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REEF ENCOUNTER

Newsletter of the International Society for Reef Studies

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Newsletter of the International Society for Reef Studies

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The **International Society for Reef Studies** was founded at a meeting in Churchill College, Cambridge, UK in December 1980.

Its aim under the constitution is to "promote for the benefit of the public, the production and dissemination of scientific knowledge and understanding concerning coral reefs, both living and fossil."
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

Welcome to another **Reef Encounter**. This time we have finally bucked the fishy trend and bring you plenty of articles on the corals themselves, including a **Feature** on a Mediterranean species, and **News** of a North Atlantic species which has been surprising both conservationists and industrialists. Not just corals—we also report on their predators with two articles on coralivorous snails, efforts to rehabilitate reefs in the Philippines, and signs of a tentative *Acropora palmata* recovery from the Caribbean (**Currents**). Bleaching is still a 'hot' topic with **News** from Mauritius and **Meeting Reports** from several international gatherings. And if that all seems too hectic, we've been wondering whether we shouldn't call this issue the holiday summer special because it's packed with reviews in the **Book Reviews** and **Book Shelf** sections. Many thanks to all who contributed, and please keep your articles coming. Geologists out there—lets hear from you next!

Maggie, Kristian and Maria João
ReefEncounter@bigfoot.com

ISRS COMMENT

From the President

The second half of 2000 is shaping up to be a momentous one for the Society. First, it is election time. Thank you to all who accepted nomination, and now its up to all of us to make our selection. Please consider your choices carefully and forward your vote to the Returning Officer by the due date in September. The winners will be announced at the 9th International Coral Reef Symposium, Bali, Indonesia, 23–27 October 2000. Special thanks to retiring Treasurer Daphne Fautin, retiring Recording Secretary Steven Miller and retiring Council Members Rolf Bak, Gregor Hodgson, Michel Pichon, Don Potts, Paul Sammarco and Bernard Thomassin. I greatly appreciate your guidance, your support and your efforts on behalf of the Society.

The Symposium is shaping up to be one of the best ever. The Society is working effectively to support Dr Anugerah Nontji and his Indonesian Organizing Committee. David Hopley is leading the development of an excellent program of presentations, Mark Erdmann and Arnaz Mehta have set up 10 superb scientific field trips on live-aboard dive-boats, and Kevin Kohler is keeping the conference homepage current (www.nova.edu/ocean/9icrs). Check the homepage for registration details and opportunities for participation. **ISRS** has been very successful in raising substantial financial support for the meeting, including assistance for attendees from developing countries (see **ISRS News**). Special thanks to former **ISRS** President John Ogden for his outstanding efforts and success.

The journal **Coral Reefs—**the most public face of the Society—has regularly rated as the most read of all marine science journals. The quality of this journal is a credit to you the membership who contribute the articles, to Springer Verlag who publish at such a high standard, and to the editorial teams, who work hard to select, revise and polish the articles. At this time, we owe special thanks to Terry Hughes, who is stepping down after four yeas as Managing Editor, and 11 years on the journal's editorial panel. Terry is our third Managing Editor (1997–2000), following David Stoddart (1982–1992) and Rick Grigg (1993–1996). Thank you Terry for continuing the fine tradition of producing a quality journal that brings credit to the Society.

ISRS's unique role as an informed voice has given added credibility to broader community concerns about the plight of coral reefs. Our recent consensus statements on coral bleaching and coral diseases have been timely, well received and influential. But the respect in which we are held is founded not just

on such statements, but on our reputation as a society for reef studies. Not only do we possess a passion for coral reefs; we also possess a great deal of specialized knowledge and experience about coral reefs, and increasingly, about their interactions with people. Please encourage potential new members to join the Society (see www.uncwil.edu/isrs)—what better way to help create a better future for coral reefs, not to mention the good discount members receive on registration for the Bali Symposium!

With my very best wishes,

Terry Done
President

ISRS NEWS

ISRS Financial Report 1999

Actual values are given first (with budget amounts in parentheses)

INCOME (US$)		
Memberships	54,347.00	(48,000.00)
Interest	2,969.85	(2,500.00)
Editorial allowance	2,403.28	(2,200.00)
Page charges	--.--	(100.00)
Miscellaneous	150.00	(--.--)
TOTAL	**59,870.13**	**(52,800.00)**

$12,500 from ICRS VIII for the use of ICRS IX that was deposited temporarily in the **ISRS** treasury is not included.

EXPENDITURES		
Coral Reefs volume 18	11,155.10	(18,000.00)
Allen Press management	14,254.19*	(11,500.00)
Reef Encounter 24 and 25	9,531.99	(8,000.00)
ICRS IX	9,850.00	(7,350.00)
Editorial allowance	2,400.00	(2,200.00)
Membership directory	3,914.38	(3,500.00)
Local meetings (x2)	--.--	(3,000.00)
Postage	100.00	(1,500.00)
Audit and tax return preparation	250.00	(1,250.00)
Student travel award	1,211.40	(1,200.00)
Bank charges	926.89	(1,000.00)
TOTAL	**53,593.95**	**(58,500.00)**

*includes some postage for **Coral Reefs** and **Reef Encounter**

CASH ON HAND at the end of 1999		
Checking accounts (amount at beginning of year)		
Douglas County Bank	54,348.78	(41,156.18)
Capitol Federal S&L	11,672.68**	(19,880.79)
Certificates of deposit		
5488677	11,679.19	(11,134.90)
5488678	12,241.38	(11,541.00)
TOTAL	**89,942.03**	**(83,712.87)**

**does not include $12,500 in ICRS funds

Contrary to projections, income exceeded expenditures. Part of this difference, however, is due to the way the books are kept. The dues notice for 1999 was sent late, so the income for this category was posted to 1999, whereas the dues notice for 2000 was sent on time in late 1999, so some income for this category was posted to 1999. Thus dues income for 1999 is artificially high by about $10,000. If this amount is taken into considerattion, income for 1999 was roughly $50,000 and expenditures were about $53,500, for a deficit of $3,500—a deficit of $5,700 was projected.

2000 Budget—A Balanced Budget is Projected for 2000

INCOME (US$)	
Memberships	48,000.00
Interest	2,000.00
Editorial allowance	2,100.00
Page charges	100.00
Miscellaneous	100.00
TOTAL	**52,300.00**

Dues income is expected to be higher than in 1999 both because people will join for the ICRS, and because rates were raised

EXPENDITURES	
Coral Reefs volume 19	15,000.00
Allen Press management and miscellaneous expenses	15,000.00
Reef Encounter 26 and 27	10,000.00
Membership directory	4,000.00
Editorial allowance	2,100.00
Membership subsidy	1,500.00
Student travel award	1,200.00
Audit and tax return preparation	1,000.00
Bank charges	1,000.00
ICRS	1,000.00
Postage	500.00
TOTAL	**52,300.00**

Summary of memberships: Honorary 6, Sustaining 10, Family 45, Student 69, Individual 635, TOTAL 765

Daphne Fautin
Treasurer

Subsidised Memberships of ISRS

You may remember in the last issue of **Reef Encounter** we advertised a new scheme for subsidised memberships. I am please to be able to announce that we awarded two such memberships to deserving applicants for the year 2000–2001. However I should say we only received two applications! If you know of anyone who might benefit from this scheme then I ask that you photocopy the advertisement in **Reef Encounter** Number 26 and pass it on to them. The next deadline for applications will be 1 March 2001.

