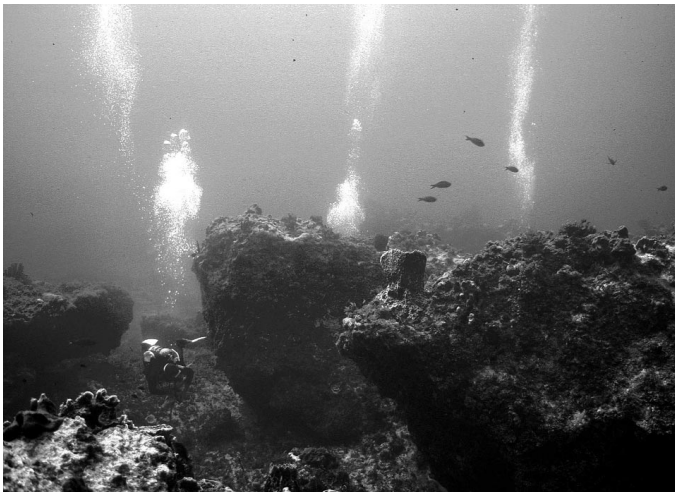


Figure 3. On the East coast, house-sized blocks lie under water.

encountered during our more than 30 years of SCUBA surveys.

Grazing by the abundant herbivorous fishes [Scaridae (parrotfishes), Kyphosidae (chubs) and Acanthuridae (surgeonfishes)] and sea urchins (mostly *Diadema antillarum*) was fairly high, as was evident from (a) the paucity of fleshy red algae (i.e., encrusting forms dominate) and (b) a predominance of chemically-defended green and brown algae. Furthermore, an abundance of nitrogen-fixing blue-green algae (*Cyanophyta*) both indicated, and presumably alleviated, nitrogen limitation. Consequently, non-palatable algal forms such as coralline algae, blue-greens, the brown algae *Lobophora variegata*, *Dictyota* spp. and *Stypopodium zonale*, as well as the sediment-producing *Halimeda* spp., characterized the marine flora, with many common Caribbean red algal genera being conspicuously absent. Also uncommon or absent were the typical invertebrate and fish taxa associated with, or requiring, either mangrove (*Rhizophora*) or turtlegrass nursery habitats. Therefore, the marine biota, although teaming with life, is most remarkable for what it lacks.

The east coast receives the greatest wave shock, as indicated by the general lack of terrestrial plants and sea-bird nests along the cliff face, as well as the presence of recent fractures and fallen, house-sized blocks underwater (Fig. 3). We think upright branched hermatypic and non-hermatypic corals and frondose (fleshy) algae tend to be eliminated, by severe wave shear. We also posit that the intermediate phosphate levels here (see below) only allowed for an intermediate abundance of encrusting, massive coral development; i.e., many reef building (hermatypic) corals are limited by phosphate (well known as an inhibitor/poison of marine calcification) from seepage and runoff. This may have led to the dominance by two-dimensional forms such as encrusting coralline algae, sponges and turf-forming brown algae. We hasten to point out that cnidarian colonies appeared to be largely disease-free and unbleached, although many were interacting competitively with other organisms at their margins.

Coastal guano deposits, characterized by stark-white, phosphate-covered rock, dominated the cliffs from approximately 1.0 km to the east of the northwest point, clockwise along the north coast to about halfway down the east coast toward the south point. Therefore, hermatypic coral formations, some of which are susceptible to both phosphate poisoning and wave-shearing forces, were predicted to reach their peak abundances along the west (southwest) coast. This prediction was supported by the following: (a) the unique presence of delicate branching coral forms (e.g., *Acropora cervicornis, A. palmata*), as well as increased cover of massive corals (e.g., *Montastrea annularis, Porites astreoides, Diplora strigosa*) leading to recognizable spur-and-groove formations in this region; (b) the only shallow fringing reef development, restricted to the shoreline from the northwest point to approximately 1.0 km (only) eastward along the north coast; (c) non-hermatypic corals (gorgonians) which attained maximum development in the two habitats described above.

Spectacularly colorful, mixed communities of sponges, coralline algae, tunicates, bryozoans, hydroids

Submerged (drowned) spur-and-groove habitats dominated the offshore bank along the central west coast (Fig. 4), indicating a formerly well developed fore-reef slope system. Dominant constituents were branched gorgonians (e.g., *Pseudopterigorgia* spp.), barrel sponges (e.g., *Xestospongia muta*), fan gorgonians (*Gorgonia ventalina*), calcareous corals, the brown algae *Sargassum hystrix, Lobophora var-*

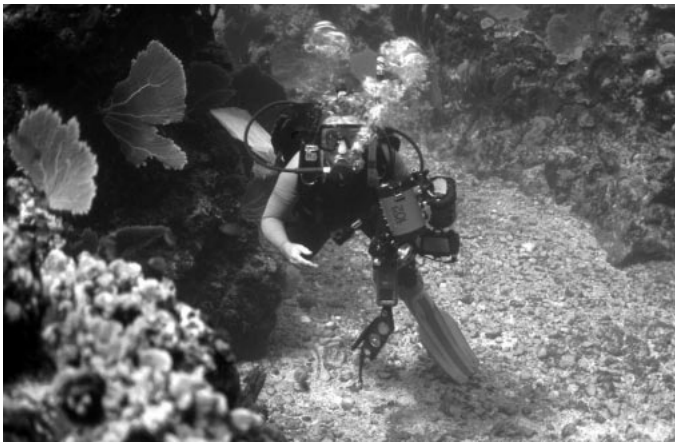


Figure 4. Submerged spur-and-groove habitat dominated the offshore bank along the central West coast.

iegata and *Dictyota* spp., along with considerable epiphytic blue-green algae. The spurs ran parallel to the west coast to windward, starting at 28 m deep and were approximately 3-4 m above the sedimentary grooves. Widths varied, but most spurs reached ~15 m wide. *Montastrea annularis* and other hermatypic (e.g., *Agaricia*) corals were actively forming raised pinnacles and heads.

Intertidal communities were uniform around the island with a black layer of blue-green algae forming the uppermost zone, followed by the encrusting *Porolithon pachydermum* and other corallines lower. The brown turf *Dictyota delicatula* formed a dense belt still lower, with the iridescent green alga *Bryopsis* spp. scattered amidst the patches of *P. pachydermum*. Large chitons, the dominant intertidal grazer, were observed in the exposed undercut zone. Chitons were largely responsible for the undercut nature of all sides of Navassa Island, which adds to the difficulty in going ashore. On Navassa Island's east coast, a 10 m-wide ledge occurred below the intertidal to 7 m, and was dominated by encrusting sponges and the lower intertidal community described above.

The north coast presumably receives the maximum guano-derived runoff and seepage and is characterized by a paucity of hermatypic corals (although some occurred on deeper collapsed cliff rocks). However, this more shaded coast contained interesting shallow caves, ledges and overhangs that were lined with crustose sponges, corallines, *Peyssonnelia* spp., tunicates, hydroids and bryozoans that approached those off the south point in terms of their vivid colors.

Sand-dwelling communities occurred off the west and north coasts (Fig. 5) which were dominated by green algae such as *Halimeda* spp., *Caulerpa* spp., *Avrainvillea* spp. and *Udotea* spp., and which appeared to occupy the missing turtlegrass (*Thalassia testudinum*) niche on sand-plain habitats. Some rare and delicate red-algal forms were prevalent on the psammophytic green algae. Three species of epiphyte-feeding conch (*Strombus gigas, S. costatus, S. gallus*) occurred primarily in these beds. Interestingly, the only seagrass encountered was a sparse bed of *Syringodium filiforme* (manatee grass), 28 m deep off the north coast.

The deep-water biotas (surveyed by ROV) were characterized by extensive rhodolith (coralline-algae/foraminifera) balls covering vast areas off the easternmost outer slope (60–100 m deep), similar to those described for the Bahamas (Littler *et al*. 1991). In shallower water, the rhodoliths were overgrown by a canopy of the brown alga *Lobophora variegata* with abundant interspersed

many hermatypic corals are limited by phosphate seepage and runoff

Figure 5. Sand-dwelling communities occurred off the west or north coasts.

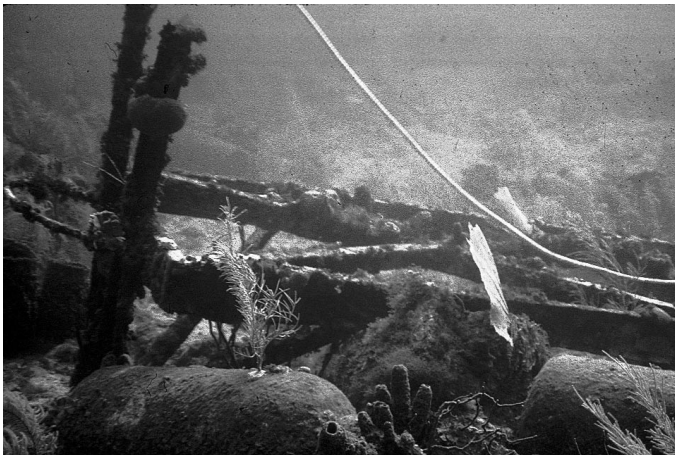


Figure 6. Lulu Bay was the only site showing anthropogenic impacts.

patches of the taller sediment-forming green alga *Halimeda* spp. The southernmost outer slope was remarkable for the abundant coverage provided by barrel, tube, rope and encrusting sponges to a depth of 80 m. The western outer slope was uninteresting with coverage consisting primarily of dead *Halimeda* segments. The northern outer slope was steeper, with sediments and rhodoliths predominant. Below 120 m on all slopes, sponges, coralline crusts, whip gorgonians (e.g., *Ellisella* spp.) and fan gorgonians (e.g., *Nicella goreaui*) were the most prevalent. A blue-green species on dead *Halimeda* segments was the deepest plant form collected (450 m); a living rhodolith constructed of an encrusting coralline and the foraminiferan *Gypsina* spp., was taken at 71 m; and the green alga *Rhipilia profunda* was recorded at 100 m.

Lulu Bay (Figure 6) was the only site showing anthropogenic impacts, consisting mostly of historical debris associated with the two former onshore operations, mining and the lighthouse. Submerged rusting items, such as railway track, mining-cart wheels, 20 large acetylene tanks (from the lighthouse operation), large ship anchors and construction materials, were concentrated here. More recently, fishermen have created a small underwater conch-shell midden next to the landing site. Interestingly, the very sheltered shallow ledge along the indented cliff wall of Lulu Bay contains the most developed stand (~12 medium-size heads) of the elkhorn coral, *Acropora palmata* that we observed during the expedition.

References:

Ekman EL (1929) Plants of Navassa Island, West Indies. Arkiv for Botanik 22A(16): 1-12.

Littler MM, Littler DS, Hanisak MD (1991) Deep-water rhodolith distribution, productivity, and growth history at sites of formation and subsequent degradation. J. Exp. Mar. Biol. Ecol. 150:163-182.

Proctor GR (1959) Observations on Navassa Island. Geonotes 2(2):49-51.

Mark M. Littler, Diane S. Littler and
Barrett L. Brooks, Department of Botany,
National Museum of Natural History,
Smithsonian Institution,
Washington, D.C. 20560-0166

What Are the Origins of the Modern Coral Reef Ecosystem?

The evolutionary origin of the coral reef ecosystem is a topical subject, especially given the current interest in the origins and maintenance of biodiversity, but it is one which has received only limited review. Recent molecular, ecological, and palaeontological data now allow us to develop a more integrated view of how these diverse communities evolve and respond to global change. Indeed, the origins of the complex ecosystems that dominate Earth today cannot be fully understood without a historical perspective.

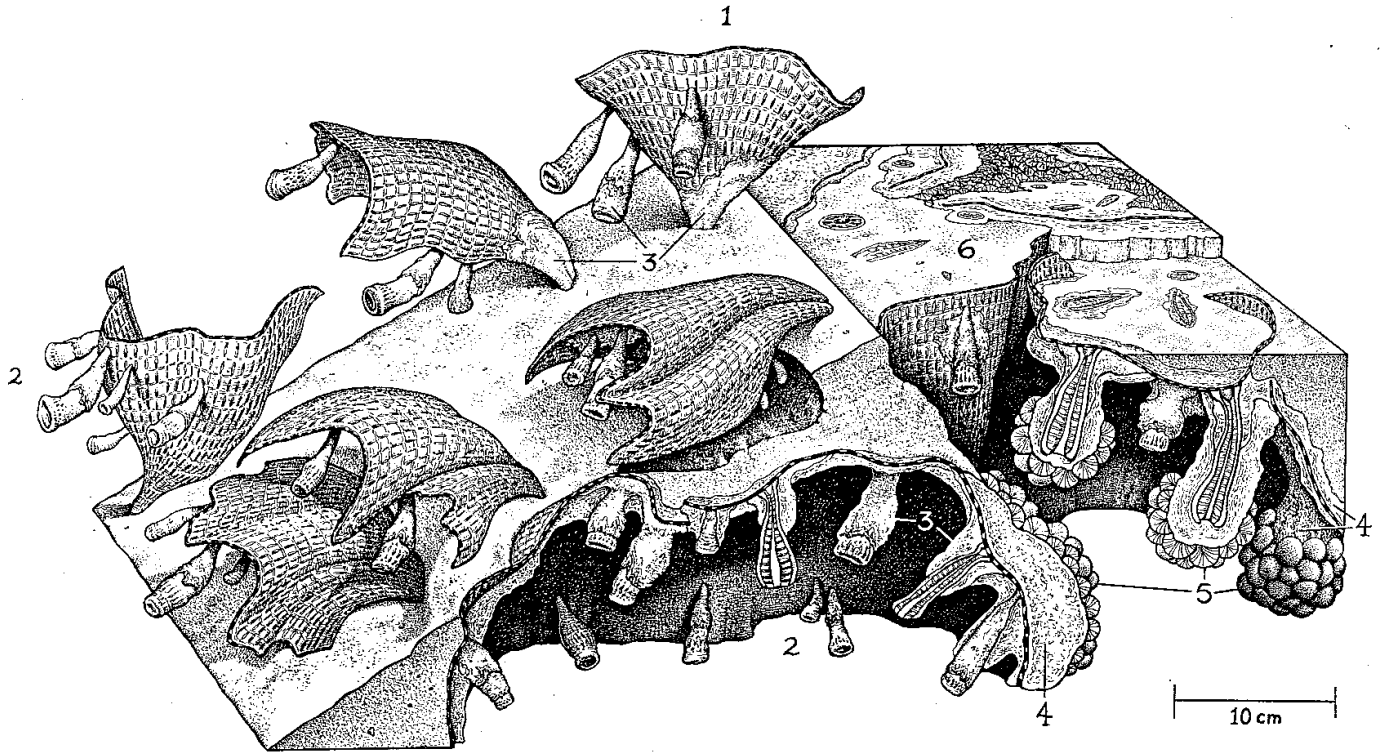
In principle, any sessile marine organism can form a reef, and the geological record shows that an array of different microbial, algal and metazoan communities have formed reefs over the last 3.5 billion years. However, not only has the global distribution of reefs varied considerably through this vast expanse of time—determined largely by fluctuating global sea level and latitudinal temperature/calcium carbonate saturation gradients—but more importantly the trophic demands of reef building organisms have changed, as has the degree of

biological disturbance faced by immobile biota occupying shallow marine environments.

The complex and multifarious photosymbiotic association of scleractinian corals with Symbiodinium is widely assumed to provide both the driving energy and physical structure for the whole coral reef community. In addition, a substantial and increasing body of research underlines the importance of predation, in particular herbivory, in maintaining the coral reef ecosystem. Yet the fossil record of reef building suggests that both acquisition of photosymbionts and the appearance of modern predator and herbivore groups are relatively recent occurrences on a geological timescale. Many ancient reefs clearly grew under profoundly different ecological controls to those that govern the modern coral reefs.

> a multitude of different microbial, algal and metazoan communities have formed reefs over the last 3.5 billion year

*Figure 1. The 250 million year old Capitan Reef of Texas and New Mexico. Although this reef accreted at rates comparable to modern reefs (estimated to be some 3–4 m yr^{-1}), it was built by a variety of relatively fragile communities whose biota appear to have lacked photosymbioses (from Wood 1999). (b) Reconstruction of the frondose bryozoan-sponge community. 1: Frondose bryozoans (*Polypora *sp.;* Goniopora *sp.) 2: solitary sphinctozoan sponges; 3:* Archaeolithoporella *(encrusting ?algae); 4: microbial micrite; 5: cement botryoids; 6: sediment (grainstone-packstone).*



Photosymbiosis: Access to a New Metabolic Capability

Symbiosis is better understood as an evolutionary innovation providing novel metabolic capabilities than the more traditional notion of mutual benefit (Douglas 1994). Microbial symbionts often have capabilities lacked by their host, so that access to a new metabolism can enable the host to exploit a new food resource or to invade a previously inhospitable environment.

Although the association of corals with dinoflagellate algae is an accepted causal link in rapid rates of calcification, photosymbiosis presents other advantages to reef-building organisms, in particular the potential for hosts to select optimal symbionts in the highly dynamic tropical marine environment. Indeed, many ancient reefs show rates of carbonate production comparable to modern examples, even though their communities functioned in the absence of photosymbiosis (Fig. 1; Wood *et al.* 1996). And while the origin of photosymbiosis in scleractinian corals can be traced back to about 210 million years ago (Stanley and Swart 1995), this did not appear to confer immediate reef-building superiority to photosymbiotic, compared to inferred non-photosymbiotic, taxa. Moreover, the absence of photosymbioses alone cannot account for periods in Earth's history when there was no globally widespread reef building (Wood 1999). We are clearly only just beginning to appreciate the complexity of many photosymbiotic relationships and their role in modern reef ecology. Exploration of the biogeographic constraints on symbiont diversity will have profound evolutionary implications.

The Rise of Predation and Herbivory

Although there is no evidence that routine physical processes have changed significantly over the Phanerozoic, there are now considerable data to suggest that grazers and carnivores throughout the Palaeozoic were relatively small individuals, with limited foraging ranges and were incapable of excavating calcareous substrates (Vermeij 1987). But by the early Mesozoic, sessile organisms had to contend with an increasing battery of excavatory feeding methods (Fig. 2) as well as sediment disruption from deep bioturbating activity (Thayer 1983). Biological disturbance reached new heights during the mid-Jurassic to early Tertiary when deep-grazing limpets, sea urchins with camerodont lanterns and especially the highly mobile reef fishes appeared. With them came the ability to excavate large areas of hard substrata. A concurrent radiation of boring organisms began in the late Triassic (210 million years ago). The oldest deep borings are known from the Jurassic. Not until the Oligo-Miocene—only about 20 million years ago—did reef bioerosion gain a modern cast (Pleydell and

> biologically induced disturbance has increased dramatically in shallow marine seas since the Mesozoic

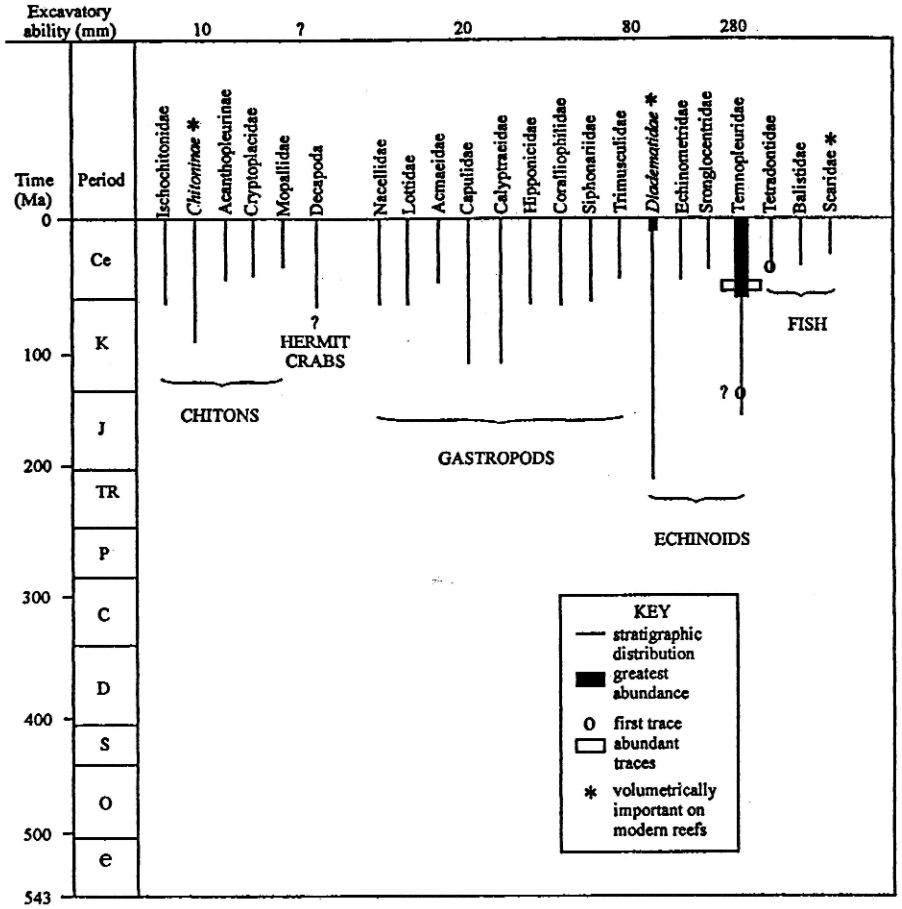


Figure 2. The rise of modern groups of coral reefs predators and herbivores capable of bioerosion, arranged in order of increasing excavatory ability (data modified from Vermeij 1987).

Jones 1988). How did reef communities respond to these new threats?

The importance of herbivory and predation in regulating modern reef community structure suggests that profound changes must have occurred with the appearance of these new consumer groups. We know that tropical marine hard substrata are usually sparsely vegetated, and only develop a richer filamentous algal flora when large herbivores are excluded or nutrient input increases. The presence of abundant coralline algae and corals within a reef community indicates intense, and often specialist, herbivory. In waters <20m deep, these two components may cover in excess of 80% of the substratum. In addition, grazers also contribute notably to carbonate sediment production and redistribution (Bellwood 1995, 1996), to algal ridge formation (Adey and Steneck 1985), to ameliorating the effects of competition and hence maintenance of high diversity, and by interacting with physical controls to produce the characteristic zonation of modern coral reefs (Wellington 1982).

Many coral reef organisms show a vast array of supposed anti-predation mechanisms, but details of their evolutionary origin and development are poorly known.

Many coral reef organisms show a vast array of supposed anti-predation mechanisms, but details of their evolutionary origin and development are poorly known. Sessile organisms have a relatively restricted range of antipredatory options at their disposal, relying upon passive constructional defenses. Organisms susceptible to partial mortality and which depend on herbivores to remove competitors or foulers usually sacrifice some of their own tissues. This means that particular anatomies are required which resume normal growth as quickly as possible. One might predict therefore that the rise of excavatory herbivory would select for organisms with structural or chemical defenses and the ability to recover from partial mortality by rapid regeneration of damaged tissue.

Many modern reef-building corals are capable of rapid regeneration from partial mortality. This capability was probably present in the Scleractinia from the early origins of the group, but only proliferated when the ability to withstand partial predation became useful (Wood, 1999). Particularly dramatic is the spectacular rise of multiserial, branching forms in the late Cretaceous (about 95 million years ago) (Jackson and Mckinney 1991), which coincides with the appearance of new groups of predatory excavators (Fig. 3a). Such forms are easily broken as a result of both high wave activity and bioerosion, especially by boring sponges that infest the colony bases. However, branching corals are able to re-anchor fragments and rapidly regenerate and grow—often fusing with other colonies—at rates up to 120 mm yr^{-1}. Branching corals have turned adversity into considerable advantage, and flourish because and not in spite of breakage.

Coralline algae are able to withstand the most intense herbivore onslaught because of distinct morphological structures that have been shown experimentally to serve an anti-predation function (Steneck 1983). These include a heavily calcified thallus that is resistant to attack, intercellular conduits for translocating photosynthates, and armored reproductive structures (conceptacles). These anatomical features were present in the oldest abundant coralline algae, Archaeolithophyllum, known from the late Carboniferous, which formed a thin, leafy crust. The well-developed hypothallus of corallines initially allowed rapid lateral growth required for life on an unstable substrate, but this structure, together with the presence of fusion cells, also allowed the corallines to encrust, acquire branching morphologies, produce conceptacles, and regenerate from deep wounds—features which probably enabled corallines to radiate as herbivory intensified through the mid to late Mesozoic and Cenozoic (Figure 3b). More than 100 million years elapsed between the first appearance of coralline algae and the subsequent radiation of the group, strongly suggesting that these distinctive features of coralline algae are traits whose benefits are secondary or incidental to the primary function to which they are adapted. Delicately branched corallines become notably less important in the tropics after the Eocene when thick crusts became more abundant. The first algal ridges are known from the Eocene. Both these events coincide with the evolution of excavatory herbivorous fishes.