Barbara E. Brown, Vice-President

ISRS Elections

Accompanying this issue of **Reef Encounter** you will find biographical sketches of the nominees for elected offices and **ISRS** Council seats. These biographical sketches are also posted on the **ISRS** web site. A ballot will be mailed separately to each member of **ISRS**, with a due date in September. Results of the election will be announced at the 9th International Coral Reef Symposium in Bali in October. Once again, we thank outgoing Treasurer Daphne Fautin, outgoing Recording Secretary Steven Miller, and outgoing Council members Rolf Bak, Gregor Hodgson, Michel Pichon, Don Potts, Paul Sammarco and Bernard Thomassin for their service to the Society

9th International Coral Reef Symposium

The 9ICRS Scientific Program

The 30th April deadline for abstracts has brought in an exciting response from reef workers all around the world. At time of writing many abstracts have yet to be processed, but we would appear to have a program which will consist of approximately 300 posters, and as many as 1000 papers. All previously advertised mini symposia have been well supported and papers in the general sessions are being organised into common interest sessions, which should provide an exciting and comprehensive program, the details of which will appear on our web page in August/September.

ISRS AGM

ISRS will hold an annual general meeting at the Symposium. We look forward to seeing you there!

ICRS Travel Assistance Update

The Society will be able to make over 75 awards for assistance with travel and registration. This has been made possible through generous grants from the David and Lucille Packard Foundation and the Summit Foundation. The Society thanks these Foundations most sincerely for their generosity. Over 300 applications were received by the April 30th deadline.

Get Your Message Out! Free Media Training

A free media training workshop will be held by SeaWeb at the venue for the 9th ICRS from 1–4.30 pm, Bali International Convention Centre, Sunday, 22 October 2000. SeaWeb, is a US-based marine communications organization. The workshop will be a special interactive training session on effective media communication about coral reef environments. In its work to inform journalists, SeaWeb facilitates the direct interaction among marine science experts and the press. This session will present statistics regarding public attitudes towards the media, the marine environment, and scientists. Session leaders will create a hypothetical opportunity to talk to CNN Headline News about the importance of coral reefs and then critique participant's response. A reception for participants and non participants will follow the session. **ISRS** and SeaWeb thank the David and Lucille Packard Foundation for their generous support for the full cost of this activity. Interested persons should register with: Jessica Brown, SeaWeb, 1731 Connecticut Ave, NW, Suite 400, Washington, DC 20009 Phone (202) 483-9570, Fax (202) 483-9354, Email <jbrown@seaweb.org>

Tenth International Coral Reef Symposium 2004

The call for Expressions of Interest and Guidelines for Application and Selection are included below. The call was also announced on the **ISRS** web page and widely circulated earlier this year

The **International Society for Reef Studies** (**ISRS**) invites expressions of interest in hosting the 10th International Coral Reef Symposium (10th ICRS) in 2004. **ISRS** will coordinate the selection process by way of an international selection committee drawn from its membership and other respected individuals previously involved with selection and/or running of an International Coral Reef Symposium.

Previous Symposia have been held in Mandapam Camp, India (1969), Great Barrier Reef, Australia (1973), Miami, USA (1977), Manila, Philippines (1981), Tahiti, French Polynesia (1985), Townsville, Australia (1988), Guam (1992) and Panama (1996). The ninth is scheduled for Bali, Indonesia in October 2000.

The Symposium is an opportunity for the dissemination of knowledge on all aspects of the science, conservation and management of coral reefs and provides a forum for the exchange of experiences and ideas.

Schedule

March 2000	Call for expressions of interest was widely circulated and posted on **ISRS** Web site.
August 31, 2000	Closing date for receipt of expressions of interest.
September 2000	Selection committee will review applications and draw up a short list who will be invited to present their bid in Bali at 9th ICRS.
October 22 2000	Short listed applicants will make a presentation to the selection committee assembled at the 9th ICRS in Bali. It is envisaged that each of these presentations will last about 1 hour including a short formal presentation and discussion.
October 27 2000	Announcement of successful bid at the closing ceremony of 9ICRS.

Expressions of interest should be forwarded **before August 31 2000** to: Dr. David Hopley, Secretary to the Selection Committee, C/- CRC Reef Research Centre, James Cook University, Townsville QLD 4811, Australia, Fax: +61 7 4779 1400, Email <David.Hopley@ultra.net.au>

Guidelines for Application and Selection

1. The International Society for Reef Studies (ISRS)
The **International Society for Reef Studies** (**ISRS**) is an international, voluntary, organisation with ~750 members from ~ 50 countries and council of 19 individuals who work for the Society in their own time. The Society uses annual subscriptions to produce two publications and accepts donations to allow it to award student prizes. It does not earn a profit, and its income and expenditures each year are closely matched. The Society does not have the capability for a major role in the organization, program development and running of International Coral Reef Symposia (ICRS), and it requires the host country and local organizing committee to take that role.

2. Coordination and selection committee
ISRS will coordinate the selection process through an international selection committee drawn from among its membership and other respected individuals previously involved with selection and/or running of an International Coral Reef Symposium.

3. Responsibilities of the host country and local organizing committee
The host country will be required to:

1. Provide the venue and logistical support.
2. Meet all costs (venue, printing of brochures, printing and distribution of proceedings, logistics, professional organizer, work delegated to other individuals or organizations, including **ISRS** if applicable).
3. Take leadership in raising of additional funds to meet financial targets (see below), and take responsibility for underwriting the Symposium.
4. Form a local organizing committee with the following responsibilities:
   (a) Development of a budget and business plan agreed with the selection committee.
   (b) Overall control and coordination of the event.
   (c) Provision of a range of accommodations, from budget to luxury, and airport-hotel-venue transfers.
   (d) Development of the symposium program of ceremonies and presentations.
   (e) Provision of a program of scientific field trips to living and, if available, fossil coral reefs.
   (f) Provision of an accompanying persons program.
   (g) Initiate fundraising to ensure the widest possible attendance.
   (h) Development and maintenance of a Symposium Web site.
   (i) Printing and distribution of announcements, programs and abstracts.
   (j) Editing, production and distribution of Proceedings of the Symposium, with editorial assistance from organizers of Mini-Symposia and others.

5. Financial targets of the local organizing committee
The host country should take primary responsibility to:

1. Cover any costs incurred in presenting the Symposium, including costs incurred in preparation of the scientific program and creation and maintenance of the Web site if applicable.
2. Raise funds to support plenary speakers.
3. Raise funds to support key people in various mini-symposia.
4. Raise funds to support attendance of students and others from developing countries.
5. Raise funds for printing and distribution of Symposium Proceedings.
6. Generate a surplus to pass on to the organizers of the following ICRS.