Community Stasis?

Biological communities are currently considered to be chance associations of species with similar ecological requirements, rather than fixed entities with

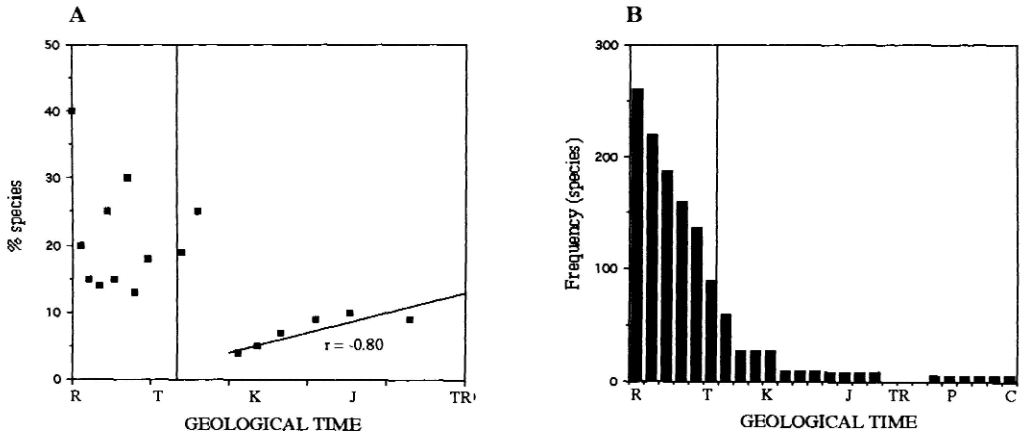


Figure 3. The rise of the modern coral reef-builders. (a) Percent of erect scleractinian coral species since the Triassic (data from Jackson and McKinney 1991). (b) Species diversity of coralline algae since the Carboniferous (data from Steneck 1983). C: Carboniferous; P: Permian; TR: Triassic; J: Jurassic; K: Cretaceous; T: Tertiary; R: Recent.

precise boundaries. This notion is supported by several models that adequately predict community composition on the basis of immigration and extinction, the spatial distribution of environments, and the size of the species pool (Cornell 1996; Hubbell 1998). Communities constantly change through local extinction and recruitments of their component species, and new communities, composed of species with geographic access to the new area, develop in previously unoccupied habitats (Buzas and Culver 1996).

Although researchers accept that many marine communities are not discrete entities, this has not yet been universally accepted for reefs (Jackson, 1992; Pandolfi, 1996). This is because the sheer abundance of specialised interactions and symbioses, as well as the diversity of ecological niches, seem to indicate long-lived coexistence between organisms. However, such specific interactions are in fact modified as the species membership of a reef community frequently changes—so that like the constituent species, the ways in which organisms interact are not fixed. This suggests that there is an enormous ecological redundancy of species in reefs i.e., many species can occupy a broadly similar niche.

During the Plio-Pleistocene some 4-1.5 million years ago, a major turnover of reef corals and molluscs occurred in the Caribbean. The coral genera *Pocillopora, Stylophora* and *Goniopora* became regionally extinct, and *Acropora* became more abundant. Despite this faunal turnover, species richness changed little and reef communities remained common. The change does not appear to have been abrupt as predicted by the theory of 'coordinated stasis', but may have taken two to three million years at any one geographic location. In a case study from Curaçao, members of the post-turnover fauna were well established in the species pool before members of the pre-turnover fauna disappeared, with faunal changes being slow and not coordinated (Budd *et al.* 1998).

Studies that integrate palaeontological and geological data with ecological observations are still in their infancy

The patchy distribution patterns characteristic of many reef-building communities at small spatial scales means that most species occur in relatively few places and tend to be uncommon or rare, even though they are often geographically widely distributed across a region (Budd *et al*. 1998). On this local scale, high variability between different sites suggests that species associations and biological interactions are not tightly bound, and that the observed faunal change may have proceeded by varying dispersal and colonization rates at different spatial and temporal scales. Moreover, this patchiness would also explain how reef faunas appear more or less "stable" at scales less than one to two million years (Jackson 1992; Pandolfi 1996).

The Future

Studies which integrate palaeontological and geological data with ecological observations are still in their infancy; but researchers are now documenting evolutionary processes and generating testable hypotheses. For example, excavating reef fish modify reef carbonate in three ways (Bellwood 1995, 1996): i) by direct erosion, ii) through decrease of particle size due to both erosion or sediment reworking, and iii) by net transport of sediment away from its site of removal. The removal of material from shallow feeding areas such as the reef crest where it might otherwise accumulate rapidly, to specific defecation sites often in deeper parts of the reef might significantly control the rate of prograding reef growth. This, combined with the decrease in sediment size, increases the likelihood of hydrological transport resulting in an active net movement of carbonate away from the reef. This behavior may therefore be an important agent of structural change on reefs, but its importance over evolutionary timescales can only be tested by study of the fossil record.

References:

Adey WH, Steneck RS (1985) Highly productive eastern Caribbean reefs: synergistic effects of biological, chemical, physical and geological factors. In: Reaka ML (ed) The Ecology of Coral Reefs. NOAA Undersea Res. Progr., Rockville, Maryland pp 163-167.

Bellwood DR (1995) Carbonate transport and within-reef patterns of bioerosion and sediment release by parrotfishes (family Scaridae) on the Great Barrier Reef. Mar. Ecol. Prog.Ser. 117:127-136.

Bellwood DR (1996) Coral reef crunchers. Nature Australia, Autumn pp 49-55.

Budd AF, Petersen RA, McNeill DF (1998) Stepwise faunal change during evolutionary turnover: a case study from the Neogene of Curaçao, Netherlands Antilles. Palaios 13:170-188.

Buzas MA, Culver SJ (1994) Species pool and dynamics of marine paleocommuities. Science 264:1439-1441.

Cornell HV, Karlson RH (1996) Species richness of reef-building corals determined by local and regional processes. Jour. Animal Ecol. 65: 233-241.

Douglas AE (1994) Symbiotic Interactions. Oxford Science Publications, Oxford University Press, Oxford.

Hubbell SP (1997) A unified theory of biogeography and relative species abundance and its application to tropical rain forests and coral reefs. Coral Reefs 16, suppl.:S9-S21.

Jackson JBC (1992) Pleistocene perspectives on coral reef community structure. Amer. Zoo. 32:719-731.

Jackson JBC, McKinney FK (1991) Ecological processes and progressive macroevolution of marine clonal benthos. In Ross RM, Allmon WD (eds) Causes of Evolution. University of Chicago Press, Chicago pp 173-209.

Pandolfi JM (1996) Limited membership in Pleistocene reef coral assemblages from the Huon Peninsula, Papua New Guinea: constancy during global change. Paleobiol. 22:152-176.

Pleydell SM, Jones B (1988) Boring of various faunal elements in the Oligocene-Miocene bluff formation of Grand Cayman, British West Indies. Jour. Paleontol. 62:348-367.

Stanley GD, Swart PW (1995) Evolution of the coral-zooxanthellae symbiosis during the Triassic: a geochemical approach. Paleobiol. 21:179-199.

Steneck RS (1983) Escalating herbivory and resulting adaptive trends in calcareous algal crusts. Paleobiol. 9:44-61.

Thayer CW (1983) Sediment-mediated biological disturbance and the evolution of marine benthos. In Tevesz M, McCall PW (eds) Biotic Interactions in Recent and Fossil Benthic Communities. Plenum Press, New York pp 480-625.

Vermeij GJ (1987) Evolution and Escalation. Princeton University Press, Princeton.

Wellington GM (1982) Depth zonation of corals in the Gulf of Panama: control and facilitation by resident reef fish. Ecol. Monogr. 52:223-241.

Wood R, Dickson JAD, Kirkland-George B (1996) New observations on the ecology of the Permian Capitan Reef, Texas and New Mexico. Palaeontol. 39:733-762.

Wood RA (1999) Reef Evolution. Oxford University Press, Oxford.

Rachel Wood, Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EQ, United Kingdom.
Email: <rw43@esc.cam.ac.uk>

Certifying Quality and Sustainability in the Marine Aquarium Industry

Collectors for the aquarium industry have common concerns around the world. Destructive fishing and poor handling practices are widespread threats to their livelihoods. Market forces may be the best way to encourage and support quality "products" and sustainable practices in the marine ornamentals industry. Demand from informed consumers can create an incentive to provide quality-assured, higher value-added marine organisms. In turn, unsustainable practices such as the use of sodium cyanide, lack of water quality control, and high levels of mortality, should decrease as suppliers either adjust their practices "upward" or lose their customers.

a sustainable future through market incentives that encourage and support quality and sustainable practices

To put these market forces to work, a Certification System is needed to establish and enforce standards, provide certificates for products, and help generate consumer demand. An independent, multi-stakeholder, international institution is required. The Marine Aquarium Council (MAC) is a non-profit organization composed of representatives of the aquarium industry, hobbyists, conservation organizations, government agencies, and public aquariums—all with a shared interest in the future of the industry. The MAC aims to involve the entire "Chain of Custody"—i.e. from collectors to exporters to importers/wholesalers to retailers and finally the consumer. Together with stakeholders, the MAC plans to develop quality standards and a labeling system, which will allow more control over exploitation of the organisms and the ecosystems on which the industry depends. Consumer demand for a high quality product will benefit the stakeholders, and strengthen the call for a quality-based, sustainable industry.

The importance of MAC's aims, its innovative basis in market mechanisms, and the broad base of participation has secured interest and support for the initial development of the certification system in pilot areas. In Hawaii, a prototype set of collecting and handling guidelines has been developed through workshops with collectors. Similar efforts are underway in the Philippines and will soon begin in a South Pacific pilot area. Initial standards will be finalized and tested in 'collection-to-retailer' operations in pilot areas. MAC will begin pilot certification and labeling in 1999. The MAC organization and process, when fully established and mature, will evolve into a largely self-financed system based on the improved economic return from certified marine aquarium organisms and fees for participation in the certification. In the meantime, external funds continue to be sought to support the development and testing of the certification system, to train fishermen in sustainable collecting and handling methods, and to raise awareness among the consumers and industry.

From the broad coalition - or network - that constitutes MAC, an Interim Board is currently composed of: American Marinelife Dealers Association, American Zoo and Aquarium Association, International Marinelife Alliance-Philippines, Marine Aquarium Societies of North America, UK Ornamental Aquatic Trade Association, Pet Industry Joint Advisory Council, Philippine Tropical Fish Exporters Association, Quality Marine Inc, The Nature Conservancy, and World Wildlife Fund. Organizations, companies, government agencies and other groups, or individuals who are ready to collaborate and contribute constructively to achieving the goals of MAC are invited to join the MAC Network by completing and submitting the form on the website at www.aquariumcouncil.org.

For further information contact: Paul Holthus,
Executive Director, Marine Aquarium Council
3035 Hibiscus Dr., Honolulu, Hawaii USA 96815.
Tel: (+1 808) 923-3254 Fax: (+1 808) 923-6023
Email: <paul.holthus@aquariumcouncil.org>
Website: www.aquariumcouncil.org

ICRI Monitoring—The GCRMN and Reef Check

The International Coral Reef Initiative (ICRI) has become an umbrella for the closely linked Global Coral Reef Monitoring Network and Reef Check program, formalizing an arrangement that has evolved naturally and clarifying the roles of ICRI, GCRMN and Reef Check.

GCRMN was set up to operate primarily through government agencies while Reef Check was designed to operate mainly through non-governmental organizations (NGOs) or community groups. The methods promoted by GCRMN are more detailed, with medium to high resolution suitable for intensive government monitoring efforts, where sufficient expertise is available. In contrast, the Reef Check methods were specifically designed to be used by non-scientists, hence are suitable for community groups. The two programs complement each other well, and collaboration is highly cost-effective, allowing sharing of coordinators, training and survey data. All survey data have been and will continue to be supplied to the global coral reef database, ReefBase at ICLARM in Manila. The role of ICRI is to provide overall coordination, particularly by soliciting donors and matching these with funding needs.

Our joint goals are to:

- establish a global network of monitoring teams linking all countries with coral reefs, and providing them with the training and tools needed to monitor biophysical and socioeconomic parameters and manage their reefs at the local and national levels;
- raise the awareness of governments and the public about the value of coral reefs, threats to their health and solutions to these problems;
- build a sense of stewardship among coastal communities and the general public regarding coral reefs;
- produce a global database on coral reefs that is updated annually, and allows the tracking of regional and global problems, such as global warming through comparable methods and measurements.

In countries with no or limited expertise (most countries), the initial training for all teams would start with Reef Check methods. As government monitoring teams gain experience, they will receive advanced training in higher resolution methods from GCRMN methodology. Most community-based groups (fishers, villagers, recreational divers, military etc.) will continue to use Reef Check methods, with many sites monitored by community groups using the low taxonomic resolution (Reef Check) methods, and fewer sites monitored by government staff using high resolution methods. This combination of two (or more) monitoring levels has already been tested, and proven very effective in both developing and developed countries.

Properly, the primary concern of most scientists and managers is the reefs in their area, however the need for a global monitoring network was dramatically emphasized by the massive 1998 coral bleaching and mortality event. Since then we have gained a better appreciation of the extent of this event; which is certainly unprecedented in recorded history. Teams from both GCRMN and Reef Check as well as other groups worked hard to document the damage in the Indian Ocean, South East Asia, the Western Pacific, and in many parts of the Caribbean. Although the network still has many gaps, it did allow us to track the bleaching and catastrophic death of corals – often in the range of 80% mortality of all corals in the upper 10 to 15 metres over large parts of the central and northern Indian Ocean.

The GCRMN published its first Status of Coral Reefs of the World: 1998 report for distribution at the International Tropical Marine Ecosystems Management Symposium in Townsville in late November 1998. That report summarized global coral bleaching using data collected by Reef Check and the GCRMN, and information provided by many people who replied to Email requests via the coral-list. The next report is scheduled for release at the 9th ICRS in Bali, October 2000. We collaborated with others to write a paper on the Indian Ocean bleaching for AMBIO, which included an initial economic assessment of the potential losses from this 1998 bleaching event. Some of our comments were in the US State Department's presentation at the US Coral Reef Task Force meeting in Hawaii in March. Thus, ICRI, GCRMN and Reef Check have helped to increase the level of discussion about threats to coral reefs and about the need for a monitoring network.

Reef Check and the GCRMN coordinated a Special Session with nine papers on monitoring at Nova Southeastern University's National Coral Reef Institute meeting held in Florida USA in mid-April. The major themes were the need for expanded monitor-

ing, particularly at the community level. At this meeting about 400 people heard reports of increasing declines in coral reefs around the world and a final report urged immediate action to arrest reef degradation from both global and local impacts. Both coordinators presented summaries of the ICRI strategy to the World Bank and NOAA en route to this meeting, demonstrating that national and international agencies are putting the current reef crisis higher on their operational, and hopefully, funding agendas.

Summaries of Reef Check results have been assembled into a publication now in press with the Marine Pollution Bulletin. These show a widespread pattern of reef degradation with increasing declines in major stocks of commercially important species like lobster, giant clams, edible holothurians, key target species of fish. The 1998 results which spanning the bleaching event documented a significant decline in the coral cover on what were previously regarded as near-pristine reefs.

The partnership between GCRMN and Reef Check was cemented at the Coordination and Planning Committee meeting of ICRI in Paris in March. Here substantial funding was announced for reef monitoring by the governments of USA, UK , Sweden and the Netherlands. Some of this funding will go into monitoring the outcome of coral bleaching and mortality in the Indian Ocean under a project called CORDIO – COral Reef Damage in the Indian Ocean.

Our primary work now is to expand the monitoring network in countries where we already have coordinators, while recruiting new coordinators where there are none. We welcome the new coordinators who offered their assistance at the NCRI meeting.

References:

Hodgson, G (1999) A global assessment of human effects on coral reefs. Marine Pollution Bulletin. 38 (5):345-355.

Wilkinson C (1998) Status of Coral Reefs of the World: 1998. Australian Institute of Marine Science, Townsville, 184 pp.

Wilkinson C, Linden O, Cesar H, Hodgson G, Rubens J, Strong AE (1999) Ecological and socioeconomic impacts of 1998 coral mortality in the Indian Ocean: An ENSO impact and a warning of future change. AMBIO 28:188-196.

Gregor Hodgson Reef Check Coordinator,
Email: <gregorh@hk.super.net> and
Clive Wilkinson GCRMN Coordinator,
Email: <C.Wilkinson@aims.gov.au>.

Reef Check would like to acknowledge the strong support of HKUST and in particular, the Institute for Environment and Sustainable Development under the Director, Prof. Gary W. Heinke. Reef Check would not have been possible without this support over the past three years. As Greg Hodgson is leaving HKUST, Reef Check Headquarters will be moving to its own office in Hong Kong. In the meantime, the website www.ReefCheck.org and Email address <reefchck@ust.hk> remain unchanged. However, to contact the coordinator, please use the new email address above.

The International Coral Reef Initiative and the ISRS

Coral reef scientists are often skeptical about international bureaucratic organizations that operate in and around the United Nations network. Skepticism is healthy, and performance rather than promises should be judged. The International Coral Reef Initiative is not just bureaucracy, and both the **ISRS** and coral reefs should benefit.

ICRI was formed in 1994 in response to growing alarm about coral reefs. It is called an Initiative, rather than a convention, commission, programme etc. because the aim is to initiate action for better conservation and sustainable use of coral reefs (and related ecosystems). ICRI is a new type of international, environmental organization with no rules or regulations, no permanent officers, no restricting mission statements or lists of objectives (other than to conserve reefs). It does not even have a fixed membership. ICRI is an 'open table' at which the major players (aid donors and recipients, international agencies, NGOs and development banks, coral reef scientists, and even foreign affairs departments) come to discuss problems and solutions for coral reefs in a open forum. Representatives come from major donor countries (Australia, France,

Japan, Sweden, UK and USA), developing countries with coral reefs (Indonesia, Jamaica, Madagascar, Mexico and Philippines), international agencies (UNEP, UNDP, IOC/UNESCO, IUCN, WWF, World Bank, Convention on Biological Diversity etc.); SPREP and regional offices of UNEP in the Caribbean, Southeast and South Asia, the Middle East and the Indian Ocean, the GCRMN; and the ISRS. UNEP and SPREP represent developing countries which cannot attend.

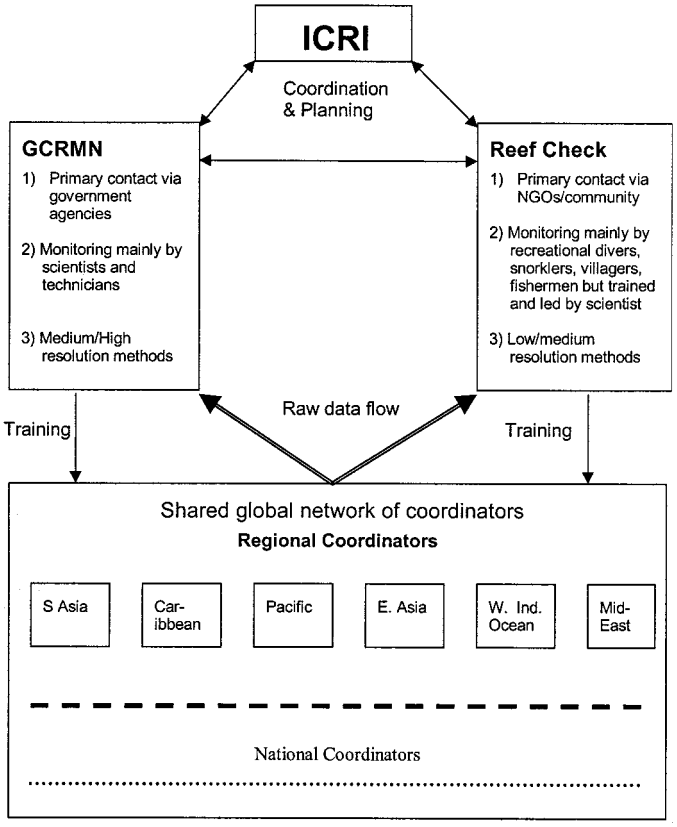
ICRI is an 'open table' at which major players come to discuss problems and solutions for coral reefs in open forum.

ICRI has held extensive consultations with representatives of over 100 countries to compile a list of perceived problems, and document the assistance required to achieve sustainable use of reefs. Thus ICRI furnishes an opportunity to match the needs of developing countries with donors, and provides a mechanism to prevent the frequent boom and bust cycles of environmental aid funding. After three to five years, funding often stops and many of the gains in capacity building are dissipated. The ICRI mechanism will track good projects and advise donors on how to build on successes. ICRI has no intention of becoming a funding body, rather it will be a catalyst to put donors, recipients and operational agencies together.

The role of **ISRS** is to provide sound scientific advice into this process. For example, the last ICRI Coordination and Planning Committee meeting in Paris in March observed that there were no policy guidelines in FAO to implement sustainable fisheries in small coral reef island states, even though many of these states have few other resources and have called for assistance. ICRI has asked the **ISRS** to develop a discussion paper on how to implement sustainable fisheries on reefs. This poses a new challenge for **ISRS**—to take on a pro-active role, similar to the **ISRS** position statements on coral bleaching and disease (**Reef Encounter 24** and this issue).

France has taken over coordinating ICRI after Australia and the USA, and now is making major efforts to expand the financial base for ICRI activities. Former president of **ISRS**, Bernard Salvat, is currently Co-Chair of the ICRI Secretariat and is assisting **ISRS** is in activities like organizing the next coral reef symposium in Bali. Similarly, the ICRI mechanism provides the chance for **ISRS** members to feed better science advice and questions back into the management process. You can follow developments in future issues of **Reef Encounter**.

Clive Wilkinson, <C.Wilkinson@aims.gov.au>.



Revolutionary Reef Rantings

It seems an age since Spyhopper popped his eyes above the water to see what is going on in the crazy crazy world of coral reef science. Particularly interesting is the kerfuffle over the coral bleaching event in 97/98 - something that seems to have affected almost everyone, everywhere. The sight of virginally white, perfectly formed yet sadly mourned coral colonies and reefs is indeed a chilling sight. Ironically, high sea temperatures are to blame. Or are they? Perhaps high temperatures encourage Zoox-expelling bacterial rampagers (see **Upwellings**). Or perhaps chronic pollution allied to high temperatures is a stress too far. Whatever - the extent of bleaching was, and still is, unprecedented and is yet another devastating setback to reef conservationists everywhere.

bleating about coral bleaching was the theme of '98

Most afternoons, Spyhopper props his feet on his bureaucrat's desk and reads the papers, pondering such issues. But recently he has lost track of the popular articles bemoaning the awful state of one of the world's greatest resources. There seems to be a new outcry about anthropogenic devastation wreaked on coral reef ecosystems almost every week; and bleating about coral bleaching was the theme of '98. Spyhopper's eyes grow heavy with collective guilt – or is it the business lunch tipple? And what are we to expect of the general population? Their compassion must be so fatigued as to be almost comatose! If Spyhopper's vital signs are any barometer, the outlook predicts a tropical depression.

But it's not the general public who make the decisions about resource management and conservation. It's the big chiefs of government, the policy makers, their pet decision takers, the obstacle movers and the law shakers. Cascading down from the top of the pyramid, regulations formulated over cups of coffee and subsidy-funded lunches complete the framework that conservationists must attempt to influence. But administrations are often so inaccessible, so imperturbable, that the campaigners feel obliged to shout and bang at the doors of power. Is this the right way forward? Should lobbyists take up diametrical opposition and protest and protest and protest? Creating a big fuss is all very well, but it loses its impact when realistic solutions are missing. We need some linkage between those who regulate and those who seek to conserve the environment. Can the **ISRS** and the International Coral Reef Initiative help to fill this gap? (see **International Initiatives**) People who know the issues and the problems should also be able to see pragmatic solutions that please both sides. All around the world, positive efforts are being made by governments to slow and reverse environmental decline. Genuinely concerned people are in positions to change the world, so it is time to call for a rational and balanced voice, to give policy makers the tools they need to repair and restore our fragile environment.