6. Expressions of interest
The bidding group should:
Make an initial expression of interest, in which key people and institutions who will make up the organizing committee are identified, including government departments or other organisations who will underwrite the venture. An agreement in principle will be made to conform to the requirements above.

Included in this expression of interest should be:

1. Suggested location and dates (taking into account worldwide university schedules and local weather phenomena which might interrupt field excursions).
2. Details of the conference venue and its facilities.
3. The availability of a range of hotels and alternative accommodation.
4. A concept budget itemizing major expenditure and income, including possible sources of sponsorship such as Government and private enterprise, and a policy for underwriting the expense of the Symposium.
5. Suggested registration fees covering **ISRS** members, non members, students and accompanying members.
6. Nomination of a Professional Conference Organiser, with a list of events they have organised over the last 3 years, or alternatively, some form of guarantee of professional organisation of the symposium if a professional organiser is not available.
7. Nomination of a local organizing committee such as: Chairman, Treasurer, Scientific program organiser, Publications editor, Scientific field trips organiser, Social events and accompanying members program organiser.
8. A timetable of organisational goals, including a schedule and procedure for publication of proceedings.
9. A range of pre and post symposium scientific field trips directed at a variety of disciplines (biology, ecology, geology, management and conservation), to locations within the region of the host country.
10. An accompanying persons program.

2000 ISRS/CMC Coral Reef Fellowship Award Announcement

We are pleased to announce two **International Society for Reef Studies/Center for Marine Conservation** Fellowship awards this year. A $10,000 fellowship was awarded to Ricardo Garla, of the Universidade Estadual Paulista, Department of Zoology. Mr. Garla's project will address the "Ecology and Conservation of the Caribbean Reef shark, *Carcharhinus perezi*, at the Fernando de Noronha archipelago, Brazil". A $5,000 fellowship was awarded to Jo Gascoigne, Virginia Institute of Marine Science, to study "Population dynamics and marine reserve design in coral reef systems," in the Bahamas. Over thirty proposals were submitted this year and their overall high quality made the selection process especially competitive. Many thanks to all the students who submitted proposals—and thanks to the many reviewers who helped in the selection process. We expect that the 2001 **ISRS/CMC** Coral Reef Fellowship announcement will be made later this summer. Ricardo's proposal is provided on the society web page as an example for students in future competitions, and a short summary of both projects are provided below. Congratulations to Ricardo and Jo from **ISRS** and CMC, and good luck with your research!

Ecology and Conservation of the Caribbean Reef shark, *Carcharhinus perezi*, at the Fernando de Noronha archipelago, Brazil. Ricardo Garla, Ph.D. student, Universidade Estadual Paulista, Department of Zoology, Rua Amador Bueno, 1342/120, Ribeirão Preto, 14010-070, SP, Brazil, Email <lucgarla@ffclrp.usp.br>

Project Summery

*(the complete proposal can be found at the **ISRS** web site: www.uncwil. edu/isrs)*

The Caribbean reef shark, *Carcharhinus perezi*, is one of the most abundant species of sharks at the Fernando de Noronha archipelago, 346 km off the coast of Northeastern Brazil. Like other reef dwelling sharks, the reef shark plays a critical ecological role as one of the numerically dominant apex predators, contributing to the healthy functioning and maintenance of diversity on the reefs of this insular ecosystem. Visible presence of reef sharks is also one of the major draws for the local dive industry. Despite this, the reef shark is presently not specifically managed at the archipelago. This is largely attributable to a lack of local awareness at Fernando de Noronha of the critical ecological role and vulnerability of shark populations, and the fragmentary understanding of the basic biology of this shark throughout its range.

The only local conservation measure that currently includes the reef shark is the umbrella protection of a "no-take" National Marine Park. Recent observations of significant landings of juvenile reef sharks suggest that the National Park does not fully encompass the local nursery grounds of the species. The objectives of this project are: (1) To determine the spatial distribution, degree of site-attachment, and seasonal patterns of movement of reef sharks, including the rate and patterns of movement into fished areas; and (2) To establish an educational program, focused on sharks, aimed at the locals and tourists to increase local awareness on conservation issues. Methods include: (1) longline surveys (working with local fisherman) where sharks will be measured, sexed, tagged and their DNA sampled in the water. To date, a total of fifteen reef sharks were tagged and released during three experimental longline sets on the windward side of the archipelago in 1999; (2) telemetry studies where fifteen juvenile sharks will be fitted with acoustic transmitters. Detection monitors will be anchored at the bottom at approximately 500 from shore in different locations around the archipelago. When a telemetered shark passes within the 500 radius range of the monitor, it will record the code of the transmitter, date and the time of the day; and (3) an educational program where I will take advantage of the large audience and existing infrastructure at TAMAR (Marine Turtle Project base) to give weekly lectures on marine conservation issues involving sharks.

Population dynamics and marine reserve design in coral reef systems. Jo Gascoigne, Virginia Institute of Marine Science, 1208 Gloucester Road, Gloucester Point, VA 23062. Email: <jo@vims.edu>.

Project Summary

No-take marine reserves are gaining support as a tool for conservation of coral reef ecosystems (Bohnsack 1996, Guénette *et al.* 1998, Roberts 1997a, Allison *et al.* 1998). They may be particularly useful for managing reef-associated fisheries, especially heavily exploited species (DeMartini 1993, Holland and Brazee 1996).

Ecological theory and empirical studies indicate that reef species may have metapopulation structures driven by larval transport processes and habitat quality (e.g. Pulliam 1988, Roberts 1997b, Lipcius *et al.* 1997). Overall, the role of spatial processes (e.g. oceanographic circulation and habitat quality) in marine population dynamics is poorly understood, despite implications for the design of reserves in management.

I intend to concentrate on the role of spatial processes in the population dynamics of exploited species in a coral reef ecosystem. My approach is to use a combination of field studies and modeling for two species with contrasting life histories (Caribbean spiny lobster, *Panulirus argus*, and queen conch, *Strombus gigas*), to draw general conclusions about the role of life history and spatial processes in optimizing the design of marine reserves. Specifically, my research will address the following: 1) How does natural mortality vary spatially between different populations, including one in a marine reserve? It is known that natural mortality varies temporally and regionally (e.g. in conch: Stoner and Davis 1994, Stoner and Glazer 1998). However the role of differential mortality in determining the effectiveness of marine reserves has not been examined. 2) How do demonstrated changes in population structure within marine reserves impact survival? There is some evidence that the presence of large adult conspecifics reduces natural mortality in juveniles (Quinn *et al.* 1993). In contrast, larger predators in reserves are likely to reduce survival. What is the collective impact of these effects? 3) How do larval life history and oceanographic circulation affect recruitment and juvenile abundance? Specifically, what is the effect on larval transport and juvenile distributions of a larval duration of 2–3 weeks (conch) vs. 4–6 months (lobster)? 4) What is the impact of marine reserve location and size for species with contrasting life histories?