On a totally different, if not less pompous note, Spyhopper was pondering recently on the evolution of Darwin's great theory, and how the great man's monograph on barnacles may have contributed. It is not too hard to conceive that the minute investigations of filter feeding crustaceans may have sent Charles' brain slightly doolally, perhaps resulting in the fits of genius that gave rise to the Origin of Species. This must surely give hope to all those researchers who spend hours looking down microscopes at the mandibles of worms and the opercular tubercles of gobiids. Just a thought. Till next time reefers,

Spyhopper

Outraged by the audacious Spyhopper? Reply care of the Editor, address on back page.

BOOK REVIEW

The Ecology of the Indonesian Seas

Tomas Tomascik, Anmarie Janice Mah, Anugerah Wontji and Mohammad Kasim Moosa

ISBN 962-593-078-7 Volume VII 642 pp. ISBN 962-593-163-5 Volume VIII 746 pp. The Ecology of Indonesia Series. Garuda Indonesia, Periplus Editions (HK) Ltd, 1997

Sound knowledge and information are vital to good decision making in living resource management and biodiversity conservation. Less of this information exists for marine ecosystems than terrestrial ones, and much of what does indeed exist is highly scattered, especially for tropical countries. The two volumes of The Ecology of Indonesian Seas make an important contribution to the knowledge which exists of tropical marine ecosystems. The importance of that contribution can be appreciated from the size of Indonesia's extended economic zone (EEZ), 5.4 million km^2, the world's second largest national EEZ, and from the fact that Indonesia encompasses more of the world's marine biodiversity than any other country. The many other countries which Indonesia borders will also no doubt find these volumes useful and applicable to their own waters.

Indonesia is the heartland of coral biodiversity

Twenty three chapters, spanning 1,388 pages in these two volumes, contain a wide coverage of subjects including: geology, oceanography, coral reefs, foraminifera, sea grasses, mangroves, the pelagic system, marine and coastal diversity and resource management, as well as human impacts. The chapters are well organized, and describe both the global situation, and Indonesia's role within this global context. Information provided gives Indonesians easier access to pertinent international literature, doubling the utility of the volumes.

…a splendid and enormous contribution

As coral reefs are amongst the most biodiverse and biologically productive marine ecosystems, and as Indonesia is the heartland of coral biodiversity, it is not surprising that 12 chapters are devoted to aspects of coral reefs. Topics include geological history, scleractinian reef builders, natural disturbances, growth and development, fringing, patch and barrier reefs, atolls and cays. The information is, overall, well digested and up-to-date. However, finalizing the vast amount of material for publication by 1997, did not permit much reference to the increasingly strong evidence for links between widespread coral reef bleaching and death due to elevated sea surface temperatures (SST). Satellite SST data and ground truthing have enabled identification of the critical thermal values.

Increasing global temperatures, eutrophication and sedimentation, driven by population and global economic forces/crises, provide reason to be less optimistic about the fate of coral reefs than when the chapters were written before 1997. The authors use boxes throughout the book to bring updates to the text and to provide contributions from other scientific experts which focus on particular topics.

The volumes are very well edited and are enhanced by the clarity of the language. Glossaries explain technical terms and ensure that the information is readily available to a wide readership and to those working in a second language. The line drawings are high quality, and most of the black and white photos have sufficient contrast for clarity. Nineteen color plates in Volume 2 provide graphics from satellite to reef organism level. The 89-page list of references reveals the immense amount of information drawn upon for the text and further increases the reader's admiration. Thirty-four pages of subject and generic indices are also provided.

This is a splendid and enormous contribution to the knowledge of the ecology of Indonesian seas. The volumes contain new findings and summarize a panoply of existing knowledge in a very readable and accessible manner. The book is highly recommended to those interested in Indonesian and Southeast Asian seas, or in global aspects of biodiversity. The authors, the Indonesian government, Dalhousie University in Halifax, Canada, and the funding body, the Canadian International Development Agency (CIDA), are to be highly congratulated for these impressive volumes. Other countries would do well to emulate the Ecology of Indonesia

Series and to accompany them with a series of taxonomic monographs and guides.

Don E. McAllister, Ocean Voice International
Box 37026, 3332 McCarthy Road
Ottawa, Ontario K1V 0W0, Canada
Email: <mcall@superaje.com>
*This article, commissioned for **Reef Encounter**, was printed in **Sea Wind—Bulletin of Ocean Voice International** 13(1).*

Corals of the Indian Ocean

Sheppard, C. 1998. Corals of the Indian Ocean. CD-ROM. Swedish International Development Agency (SIDA) and Canadian International Development Agency (CIDA)

Without fail when preparing for fieldwork, I mentally try to calculate how many identification books I can squeeze into my bags without giving the check-in agent at the airport a heart attack or getting stung by a horrendous excess luggage fee. Earlier this year, I had the opportunity to take the Corals of the Indian Ocean CD-ROM to the Seychelles, and with great enthusiasm I grabbed the disk and left the texts on the shelves with a satisfying laugh, thinking 'not this time you don't.' Those of you who are spared the ignominious task of packing for fieldwork will also appreciate the simplicity and obvious advantages of the CD-ROM format.

This CD is the first installment in a series which aims not only to document the rich marine biodiversity and biogeography of the Indian Ocean, but to serve as identification guides, and tools for mapping and education. Already the next in the series, Mangroves and Seagrasses of the Indian Ocean, has been produced (see below) with soft corals, molluscs, fishes and echinoderms to follow in the near future. The major funding bodies of this first installation were the Swedish International Development Agency (SIDA) and the Canadian International Development Agency (CIDA). Both organisations should be lauded for recognizing the very useful nature of a CD of this kind for the scientific community and general public. SIDA will remain involved with the series and is clearly demonstrating a commitment to the marine environment of the Indian Ocean with this and other programs such as CORDIO (COral Reef Damage in the Indian Ocean) which was initiated earlier this year. Other agencies would do well to follow in SIDA's footsteps.

> How many ID books can I squeeze into my bags without giving the check-in agent a heart attack?

Having completed the CD program installation process the user is given the option of accessing the coral database via alphabetic or taxonomic order. For the non-specialist either option becomes daunting when faced with the list of 178 coral species. Although these species constitute the most common and visually easily identifiable in the Indian Ocean, and indeed the Red Sea, this is no help for those who are neophytes to the identification of corals. This is where a brief taxonomic key would be useful to facilitate access to the database and narrow down the species the user has to scan before coming to the one they are looking for. However, let this not detract from this exceptional work and the remarkably multipurpose and useful nature of the CD which becomes readily apparent.

Each of the coral species listed in the database is presented with at least one high resolution color photograph displaying the most common form of the species. In a number of cases there are multiple images displaying a range of gross morphologies, identifiable characteristics and close-ups of the polyp structure. Additionally, there are excellent black and white images detailing the complexities of the skeletal, and in particular, the corallite structure of each of the species. This feature provides further essential information by which coral species can be distinguished. Each of the images can be enlarged for viewing in greater detail and all have accompanying text which describe the features and characteristics used to identify the species being examined. The description also includes notes on the habitat where the coral is likely to be found on the reef. Certainly one of the distinct advantages of the CD is evident here as it allows the user to make additions or edits to the text creating customized descriptions. These alterations are then saved on the hard drive and accessed when the CD is next used on the computer. This feature provides great user flexibility as one is able to write text which is directed at those of varied academic levels and backgrounds. Given that the countries of the Indian Ocean represent a high

diversity of languages, production of a CD to accommodate all of these would be a lengthy process. By allowing edits to the text, the CD can be translated by researchers working in countries where English is not the dominant language.

A map of the Indian Ocean indicating where the coral species being examined have been reported compliments the images and text. Localized species maps (up to 30m resolution!) can be created by the user and annotated with the location of personal observations of the coral species in question. This not only generates a site specific database, but allows the researcher to conduct biogeographic investigations at a wide range of spatial scales. Although it is not possible to geographically query the database on the distribution of coral species, the CD does come with spreadsheets which detail the sites and the coral species located there.

the CD allows additions or edits to the text, creating customized descriptions

This CD project is by no means complete and is constantly evolving as our knowledge of corals in the Indian Ocean is improved. The author of the CD encourages users at all levels to contribute information, databases generated and photographs for future iterations. CD technology clearly has its advantages in this respect by allowing the new versions to be produced at low cost. However, the prerequisite of a computer with a CD-ROM drive to access the database is an obvious limitation. This is a situation which one hopes is improving as agencies like SIDA provide technological infrastructure to countries to aid local marine biogeographic mapping and resource management programs and initiatives.

This CD is not the final word on the diversity of coral species in the Indian Ocean nor does it purport to be. One cannot help but find much praise for a piece of work which allows such user flexibility and input to the creation of further versions. This CD will certainly find a place in my bags for many days of fieldwork to come and I recommend it to not only other researchers but to those who want to begin to find their way through the complexities of coral identification and taxonomy.

Kristian A. Teleki <kat1003@cus.cam.ac.uk>
For further information contact the convenor of the series Charles Sheppard.
Email: <sh@dna.bio.warwick.ac.uk>

Mangroves and Seagrasses of the Indian Ocean

Phillips, R. and Spalding, M.D. 1999. Mangroves and Seagrasses of the Indian Ocean. CD-ROM. Swedish International Development Agency (SIDA). Contact the convenor of the series for details: Charles Sheppard Email <sh@dna.bio.warwick.ac.uk>.

Mangroves and seagrasses are widely regarded as key biological habitats. They are often a vanguard for the promotion of marine resources conservation, particularly in developing countries such as those around the Indian Ocean. Appropriate conservation practices leading to sustainable use of mangrove and seagrass habitats, as well as of other biological resources dependent on these habitats, are an urgent requirement in this region. I know from my own experience in the Western Indian Ocean region that little information on these habitats has as yet to be gathered and that few educational programs are currently being undertaken in this field.

These superb photographs cover nearly all of the taxonomic details of mangroves and seagrasses.

The Mangroves and Segrasses of the Indian Ocean CD-ROM by Ron Phillips and Mark Spalding is an excellent piece of work. It can be accessed easily and is constructed to attract both readers and viewers. The CD-ROM describes 25 species of mangroves, including one palm and one fern mangrove species, and 16 species of seagrasses. More than 200 superb photographs and drawings cover nearly all of the taxonomic details of mangroves and seagrasses. Most of these pictures have been taken *in situ* and can be seen in two sizes on the computer screen. English, French and Creole names are pro-

vided for the mangrove species, although the Portuguese names are missing. Considering the length of the Mozambique coastline—nearly 3000 km (close to one-third of the eastern African mainland coastline), and the fact that Mozambique possesses the largest mangrove forests in Africa, this seems a significant omission.

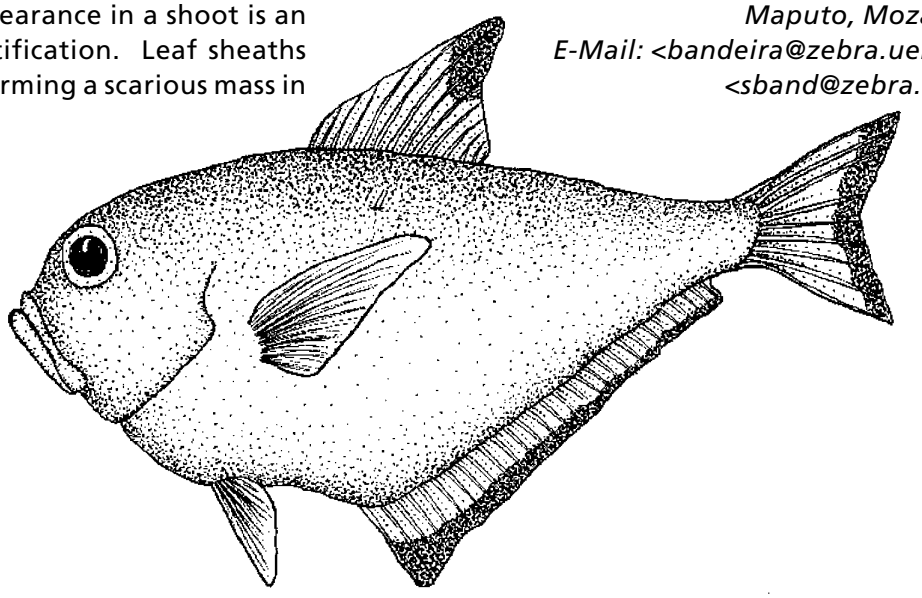
The mangrove text has been written concisely with key words for the reader to learn mangrove identification quickly. The text is accurate in providing key characteristics for identification, basic ecological parameters of the species and information of their zonation or association. Characteristics for identification include leaf form, bark color and texture, fruit shape, size and shape of pneumatophores, etc. I was delighted to read a further differentiation between *Sonneratia alba* and *Avicennia marina* based on the shape of the pneumatophores, being conical in *S. alba* and pencil-like in *A. marina*. The photographs in this section make you feel you are in a mangrove forest! They show detailed taxonomic information and give an insight into the characteristic habitat.