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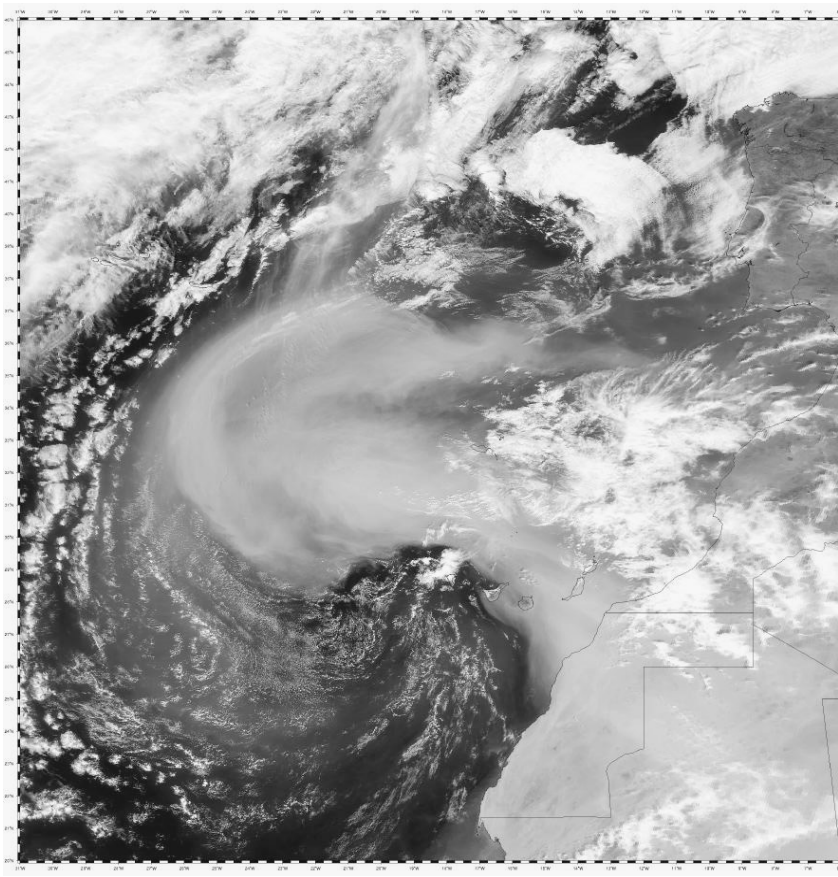
Roberts CM (1997b) Connectivity and management of Caribbean coral reefs. Science 278(1): 1454–1457.

Stoner AW and Davis M (1994) Experimental outplanting of juvenile queen conch, *Strombus gigas*: comparison of wild and hatchery-reared stocks. Fishery Bulletin US 92: 390–411.

Stoner AW and Glazer RA (1998) Variation in natural mortality: implications for queen conch stock enhancement. Bulletin of Marine Science 62(2): 427–442.

Caribbean Reefs Get a Dusting

Transatlantic transport of African dust into the Caribbean and Southeastern United States increased in the early 1970s due to combined effects of a prolonged and ongoing drought in Northern Africa and changes in the North Atlantic Oscillation. Hundreds of millions of tons of African soil dust were raining down in the Caribbean (and with it the African locust, *Schistocerca gregaria*) by the 1980s. Garriet Smith, Kim Ritchie and Juliana Weir at the University of South Carolina have shown that the dust contains the spores of numerous species of the soil fungus *Aspergillus*, including one known to cause an ongoing Caribbean-wide disease in the sea fans, *Gorgonia ventalina* and *G. flabellum*. Numerous emerging diseases affecting both humans and animal/plant populations occurred simultaneously with increases in African dust transport. The unprecedented dust event in late February and early March, shown here, highlights the need to examine the microbiological content of African dust. The potential affects of soil dust on coral reefs is the subject of a mini Symposium at the upcoming 9th international Coral Reef Symposium in Bali.



Text Gene Shin,
Email <eshinn@usgs.gov>
Image from SeaWifs, contact Gene Feldman,
Email <gene@seawifs.gsfc.nasa.gov>

webpage
http://seawifs.gsfc.nasa.gov/seawifs/html/dust.html
and also see ***Reef Encounter 26*** *p29–30.*

Coral Reef Task Force Proposes No-take Status for 20% of U.S. Reefs

In March this year, the United States Coral Reef Task Force adopted a proposal to make 20% of all U.S. reefs 'no-take' by 2010. In these areas, fishing and many other activities will be banned. Currently, less than 3% of US reefs are no-take and only around 5% are accurately mapped. The bold decision was fully endorsed and presented ahead of approximately 100 other recommendations which included expanding the existing network of protected areas (all kinds), mapping all U.S. reefs by 2009, establishing reef health monitoring programs, and formation of an All-Island Coral Reef Initiative to target coral reef related priorities in the islands of Hawaii, American Samoa, Guam, Puerto Rico, the U.S. Virgin islands, the Commonwealth of Northern Marianan Islands as well as the mainland United States. The Department of the Interior will provide

less than 3% of US reefs are no-take

$1.35 million to assist U.S. islands to improve coral reef management and protection. 2000 was the first financial year in which President Clinton requested funds specifically for coral reefs, and a record $10.5 million was allocated. Coral reefs provide services estimated to be worth as much as $375 billion annually, a staggering figure for an ecosystem covering less than one percent of the Earth's surface. They support over $1.2 billion of tourism income in the Florida Keys alone, and in Hawaii, gross revenues generated from just a single, half square mile coral reef reserve are estimated to exceed $8.6 million each year. Fishing also brings revenue. The annual dockside value of commercial U.S. fisheries from coral reefs is over $100 million while the annual value of reef-dependent recreational fisheries probably exceeds $100 million per year.

The website http://coralreef.gov/ provides more information on the new "National Action Plan for Coral Reef Conservation" and access to reports written for the Task Force. The report from the Ecosystem Science Working Group includes an appendix by Jim Bohnsack detailing the scientific rationale for protecting 20% of representative coral reef habitat.

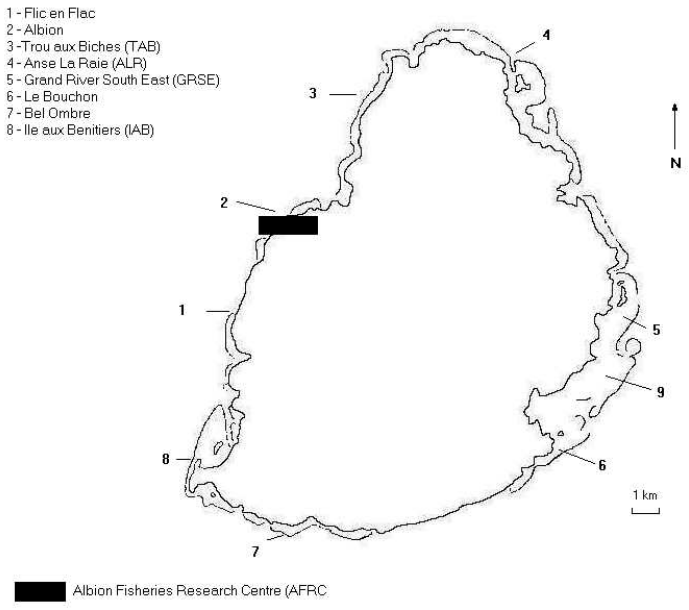
Compiled by M. Watson
from NOAA and GCEI List Press Releases

Mauritius Escapes Worst of Bleaching

Coral bleaching was observed in Mauritius during routine surveys in February 1998. Subsequent quantitative surveys conducted at eight sites (see figure) revealed that bleaching was extensive, with partial and complete bleaching of some colonies occurring at all sites and habitats visited. Southern exposed sites, along with Albion on the western coast of the island, were the most affected. At these sites harsh environmental conditions (sediment loading, retention of warm water within lagoons, discharges from nearby factories and sewage outfalls) may have exacerbated bleaching.

At all sites visited branching and tabular species of *Acropora* were the most affected on the reef flat. On the reef slope, the most dominant partially or completely bleached corals were *Porites lutea*, *Porites lobata*, *Platygyra daedalea*, *Favia stelligera*, *Leptoria phrygia*, *Pocillopora damicornis*, *Pocillopora eydouxi*, *Pocillopora verrucosa* and encrusting *Montipora* spp. *Porites lobata* and *P. lutea* were the most affected among the massive corals. Noticeably, while colonies of some species such as *Montipora* spp. and *A. pulchra* were bleached, nearby members of the same species remained unaffected. Additionally, some species were observed partly or completely bleached at certain sites whereas they remained unaffected at others. For example, colonies of *A. austera* were observed bleached on the reef slope of Anse La Raie even though they were only partially bleached on the reef flat of this location.

bleached corals on the Mauritian reefs did not sustain high mortality



However, comparison of percentage live coral cover at Ile aux Benitiers and Albion two months before and after the bleaching event showed no decline in coral cover over time at both sites. Furthermore, observations at the end of the bleaching episode in June 1998 showed the majority of corals from the reef slope of Ile aux Benitiers and Albion had already recovered or were in the process of recovery.

Although bleaching may have affected other sites not sampled, available quantitative data and visual observations suggest that most bleached corals on the Mauritian reefs did not sustain high mortality and the majority recovered.

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Distinguishing Predation Injuries Inflicted by *Drupella* and *Acanthaster*

The gastropods *Drupella* spp. and the seastar *Acanthaster planci* are major Indo-Pacific predators of reef-building corals. The nature of the damage they cause is similar in that they prey preferentially on the same group of branching corals, genus *Acropora*, and remove living tissue while leaving the skeleton intact. Consequently, injuries from *Drupella* can be confused with the better-known *A. planci*, especially because *Drupella* are small (2–3 cm length) and well concealed amongst coral branches and in substrate crevices.

Prior to a major *Acanthaster planci* outbreak at Lizard Island, Great Barrier Reef in 1993, *Drupella* spp. and *A. planci* inflicted characteristic feeding scars, making it possible to distinguish causes of coral injury after the event. The scars were distinguishable in three ways. First, *Drupella* scars were always at the edge, never in the middle of live coral tissue (Fig. 1) because *Drupella* avoid crawling over live coral. They feed from the live/dead tissue interface and are often found clumped at this interface (see Cumming and McCorry 1998). *A. planci* scars can be in the center of a colony, surrounded by live tissue (Fig. 2).

Drupella spp. and *A. planci* inflicted characteristic feeding scars, making it possible to distinguish causes of coral injury

Second, in corymbose species (with small, closely-packed vertical branches), dead sections of colonies occupied by *Drupella* often had a banded pattern of algal covering, graded from white recently killed areas to dark old scars with heavy algal covering (Fig. 1). *A. planci* scars were inflicted at one point in time and developed a uniform algal covering, and were typically round (Fig. 2).

Third, *Drupella* grazed the branch bases first, where they clumped while inactive during the day, sometimes leaving the tips alive. Conversely, *A. planci* scars were often on the tips of branches with the basal parts left alive (Fig. 2). Their everted stomachs could not reach the branch bases, leaving the colony dead on the extremities but alive at the base.

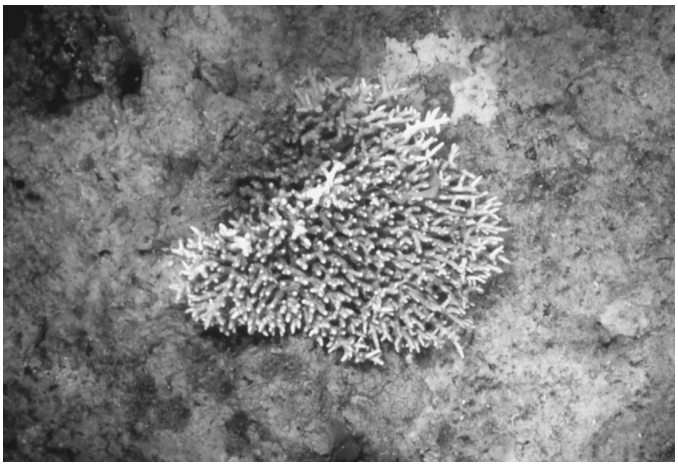

Fig. 1. A corymbose Acropora colony with a characteristic feeding scar inflicted by Drupella spp. The top left section is dead and is separated from the living section by the white, freshly-killed band of feeding scars. The graded effect from recent through to older feeding scars, with progressively thicker algal covering, can be seen at the top of the picture.

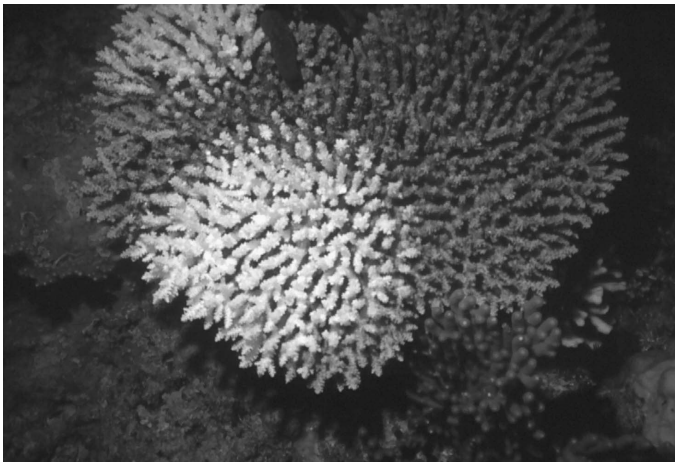

Fig. 2. A corymbose Acropora colony with characteristic feeding scars inflicted by Acanthaster planci (the white circles). Living tissue can be seen at the bases of the vertical branches.

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Acknowledgments

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Do Large Aggregations of *Drupella* Lead to Population Outbreaks?

The corallivorous gastropods *Drupella* spp. are major Indo-Pacific predators of reef-building corals. Population outbreaks of *D. cornus* and *D. fragum* have caused extensive damage to coral reefs in Western Australia and Japan, respectively (Turner 1994), and high densities of *D. cornus* have recently been reported in the Red Sea (Loya and Gur 1996; Al-Moghrabi 1997).