Above-substrate taxonomic features were used to characterize different seagrass species and these are clearly shown by the accompanying photographs and drawings. The minutely serrulated leaves of *Halophila stipulacea* are one very good example of this. Some emphasis could have been given to the below-substrate features such as shoot insertion in the rhizome sequence of nodes. Leaves become detached from a shoot after a certain age, which can be measured in days or weeks. This together with leaf sheath appearance in a shoot is an important feature for identification. Leaf sheaths can be persistent features forming a scarious mass in species such as *Cymodocea rotundata* and *Thalassia hemprichii*. Alternatively, the leaf sheath can have a rather triangular shape in species such as *Thalassodendron ciliatum* and *Cymodocea serrulata* and become detached when old. Extremely long leaf blades of *Enhalus acoroides* (up to 150 cm long) and the presence of translucent transverse veins on the leaves of *Zostera capensis* are very distinct characteristics of these species not appearing in the text. Due to the little research in Africa the distribution map of some seagrass species requires updating e.g. both *Halophila stipulacea* and *Halophila minor* occur in Tanzania and Mozambique, as well as *Enhalus acoroides* in Mozambique. I also believe *Halodule wrightii* occurs in some island states of the western Indian Ocean e.g. Comores.

a valuable tool for educational purposes at any level

The convenors and the Swedish International Development Agency (SIDA) must be congratulated for producing this important material. Indeed, this CD-ROM is invaluable, and I believe this is the best work to date documenting mangroves and seagrasses of the Indian Ocean region as a whole. The CD-ROM should be recommended for promoting of the identification and mapping of mangroves and seagrasses in the Indian Ocean region, and thereafter, could help to establish linkages with aspects of resource conservation. This wonderful work is also a valuable tool for educational purposes at any level from school children to university students to politicians.

Salomão O. Bandeira,
Department of Biological Sciences,
Universidade Eduardo Mondlane, P.O. Box 257
Maputo, Mozambique,
E-Mail: <bandeira@zebra.uem.mz> or
<sband@zebra.uem.mz>



BOOKSHELF

Status one Coral Reefs of the World

Edited by C. Wilkinson. Published on behalf of the GCRMN by the Australian Institute of Marine Science.

The Global Coral Reef Monitoring Network published its first comprehensive report in November last year. A limited number of hard copies have been made available to institutions, and the full text is now available on the internet through the AIMS Page at: http://www.aims.gov.au/scr1998. Formed at the International Coral Reef Initiative meeting in Dumaguete, Philippines in 1995, the GCRMN is tasked with producing reports on the ecological condition of coral reefs for international forums. This report includes many updated papers on the regional status of coral reefs, some of which were first presented at the 6th ICRS in Panama, 1996. There is also a major section on the 1997-1998 mass bleaching event. A further report is planned for 2000. Comments or corrections are welcomed. Contact Clive Wilkinson at Email: <c.wilkinson@aims.gov.au>.

Online Bioscience Journals

The UK charity, Electronic Publishing Trust for Development (EPT) is supporting the online publication of a number of less well-known bioscience journals published in developing countries. They include the Ichthyological Bulletin and Special Publications, both from the JLB Smith Institute of Ichthyology at Grahamstown, South Africa and the Indian Journal of Marine Science from CSIR, New Delhi, India. Marine science papers can also be found in the Tropical Biodiversity journal from Indonesia and a number of other publications found on the same site. Access to the journals is via the EPT home page at http://dspace.dial.pipex.com/bioline/ or the Bioline system, which hosts the journals, at http://www.bdt.org.br/bioline/journals.

Reef Evolution

Rachel Wood, Oxford University Press, Oxford UK. 122 illustrations, 256 pages. £55.00 (hardback) ISBN 0-19-854999-7, £19.99 (paperback) ISBN 0-19-857784-2.

This text documents those biological innovations which have moulded the evolution of reef ecosystems and given rise to the highly complex reef communities found today. The appearance of clonality, the acquisition of photosymbiosis and the radiation of predator groups are discussed in depth. Data from the fossil record documents the evolutionary development of reef ecosystems. This interdisciplinary approach aims to provide an analytical text which will appeal to biologists, ecologists and geologists with interests in ancient and modern reef ecology.

DIVE MALDIVES: A Guide to the Maldives Archipelago.

Tim Godfrey. Atoll Editions, Victoria, Australia. 2nd edition, 1998. 152 pages, softcover, ISBN 1-876410-00-0. In: English, German, Italian. US$29.95 from www.atolleditions.com.

Tim Godfrey's Dive Maldives is a first rate production reflecting his careful observation and attentive listening during his 12 years experience in the Maldives. Two hundred and seventy dive sites in the tourism zone are described in detail based on Tim's experience augmented with that of others routinely diving the sites. This knowledge has been distilled into concise text brought to life with illuminating detail, photographs and professionally illustrated maps and figures. The maps, ranging in scale from regional to atoll to dive site maps, follow a standard presentation using intuitive symbols. The symbols

describe various aspects of the dives sites and site locales including the physical aspects of the reef and the more conspicuous animals. The dive difficulty of each site is indicated next to the site name. Dive site maps are provided for the most important sites including the 15 marine protected areas. The reader can learn a great deal about a prospective dive site at a glance. The chapter "The Reefs of the Maldives" covers important general topics tuned with locally relevant details, such as climate, currents, tides, dive safety and special sites such as marine protected areas and shipwrecks. The sections on coral reef structure and maritime history put the Maldivian dive experience in context and the maps and definitions of local terms for reef features are very useful for accurate documentation of locations visited and communication with boat crews about desired locations. The book is not a photographic atlas but the 191 well-captioned photographs are eye-catching and informative. Ease of use is further enhanced by the index of fish, dive sites, resorts and live-aboard vessels. Dive Maldives with its contact information, local flavor and maps is an invaluable resource and working souvenir for anyone contemplating a scientific expedition to Maldives. The excellent maps are also available in sheet format and as an atlas/directory called Malways.

William (Bill) Allison
is a Reef Ecologist living in Male.
Email: <wallison@dhivehinet.net.mv>

The Northern Great Barrier Reef

This 1978 publication from The Royal Society derives from a discussion organized by D. R. Stoddart and Sir Maurice Yonge and contains 172 pages. Copies are available for US$25, including postage. Orders should be directed to Daphne Fautin, 1930 Constant Avenue, Lawrence, Kansas 66047 USA. Email: <fautin@ukans.edu>

Proceedings of the 28th Meeting, Association of Marine Laboratories of the Caribbean (AMLC)

San Jose, Costa Rica, 21–25 July, 1997.

This Special Issue of the Revista de Biologia Tropical is available at $15 a copy, including delivery by Air Mail. Send check payable to FUNDEVI and send to: Jorge Cortés, CIMAR, Universidad de Costa Rica, San Pedro, Costa Rica

Zone Performance Report: No-Take Zones in Florida Begin to Increase Fish and Lobster Populations

After their first full year of protection, 23 no-take zones within the Florida Keys National Marine Sanctuary (FKNMS) are showing signs of restoring spiny lobster and fish populations. Established in July 1997, the zones comprise less than one percent of the 2,800 square nautical miles FKNMS, but aim to protect critical coral reef habitat. Ben Haskell, sanctuary science coordinator suggests the quick response is a good indication of intense exploitation outside the no-take zones. Lobsters of legal size are now significantly larger within the zones. Surveys of economically important fish also showed some increases compared to a long term baseline. Herbivory rates may have declined as numbers of predators increase. Copies of the first year Zone Performance Report are available from Ben Haskell at Email: <bhaskell@ocean.nos.noaa.gov>.

Participatory Coastal Resource Assessment:
A handbook for community workers and coastal resource managers.
Walters, J.S., Maragos, J., Siar, S. and White, A.T. Coastal Resource Management Project and Silliman University, Cebu City, Philippines. 113p.

With a strong emphasis on participation, this handbook aims to help community workers maximize their contribution to coastal resource assessment, and to ensure dialogue with community stakeholders. The text is aimed at the Philippines and has an extensive list of local names and terms for coastal resources. Three chapters give an overview of techniques, detailed methods, and a section on interpreting results. Sections cover data collection and organization, mapping, and displaying findings. Acceptance in and familiarity with the community are assumed, but the text includes advice on interviewer sensitivity to ethical and political considerations. The motto is 'learning by doing'.

Available from the
Coastal Resource Management Project.
Email: <prccebu@usc.edu.ph>
Website http://www.oneocean.org

TAMBULI: A Publication for Coastal Management Practitioners

This newsletter is published biannually by the Coastal Resource Management Project in the Philippines. It is distributed free of charge on request. Articles cover all aspects of conservation, sustainable development, community management, news, upcoming events, lists of recent publications, and a 'how to' section. Contributed articles are encouraged. More information from Email: <prccebu@usc.edu.ph> Website www.oneocean.org

MEETINGS

International Conference on Scientific Aspects of Coral Reef Assessment, Monitoring and Restoration

Fort Lauderdale, Florida USA. 14–16 April 1999

The scientific program of the Conference included 4 plenary speakers, 1 keynote speaker, 8 special sessions, 10 general sessions with 130 oral and 130 poster presentations. There were 475 participants from 39 countries.

The focus of this conference was:

- To examine and comment on current aspects of reef assessment, monitoring, and restoration in a rigorous, scientific approach.
- To facilitate interaction of a global network of research and training for reef scientists, technicians, and resource managers that is responsive to needs.
- To identify and promote discussion on emerging aspects and techniques of coral reef assessment, monitoring, and restoration that show sound theoretical and technical promise for providing enhanced understanding of reefs.

Despite the diversity of interests among the coral reef scientists, resource managers, and conservationists who participated, six major themes emerged clearly

during the course of the Conference:

1. Persuasive evidence exists for systemic declines in corals and reef communities worldwide.
2. Reef systems are already showing distinct and measurable responses to global stresses, and may do so at an accelerating rate in the future.
3. Any attempts to protect the world's remaining healthy reefs from further degradation must include quick and decisive action at a variety of spatial scales ranging from local to global.
4. Meso- and large-scale, time-dependent integrated risk assessment, and risk management protocols are needed which operate through a cooperative research center model.
5. A global network of coral reef marine protected areas (MPAs) can ensure the long-term survival of high value communities, but an increased emphasis on scientific protocols to site and monitor effectiveness of MPAs is urgently needed.
6. The science of coral reef restoration-rehabilitation is in its formative stages and has promise for expediting reef recovery. The development of reef restoration into an effective management tool will require approaches that encompass hypothesis-based measures of efficacy and outcome assessment.

The Conference was sponsored by the National Coral Reef Institute of Nova Southeastern University Oceanographic Center. A limited number of Abstract books remain available. Abstracts will be posted to the NCRI web site http://www.nova.edu/ocean/ncri/conf99sum.html as will further Conference outcome information. Conference Proceedings will be published in a special issue of the Bulletin of Marine Science in late 1999 or early 2000. Conference shirts, an early sell out at the meeting, are now available by contacting the NCRI office via Email: <ncri@ocean.nova.edu>; Tel: (954) 923-3390), or Fax: (954) 921-7764.

Coral Reef Restoration: The Status of the Science

A Summary of the *Special Sessions on Restoration* at the NCRI—International Conference on Scientific Aspects of Coral Reef Assessment, Monitoring, and Restoration, April 14-16, 1999, Fort Lauderdale, Florida, U.S.A.