Population outbreaks (defined as high densities over whole reefs, or zones within reefs) of *Drupella rugosa* (Figure 1) have not been reported, but large aggregations (usually occupying just one coral colony) of hundreds to thousands of adults have been observed in several locations (Cumming 1999), ranging from Hong Kong in the north (Cumming and McCorry 1998) to Heron Island, Great Barrier Reef, in the south (Fellegara 1996). Whether large aggregations are the initial stages of outbreaks is not known, but they could contribute to outbreaks if they enhance recruitment or reduce mortality.

I have suggested that large aggregations of *Drupella rugosa* are transient reproductive swarms (Cumming 1999), like the annual swarms of *Thais*, a fellow muricid (Tong 1988). This is supported by Fellegara's (1996) observation of copious spawning in an aggregation of 3000 *D. rugosa*, and the fact that until now observed aggregations consisted of adults only (Cumming 1999). If large aggregations are reproductive swarms, they form through the movements of adults, but this has not been observed directly. Alternatively, if they represent high density local recruitment events (followed by lack of dispersal) we should be seeing large aggregations of recruits as well. The following is the first report of large aggregations of juvenile *D. rugosa*.

In December 1997, I observed three large aggregations of juvenile *Drupella rugosa* at Puerto Galera, Mindoro Island, the Philippines, on the fringing reefs adjacent to Little La Laguna Beach and Big La Laguna Beach. The reefs were luxuriant, dominated by very large plate acroporids (*A. hyacinthus* and *A. cytherea*), some over 2m in diameter, and large staghorn thickets (*A. microphthalma* and *A. formosa*) (Figure 2). Extensive staghorn thickets, stunted in height, dominated shallow areas 1–2m deep which would be partially exposed at low tide. The adjacent beaches were heavily built up with tourist resorts and the reefs themselves attracted heavy boat traffic and tourist usage. Broken coral was common.

the first report of large aggregations of juvenile *D. rugosa*

The aggregations were all in the shallow staghorn thickets. One was all juveniles (approximately 100) and two were adults and juveniles together. One of these was composed of several hundred individuals and the other more than 2000, of which more than half were juveniles. I found it by following a trail of scarring 1.5m long and 0.3m wide, then removing the overlying staghorn thicket. The aggregation was well concealed under rubble at the base of the thicket (Figure 3).

Pairs or small groups of 5–10 *Drupella cornus* were abundant on the reef, especially in the shallow staghorn thickets, but no large aggregations were seen. In contrast, small groups of *D. rugosa* were rare, and most individuals were concentrated in the few large aggregations.

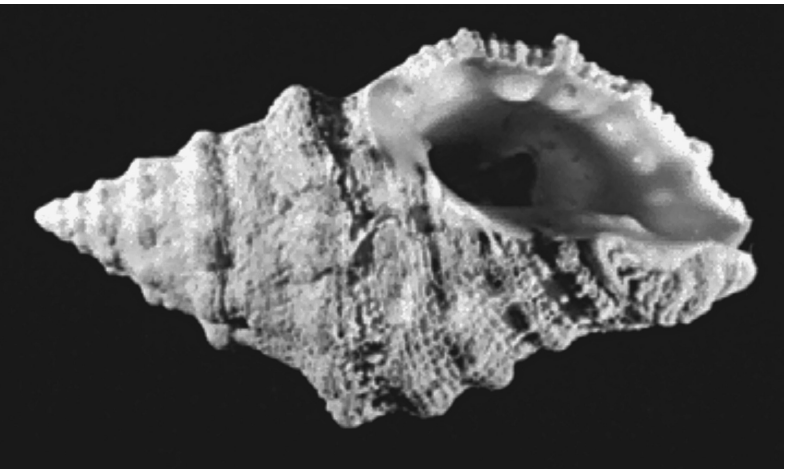

Figure 1. Adult Drupella rugosa from Lizard Island, Great Barrier Reef.

Little is known about natural mortality rates of *Drupella*, for any of the species or any of the life-history stages, and it is therefore not clear how large aggregations of juveniles translate to adult numbers. Estimates of the life-span of *Drupella* are up to 20 years (Black and Johnson 1994). It is now two and a half years since I made these observations and I encourage anybody that has visited these reefs and observed the coral communities and *Drupella* to share their information.

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Figure 2. Large staghorn thicket at Little La Laguna Bay, Puerto Galera, the Philippines showing feeding scars of a Drupella aggregation down the center of the photo.

Figure 3. Large aggregation of Drupella rugosa *juveniles amongst staghorn rubble and fragments (many with fresh feeding scars). The overlying staghorn thicket was removed for the photograph.*

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Acknowledgments

I am grateful to Steve Mullaly for field assistance.

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Is *Acropora Palmata* (Elkhorn Coral) Making a Comeback in the Virgin Islands?

White band disease (WBD) ravaged *Acropora palmata* (elkhorn coral) on many coral reefs in the Caribbean in the late 1970's and 1980's, including those around St. John and St. Croix, U. S. Virgin Islands—USVI (Gladfelter 1982, Rogers 1985). Quantitative data, photographs, and anecdotal observations indicate WBD killed large stands of elkhorn coral in the USVI from about 1976 until sometime in the late 1980's. Branching Acroporid species, which are most susceptible to WBD, are also the most vulnerable to storm damage (Rogers *et al.* 1982). Since 1979, eight hurricanes have passed near or over the USVI.

Because elkhorn coral contributed most of the living coral and determined the physical structure of many shallow reef zones, its demise dramatically altered many areas. But now, some of the reefs in the Virgin Islands once again have large, actively growing colonies of this important, reef-building species.

numerous, large elkhorn colonies, some reaching 2 m across, are now found

Buck Island Reef National Monument, St. Croix, US Virgin Islands

A 1973 report on reefs at Buck Island Reef National Monument (St. Croix), includes a sketch representing the first documentation of WBD, with the distinctive narrow white band (Robinson 1973). In 1976, only a few percent of the colonies around Buck Island exhibited WBD (Gladfelter *et al.* 1977). Impressive stands of living elkhorn still characterized the barrier reef, the significant feature for which Buck Island was designated a national monument. The demise of these *Acropora palmata* colonies from storms and WBD has been the most significant change to occur on the island's reefs. Recovery of elkhorn after Hurricane David in 1979 was hindered by WBD. *Acropora palmata* cover fell from 85% in 1976 to 5% in 1988 (Rogers *et al.* 1982, Gladfelter 1991). In 1989, exceptionally powerful Hurricane Hugo reduced some areas on the south side to rubble pavement while other areas escaped serious damage. The southern reef crest was moved 30 m landward (Hubbard *et al.* 1991), and in some shallow zones *Acropora palmata* cover fell to 0.8% (Gladfelter 1991).

149 living elkhorn colonies and 51 living fragments were recorded in about 100 m^2

However, by 1992, some *A. palmata* colonies had recruited to portions of the southeast forereef scraped clean by Hurricane Hugo. In 1995, Hurricane Marilyn damaged some colonies that measured up to 1–2 m high. More colonies have recruited to the area in the last 5 years. All appear to be in good condition despite subsequent storms and predation by corallivorous snails. North and west of Buck Island's barrier reef, numerous, large elkhorn colonies, some reaching 2 m across, are now found. These survived the most recent major storm, Hurricane Lenny (November 1999).

St. John, US Virgin islands

In 1984, Beets *et al.* (1986) found WBD on reefs in seven bays off the north shore of St. John, although it was not common at any location. Stands of living elkhorn were still present on many reefs, but others had piles of storm-generated rubble and standing dead colonies probably killed by WBD. The most impressive stands of living elkhorn were found along the western shore of Haulover Bay. This site is now a graveyard of dead elkhorn coral, with branches and fragments interspersed among algal-covered skeletons still upright in normal growth position. In July 1999, only nine living *A. palmata* colonies were found on this reef. However, on the eastern side of Haulover Bay, many

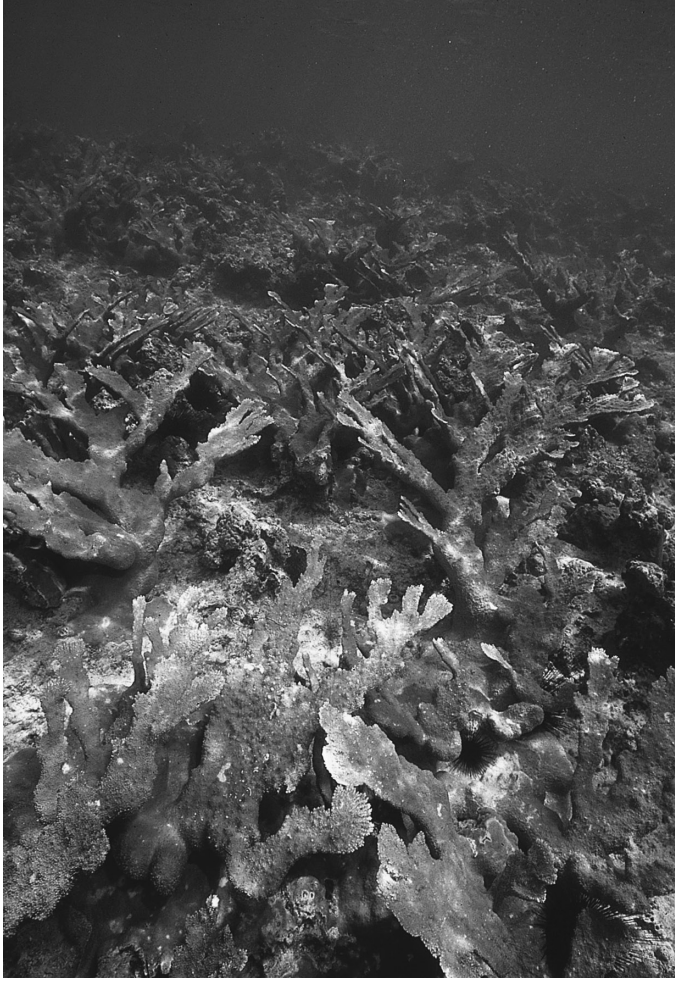

Photo: Jeff Miller

small elkhorn colonies have recruited to an area just off-shore in water less than 2 m deep.

The elkhorn coral in Hawksnest Bay declined in the late 1980's, presumably from a combination of WBD and storm damage. In 1985, mean live coral cover on three patch reefs in the bay was estimated as 26 ±5% with over 90% of this live *Acropora palmata* (Rogers and Zullo 1987). Later this species declined considerably. However in 1999, numerous elkhorn colonies were growing on patch reefs in this bay in less than 5 m. Hurricane Lenny (November 1999) and a storm that brought extremely large swells in January 2000 destroyed some of these colonies, although most remain intact. The stand in Hawksnest has the highest density and live cover for *A. palmata* of any area examined recently around St. John. In February 2000, 149 living elkhorn colonies and 51 living fragments were recorded in about 100 m^2 on a patch reef in the bay. Eighty-three percent of the colonies were 50 cm or less in greatest dimension, 6% fell in the 50 to 100 cm range, and 11% were over 100 cm. The largest colony was about 2 m across. Many of the fragments were cemented to the bottom and showed active, recent growth. The cover of living elkhorn was about 30%.

Although not abundant, actively growing *A. palmata* colonies are now found on most of the other reefs around St. John, including Johnson's reef, Waterlemon Cay, and Mary's Creek.

Virgin Gorda, British Virgin Islands

Further evidence of at least limited recovery of *Acropora palmata* comes from reefs off the west coast of Virgin Gorda, British Virgin Islands. In May 1995 surveys of Nail Bay Reef revealed exceptionally low abundance of living elkhorn in a reef zone once dominated by this species. The extensive mortality was probably a result of WBD as most of the dead colonies were still upright, in normal growth position, and the bottom was not littered with dead elkhorn fragments, a sign of storm damage. In June 1999, numerous colonies of this species were found recolonizing the reef. In one hour of snorkeling I observed 50 colonies, ranging from about 5 cm to over 1 m across. Most were "recruits" that had grown from coral larvae that settled on dead elkhorn branches. Numerous living elkhorn corals were also seen on Plum Tree Reef, just south of Nail Bay. Although greater than 95% of the elkhorn coral on these two reefs is dead, there is definite evidence of recolonization.

Despite the evidence of recovery, it is too early to tell if elkhorn is making a comeback. It may never recover its former abundance. Although one of the fastest growing coral species, it grows at most about 10 cm/year (Gladfelter *et al.* 1978). Even without future hurricanes, new incidence of disease, and other stresses, it would take decades for this coral species to once again dominate the shallow reefs in the Caribbean.

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Coral Colonies Make a Home on North Sea Oil Rigs

To most coral biologists it's surprising to learn that off the Norwegian coast there's a series of coral bioherms extending for 13 km far beyond the reach of sunlight at water depths of around 250 m. These azooxanthellate corals are found scattered along the continental margins around the world as well as on offshore banks and seamounts.

It's perhaps a rather more familiar and depressing scenario to learn that these deep-water coral habitats are increasingly threatened by deep-water trawling and oil exploration—so much so that they have been seized on by environmentalists campaigning to stop oil exploration in the deep-waters of the north east 'Atlantic Frontier'. What came as a new surprise was the discovery that the most common deep-water coral species in the north east Atlantic, *Lophelia pertusa* was happily growing on the steel and concrete platforms put into the North Sea by the oil industry over the last 25 or so years.

This first came to light when the Brent Spar was being dismantled. After the long-running saga of its decommissioning, Shell Expro opted to tow their troubled oil storage buoy to a Norwegian fjord where it would be cut up and used in building a pier. In a paper published in Nature last year, Niall Bell and Jan Smith from environmental consultants Cordah described how several large *Lophelia pertusa* colonies were found growing on the Spar. Given the huge concern over the sensitivity of this species to oil exploration—particularly the smothering effects of drill cuttings—it was ironic that they had colonised, of all things, the infamous Brent Spar. This concern reached a peak last year when the UK government was taken to the High Court over, amongst other issues, failing to consider whether areas it licensed for oil exploration might have contained *Lophelia.* With corals growing on oil platforms, could it be that all those worries over environmental sensitivity were misplaced after all?