Coral reefs around the world have changed dramatically over the past two decades. Many types of disturbance, separately and in combination,are changing the face of reefs. These include: hurricanes, coral bleaching, diseases of corals and sea urchins, over-fishing, nutrient loading, sedimentation, hyper- and hypothermic stress, various forms of pollution, harvesting of reef invertebrates, coral mining, trampling by tourists and divers, and the destruction and devastation caused by ship anchors and groundings. It is obvious that this resource needs protection, and that many of the cited anthropogenic causes can be reduced or avoided by implementation of scientific-based management programs.

If we keep up the present rate of destruction, reef ecosystems will likely suffer continued significant degradation, possibly to the point of irreversible decline. To continue on the same course is imprudent - it is imperative that we act now to shift this imbalance. It is possible that the most appropriate course of action is to replace damaged and disturbed reefs with fully functional, restored ecosystems at a rate where reef destruction is offset by reef repair. To date, most coral reef restoration programs have been focused on the physical damage caused by man. Of these, ship groundings are among the most destructive chronic anthropogenic factors causing significant localized damage on coral reefs and have been the focus of many early attempts at reef restoration. Managers and policymakers need to understand the effects of human-induced disturbances, be able to properly assess these damages, and develop subsequent restoration efforts on reefs under their stewardship.

At the NCRI meeting delegates attempted to bring this applied science to the forefront. A general session on reef restoration was chaired by Richard

Dodge. Five special sessions covered restoration following anthropogenic disturbance, improved decision making, the use of artificial structures, enhancement of sexual recuritment for coral reef restoration and adaptive management.

These sessions have forged a scientific framework for future efforts. The main themes to come out of this conference include the following:

- The most widely accepted definition of restoration is "the return of a habitat to a close approximation of its condition prior to disturbance". This includes placing all restoration efforts in a landscape context where the restored patch is integrated into an ecosystem context.
- The type and level of proposed restoration should be commensurate with the level of injury sustained by the resource.
- As we move into the new millennium, it will be imperative that we restore anthropogenically disturbed reefs to a level that closely resembles (both functionally and aesthetically) a pre-injury baseline.
- Restoration should be performed as soon as possible after the injury to the resource to reduce the amount and duration of lost ecological services.
- Science and not legal precedence must guide future restoration efforts.
- Developing countries could be aided by the development of low cost and low-tech restoration programs.
- Coral nursery programs and the use of cultured coral larvae could lead efforts to return coral cover to damaged reefs, especially in areas that are recruitment limited.
- Although quantification of reef restoration projects has been slowly increasing over the past decade, our level of understanding varies greatly based on our personal experiences. Compared to terrestrial and wetland restoration with thousands of implemented projects, coral reef restoration is in its infancy (tens of projects).
- Socio-economic criteria and cost-benefit analysis of proposed restoration alternatives need to be developed and addressed.
- A general lack of quantitative descriptions of the ecological effects of anthropogenic disturbance on coral reefs and an even greater lack of data describing the direction and rate of natural reef recovery hampers efforts to find appropriate solutions to particular damage scenarios. There is little basis for understanding what works, what does not, and why.
- We need to set goals for what we are ultimately trying to accomplish with restoration.
- Hypothesis driven, ecological studies and quantitative, long-term monitoring programs are the only means of answering many of these critical questions. Formulating and testing hypotheses about the response of both corals and reefs to these disturbances allows us to establish: a) the scientific protocol necessary to design and implement restoration strategies (by setting definable scientific goals), b) a baseline for developing quantifiable success criteria, and c) the efficacy of the restoration effort.
- Various methods as well as different locations may produce unexpected results. Accordingly, if restoration designs are not meeting the desired objectives, they should be modified or revised as part of the greater vision of the whole ecosystem. The use of adaptive management techniques to guide future restoration efforts is also an important approach.
- Reef restoration is a multidisciplinary effort. Accordingly, the implementation of successful projects will require a team of dedicated individuals. This team should include biologists, geologists, engineers, economists, and others as required, each committed to a common vision.
- Important ethical questions need to be addressed for the future, these include "Should only anthropogenically damaged reefs be considered for restoration?"

It is possible that the most appropriate course of action is to replace damaged and disturbed reefs with fully functional, restored ecosystems

It is to be hoped that some of these lessons learned will help to develop successful restoration efforts into the future. In addition, because of the infancy of this enterprise, the continued sharing of information will be vital to improving restoration strategies over time. The status of reef restoration has improved a great deal in a very short time. As reef scientists and managers we should all be excited with the opportunities that lie ahead.

William F. Precht,
7310 Poinciana Court, Miami Lakes, FL 33014 USA.
Email: <BPrecht@kennesaw.Lawco.com>

International Tropical Marine Ecosystems Management Symposium (ITMEMS)

The International Tropical Marine Ecosystems Management Symposium (ITMEMS) was held in Australia in November 1988. Participants from 49 nations, and a wide range of international, government and non-government organizations attended. The Symposium bought together managers, decision makers, scientists and community representatives in an unusual forum which had three tasks. The first was to review and evaluate the extent and the success of the program of action recommended by the International Coral Reef Initiative (ICRI) at its meeting in Dumaguette City, Philippines 1995. The second was to update the framework and priorities of action to establish the basis for work which will provide for conservation and management of reefs in the immediate future. The third task was to provide a peer group forum for managers to share experience and develop professional networks for peer support in management related work.

ITMEMS reaffirmed the Call to Action adopted by the ICRI in June 1995. In doing so, ITMEMS reaffirmed the importance of reefs to the cultures, communities and economies of tropical, coastal and island areas, and the strong relationship between healthy reefs and the sustainable livelihoods of many sectors of society.

ITMEMS reaffirmed the importance of reefs to the cultures, communities and economies of tropical, coastal and island areas.

In the first phase of the workshop, participants considered progress reports from the various regions which have coral reefs. Following this delegates then separated in to a series of workshops that used case studies from around the world to consider a series of issues relating to the management of tropical marine ecosystems. The workshops addressed such topics as coastal development, pollution control, fisheries and protected areas, protected areas in the private sector, tourism and protected areas, destructive fishing practices and collecting methods, and coral reef assessment and monitoring. In these workshops participants analyzed the successes and failures of the case studies in order to identify clearly the lessons learned for each of the above issues.

In a second step, participants considered the lessons learned from the initial workshops in terms of four general and cross cutting or multidisciplinary needs that underlie all management efforts. These needs were identified in the regional strategies developed through the International Coral Reef Initiative in the period 1995 to 1997. Based on the lessons learned and experience of ICRI these needs were reiterated and can be expressed in the following four statements.

- Successful integrated management requires coordination and linkages with other programs, initiatives and legal instruments.
- Stakeholder partnerships and community participation are essential elements for effective management and they require the development of culturally sensitive processes of empowerment.
- Public awareness and education including capacity building are required to highlight problems and to support effective management.
- Data and information, both in accessible and understandable forms, from a wide range of sources are fundamental to successful management.

An enormous wealth of experience was present along with an eagerness to share knowledge, discuss issues and identify priorities.

The design and conduct of ITMEMS was largely experimental. People from the disparate worlds of management, government, non-government, community action and science were bought together. Stakeholder considerations and discussions of case studies were the focus rather than detailed presentation of papers with formal question and answer sessions. An enormous wealth of experience was present along with an eagerness to share knowledge, discuss issues and identify priorities. Delegates worked long hours and the Chairs and Rapporteurs made prodigious efforts to synthesize reports which were representative of the contributions and recommendations from the wide range of

experience present at ITMEMS.

Inevitably there was considerable overlap in the lessons learned and the priority actions identified by the four cross cutting workshops. The first lesson learned was that an additional one or two days could have usefully been added to the Symposium in order to achieve more complete discussions and synthesis of priorities. There were differences in approach and expression which reflected the wide ranging nature of both the issues addressed in the workshops and the professional disciplines of the participants.

The ITMEMS participants identified a number of recurring priority issues, which they saw as important to amplify and strengthen the efforts of all those in the ICRI partnership.

Issue - Ignorance is destroying coral reefs and related ecosystems

Response - Launch multi-facetted, global to local level mass marketing awareness campaigns to change the behavior of people. Bridge the gap between global knowledge and local action through the creation of national coral reef initiatives.

Issue - Pollutants, including sediments and nutrients from land based human activities severely threaten the health of coral reef ecosystems.

Response - Develop and implement participatory integrated coastal management strategies that incorporate water sheds.

Issue - Destructive and unsustainable fishing practices, such as cyanide, explosives, trawling and other forms of drag-netting, as well as overexploitation, are destroying coral reefs and related ecosystems.

Response - Commit to eliminating fishing practices that are not demonstrably sustainable, by promoting effective enforcement, alternative methods and market incentives.

Issue - Activities of the private sector, including tourism and the trade of coral reef products, can protect or destroy coral reef ecosystems.

Response - Work with the private sector to foster appreciation of the value of coral reefs and encourage the private sector to use and protect coral reefs and related ecosystems in ecologically sustainable ways by introducing incentives, such as awards and accreditation for better environmental practices.

Issue - An ecosystem approach to management is needed to conserve and restore the values and functions of coral reefs and related ecosystems.

Response - Implement an integrated approach to management, that includes effective marine protected areas, including "No Take" zones, as a vital component in managing human activities within the larger biogeographic frameworks.

Issue - Recognition of traditional knowledge and management systems is vital.

Response - Increase the confidence and capability of communities to manage sustainably and to conserve resources through capacity building and validation of their traditional practices. Integrate traditional and modern approaches to management for effective results.

Issue - Projects have failed because they have not taken into account socioeconomic and cultural factors.

Response - Socioeconomic and cultural factors are essential components in developing community-based management programs, for tailoring management to local conditions, and for demonstrating the value of tropical marine ecosystems to policy makers and users.

Issue - Managers and communities are not getting the information and management tools they need to make sound management decisions.

Response - Create and use networks of knowledge based management systems through networks of people, ideas and information to promote science-based management and public participation in that process.

Issue - Data produced by the global coral reef monitoring network (GCRMN), Reef Check and other innovative programs have proven the value of monitoring to global reef assessment and local management, but more widespread monitoring is needed.

Response - Strengthen physical and socioeconomic monitoring efforts on all scales to improve management effectiveness, and to secure long-term financing.

Issue - Lack of funding undermines actions to address threats to coral reefs, to monitor their health, and assess the impact of management practices.

Response - Develop financing in a strategic manner at local, regional and international levels.

Issue - Coral reefs are the life support systems for the existence for small island developing states and many coastal communities of developing tropical countries.

Response - Urge governments to promote the consideration of this report during the next session of the Commission on Sustainable Development (CSD) as part of its review of small islands developing states, oceans and sustainable tourism issues in 1999. The CSD is urged to recognize this vital relationship and support immediate and effective action to understand and address the threats to these ecosystems.

Urge governments to promote ICRI goals within the World Heritage and RAMSAR Conventions, in implementation of the Convention on Biological Diversity and its Jakarta Mandate as well as other relevant international and regional instruments.

ITMEMS also provided an opportunity for global experts to agree with statements on two of the major issues which have impacted coral reefs in recent years, namely coral bleaching and the predation of the Crown of Thorns Starfish.

The ITMEMS identified gaps and priority actions for conservation and management of coral reefs. The outputs of ITMEMS are a renewed Call to Action which has been published by The Great Barrier Reef Marine Park Authority and is available through the Authority's website (www.gbrmpa.gov.au). A more substantial Report of the Workshop proceedings will be published shortly and will also be made available through the Authority's website. These two documents provide a wealth of information and practical suggestions for action which have relevance not just to coral reefs and related ecosystems, but to most of the world's coastal and marine environments.

Richard Kenchington,
Great Barrier Reef Marine Park Authority,
PO Box 791, Canberra, ACT 2601, Australia
Email: <r.kenchington@gbrmpa.gov.au>

DIARY

World Coral Reefs in the New Millenium: Bridging Research and Management for Sustainable Development

9th International Coral Reef Symposium

The Indonesian government, with the support from the Indonesian scientific community and **ISRS**, is honored to host the 9th International Coral Reef Symposium at the Bali International Convention Center, Denpasar Bali, 23-27 October 2000.

Scope of Discussions

- **State of Knowledge:** What coral reefs are, how they have developed, what inhabits them, and how they function in natural and stressed environments; exciting new insights, technologies and approaches; the roles and significance of history, geology, evolution, the physical environment, water quality, and ecological interactions.
- **Resource Management:** Approaches to sustainable utilization of coral reef resources while achieving conservation goals; managing risk and uncertainty, performance indicators for management.
- **Socio-Economic Values:** What are they and are we using them wisely? What are the best incentives for good environmental practice? Public awareness and education; legal aspects; law enforcement.
- **Assessment, monitoring, rehabilitation:** The 'why, where, what, how, and how much' of assessment, monitoring and rehabilitation; ecological goals and performance indicators.
- **The Future of Coral Reefs:** ICRI's Framework of Action and its implementation; global climate change and adaptation in coral reefs: implications for people.

Objectives

The symposium will provide an international forum for exchanging information and ideas and transfer of technologies and knowledge among researchers, managers, policy makers and other stakeholders in coral reefs. It is also aimed to encourage cooperation among the coastal states in the tropical regions to meet:

1) Regional needs of sustainable coral reef development and management for mutual benefits, and
2) Global needs for interdisciplinary and international monitoring and assessment of direct human impacts and global climate change on coral reef productivity, biodiversity and ecosystem function.

Categories of presentation:

- ***Invited papers:*** plenary speakers will cover key issues of global concern for coral reefs.
- ***Contributed papers:*** will relate to coral reefs and fall within the broad "Scope of Discussions".
- ***Mini-symposia papers:*** will contribute to more specific topics defined by participant organizers.

Mini-Symposia topics—deadline August 15, 1999

Persons interested in leading a mini-symposium and taking responsibility for organizing peer-review of papers within that mini-symposium should complete Form 4 available on http://www.nova.edu/ocean/9icrs. (See Proceedings of earlier symposia for earlier examples - but be imaginative!)

Abstracts—deadline April 30, 2000

Abstracts (maximum of 300 words) should be submitted by April 30, 2000. Format may be copied from the homepage http://www.nova.edu/ocean/9icrs .

Full paper—deadline December 30, 2000

Papers submitted for inclusion in the Proceedings will be peer reviewed.

Publications

The program / schedule and abstract book will be available at registration. The proceedings will be distributed as soon as possible, but likely at least one year after the symposium.

Language

English will be the official language for the Symposium and no simultaneous translation facilities will be available.

Scientific Program

Plenary Sessions A plenary session will take place each morning, with a second immediately after lunch. Keynote and other invited papers will be delivered during the plenary sessions. No concurrent activities will be conducted during the plenary sessions.

Parallel Sessions Ten separate groups will carry out simultaneous parallel meetings, including contributed papers and mini-symposia.

Poster Sessions Posters are welcomed. Space and boards will be provided upon request. Posters must be easily readable from a distance of one meter and should be visually attractive and professional in appearance. During viewing times in the morning and in the afternoon, authors are expected to be near their posters to answer questions.

Satellite Meetings Groups of participants arranging satellite meetings can book rooms, provided the organizer is informed well in advance.

Registration

The registration fee will cover all scheduled activities, such as scientific sessions, receptions, symposium banquet and symposium publications. Accompanying persons will be eligible for all ICRS events, but will neither present a paper nor receive a copy of the symposium proceedings.

	Before July 30, 2000	After July 30, 2000
Participating ISRS:		
• Full	US$ 450	US$ 500
• Student	US$ 175	US$ 225
Participating Non-ISRS:		
• Full	US$ 500	US$ 550
• Student	US$ 225	US$ 275
Accompanying Person	US$ 300	

Visas

The Government of Indonesia will facilitate entry visas for all persons attending the Symposium. Obtain advice from your travel agent regarding individual visa requirements. If you need a visa before departure please tick the box marked 'Issue of Visa requested' on the registration form and indicate your passport number and date of expiry.

Registration and general inquires:-

9th International Coral Reef Symposium
Royalindo International
Hotel Wisata Internasional,
Suite 302, Jl. M.H. Thamrin

Jakarta
INDONESIA
Attention: Ms. Evita Nursanty, Managing Director
Tel. (62-21) 314 0982
Fax. (62 - 21) 334 470, 315 0886
Email: <evita@royalindo.co.id>

Abstracts and suggestions for Mini-Symposia:

Dr David Hopley
Chair Scientific Program Committee 9ICRS
c/- CRC Reef Research Centre
James Cook University
Townsville
Queensland 4811
AUSTRALIA
Phone/Fax: (61 7) 47 79 1400
Email: <David.Hopley@ultra.net.au>

Access through Website

You can register, submit abstracts and propose mini-symposia through the Conference Homepage at http://www.nova.edu/ocean/9icrs

Supporting Institutions

The State Ministry of the Environment of the Republic of Indonesia, Indonesian Institute of Sciences, Directorate General of Forest Protection and Nature Conservation, Directorate General of Tourism, Indonesian Association for Coral Reef Studies (IACRS), Coral Reef Rehabilitation and Management Program (COREMAP), National Marine Council (Dewan Kelautan Nasional), Provincial Government of Bali, National Development Planning Board (BAPPENAS)

International Workshop on the Extent and Impact of Coral Reef Bleaching in the Arabian Region

A workshop on bleaching in the Arabian region will be held at the National Commission for Wildlife Conservation and Development (NCWCD) Headquarters, Riyadh, Kingdom of Saudi Arabia, November 1999. The workshop aims to determine the present status of coral reefs in the Arabian region, following bleaching in 1998. The meeting will also attempt to define the causes, suggest remediation action, and enhance understanding of bleaching and of other threats to coral reef ecosystems amongst scientists and managers in the region and elsewhere.

Papers will be accepted for oral presentation in Arabic or English in five scientific sessions. Each paper will be given 15 minutes for presentation and 5 minutes for discussion. Up to 12 posters will be accepted for the workshop. Selected participants will meet in the NCWCD to recommend conservation actions for the coral reefs in Arabian seas to minimize further damage and to discuss the framework for management plans applicable to the region.

For further information, contact: Secretary General, National Commission for Wildlife Conservation and Development (NCWCD), P.O. Box 61681, Kingdom of Saudi Arabia, Tel: + (966 1) 441 8700 Fax: + (966 1) 441 0797 Email: <ncwcd@zajil.net> or Dr. Hany Tatwany, Chairman of the Organising Committee. NCWCD, P.O. Box 61681, Kingdom of Saudi Arabia Tel./Fax: + (966 1) 441 8413, Email: <tatwany@naseej.com.sa>

5th International Aquarium Congress

Monaco, November 20-25, 2000

The First International Aquarium Congress, held in Monaco in 1960, defined the basic principles of a modern scientific discipline. Subsequently, the meetings of Monaco in 1988, Boston in 1993 and Tokyo in 1996 developed the role of aquariums and measured the extent of their scientific, technical and educational growth.

The 5th International Aquarium Congress will take place in Monaco from November 20 to 25, 2000, under the High Patronage of H.S.H. Prince Rainier III of Monaco.

The general theme will be "The aquarium, a new link between Man and Nature in the search for authenticity".

Registration and information: 5th IAC 2000, Dr. Nadia Ounaïs, Musée océanographique, MC-98000 MONACO, Phone: +377 93 153 600, Fax: +377 93 505 297 Email: <iac2000monaco@meditnet.com>

36 International Initiatives
Certifying quality and sustainability in the marine aquarium industry. *P. Holthus*
ICRI monitoring—the GCRMN and Reef Check. *C. Wilkinson, G. Hodgson*
The International Coral Reef Initiative and the ISRS. *C. Wilkinson*

40 Spyhopper
Revolutionary reef rantings

41 Book Reviews
Ecology of the Indonesian Seas. *D. MacAllister*
Corals of the Indian Ocean. *K. Teleki*
Mangroves and Seagrasses of the Indian Ocean. *S. Bandeira*

45 Book Shelf
Status of Coral Reefs of the World: 1998.
Online Bioscience Journals.
Reef Evolution.
Dive Maldives.
The Northern Great Barrier Reef.
Proceedings of the 28th AMLC.
Participatory Costal Resource Assessment.

47 Meetings
International conference on scientific aspects of coral reef assessment, monitoring, and restoration. *R. Dodge*
Coral reef restoration: the status of the science. *W. Precht*
ITMEMS. *R. Kenchington*

52 Diary
9ICRS, Bali 2000.
Extent & impact of coral reef bleaching in the Arabian region.
5th International Aquarium Congress.

MEMBERSHIP

The annual subscription for individual membership of **ISRS** is currently US$70, provided renewal payments are made by 1st March each year. Individual and Family Members receive the journal **Coral Reefs**, the newsletter **Reef Encounter** and other periodic mailings. Family membership is US$80. Student membership costs US$20 and benefits include all of the above except the journal **Coral Reefs**.

The category—Sustaining Member—is for those supporting the society with a subscription of $150. In addition to other benefits sustaining members will see their names printed in each issue of **Reef Encounter**.

Renewals received between 1 March and 30 April will cost US$320 for a student member, US$80 for a full member and US$90 for a family membership. Those received after 1 May will cost US$35, US$90 and US$100 respectively. New memberships will be at the base rate of US$20, US$70 and US$80 regardless of what time of year they join. Financial assistance may be available to prospective members with legitimate needs. Please contact **ISRS** Corresponding Secretary. E-mail raronson@jaguar1.usouthal.edu

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

The aim of **Reef Encounter** is to provide a magazine-style newsletter on any aspect of reefs, the livelier the better. In addition to news, meeting and expedition reports and announcements, we aim to have discussions and debates about particular issues concerning **ISRS** or the broader field of reef science in general. **Reef Encounter** does not publish original scientific data, so please do not submit such papers. The newsletter aims to complement the journal which carries scientific paper, in that it provides an outlet for book reviews, discussion of issues of general interest and a correspondence column (**Upwellings**). It also carries short reviews of recent trends and developments in reef research or events that bear on reef studies. In the tradition established by the first editor, **Reef Encounter** is cheerfully illustrated, with cartoons, newspaper cuttings and other entertaining material.

Please note that **Reef Encounter** is an entirely voluntary effort. We do not have funds to pay authors, and the editors are also unpaid. Please Help **ISRS** by submitting material on a regular basis and in a form that does not require too much editing.

To save time and postage, we shall not normally acknowledge submitted material, except by e-mail, and this will not normally be refereed or returned for corrections. Opinions expressed and errors of fact will have to remain largely the authors' responsibility. No published item should be taken as **ISRS** opinion unless indicated.

Please help by sending items of not more the 2,000 words in length, preferably by e-mail or diskette using Word or ASCII text and in an IBM compatible format. You can expect some gentle editing for flow and sense and to address our readership as appropriately as possible. Illustrations should be of a size compatible with our format. Black line drawings are preferable. Diagrams should have legends and/or captions to explain all symbols, abbreviations and shading patterns etc. Maps should have a scale and indication of orientation. Use **World List** abbreviations in references. References are to be styled in the format as prescribed by **Coral Reefs**. Please use metric, or imperial-with-metric units, but not imperial units on their own. Do not forget to give your name and full address, or any other contact address where applicable.

We have no regular reprint systems, but contributors will receive a free copy of the relevant issue. We encourage contributors to join the society if not already members.

DEADLINE FOR COPY FOR REEF ENCOUNTER 26 (DUE OUT DEC 1999) IS OCTOBER 1st 1999;
please send to one of these addresses:

Maggie Watson, ICLARM CEPO, Suite 158, Inland Messenger, Road Town, Tortola, British Virgin Islands, OR Suite 158, Box 305498, St. Thomas, USVI. VI00803.
Fax: (1-284) 495 1389 Phone: (1-284) 495 1291
e-mail: habari@candwbvi.net

Kristian A. Teleki, Cambridge Coastal Research Unit, Department of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN United Kingdom
Fax: +44 1223 355674 Phone: +44 1223 339775
e-mail: kat1003@cus.cam.ac.uk

APPLICATION FORM FOR MEMBERSHIP

Name: .....

Address: .....

.....

.....

Title: .....

Fields of interest: .....

.....

.....

.....

I/we enclose a cheque (in US$ ONLY please) of:

..... US$70 for FULL membership

..... US$20 for STUDENT membership

..... US$80 for FAMILY membership

..... US$150 for SUSTAINING membership

Credit Card Payment: VISA/Mastercard

No. ..... Expir. Date .....

Signature .....

Bank drafts and cheques to be made payable to: INTERNATIONAL SOCIETY FOR REEF STUDIES. If a receipt is required, please request it at the time of payment.

Send completed application form and your cheque to:
International Society for Reef Studies, P.O. Box 1897, Lawrence, Kansas 66044-8897, USA