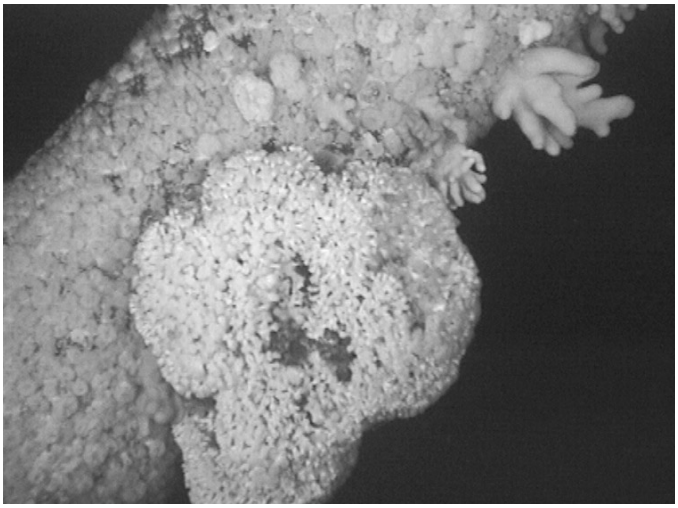
it was ironic that they had colonised, of all things, the infamous Brent Spar

But it may not be as simple as that. Even though corals have grown on and around oil platforms, at present it is not certain that they will have actually

The Beryl Alpha oil production platform in the Northern North Sea (photo JM Roberts, SAMS).

come into contact with any drilling discharges. At the Scottish Association for Marine Science we were able to follow a routine survey of pipelines and moorings in the North Sea Beryl field. As the survey progressed, it became clear that there were hundreds of *Lophelia* colonies growing on two moorings used by tankers to transport oil ashore from the Beryl Alpha platform. But these moorings were over 1.5 km from the site of drilling—could they have been exposed to any drilling discharges? We don't yet know. Closer to the drilling site we also found a coral colony growing on the steel tower that supports the platform's flare—the bright lick of flame you see on oil platforms as excess gas is burnt off. This colony was a lot closer to the site of drilling but still around 200 m upstream of the cuttings pile that had developed by the platform.

The platform corals are the first verified reports of live *Lophelia pertusa* from the North Sea. The North Sea examples are found at very shallow depths for this species of coral, similar to those in the Norwegian fjords. Their depth zonation seems to correspond with the depths at which there is always Atlantic water in the northern North Sea. But apart from these new findings and the question of their tolerance of drilling discharges the platform



A white colony of Lophelia pertusa growing on the flare support tower of the Beryl Alpha production platform. The coral is about 30 cm in diameter, or at a water depth of 72 m and is surrounded by sea anemones and soft corals (video frame grab taken by remotely operated vehicle, SubSea Offshore Ltd., courtesy of Mobil North Sea Ltd.)

corals show how important it is to maintain an open, well-informed debate before judging the environmental sensitivity of any species.

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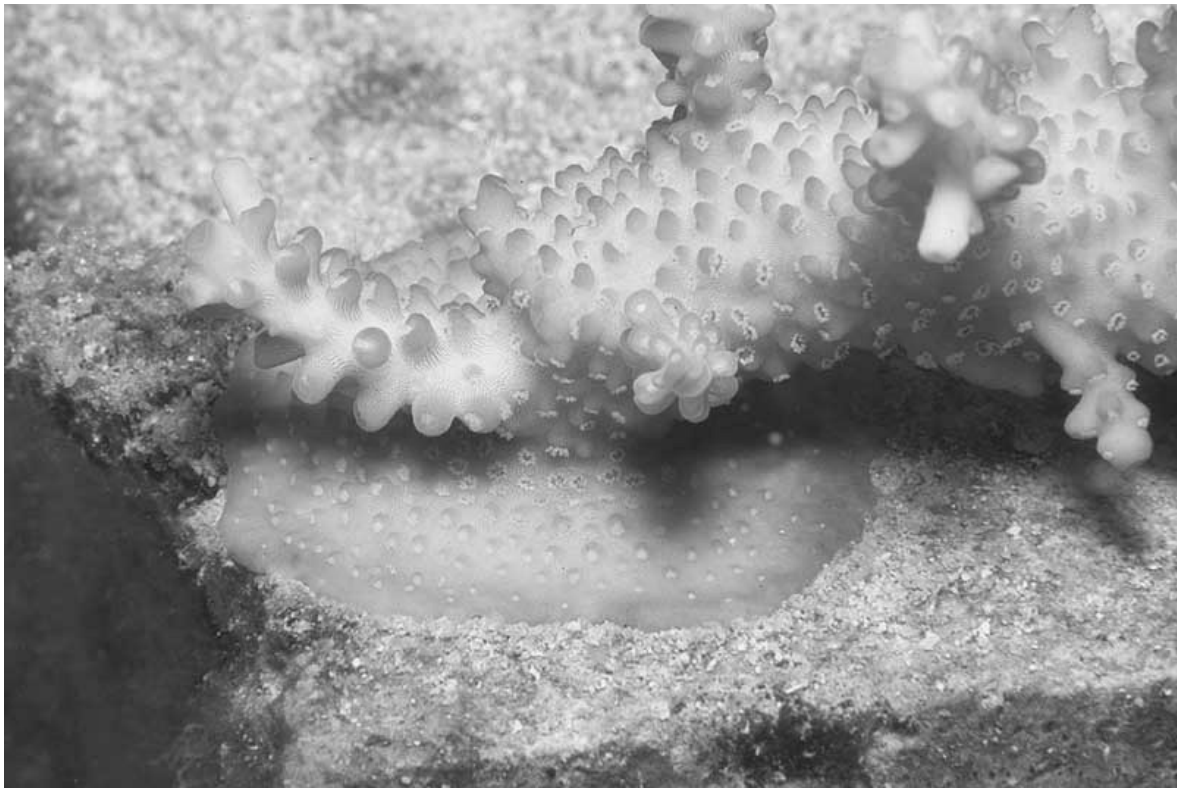
Coral Farming: Inexpensive Rehabilitation Tool and a Livelihood Option for Fisherfolk.

Three years ago, a low-cost coral farm was set up with the village people in Barangay Caw-oy, Olango Island, Cebu, Philippines. Rehabilitation of coral cover on degraded reefs is the primary aim, but the farm also provides an alternative livelihood to fisher families who might otherwise use destructive fishing practices. The farm uses the natural ability of corals to propagate asexually through fragmentation. Fragments are cut from "donor" or "mother" corals (which in the case of branching species usual-



A coral fragment grows on a fossil limestone base.

ly show the beginnings of regrowth at the fragmented part after a week). The fragments are then attached to fossil limestone substrates with galvanized wire. No fragments are exposed to air for more than 30 minutes, and live polyp tissues are unharmed. Depending on the species, it takes one to three months to grow-out 6–8 cm stony coral fragments to a suitable size. Grow out takes place in Coral Nursery Units where predation from fishes and invertebrates is minimized. The nursery units are monitored and cleaned of sediment and algae regularly. Local fisherfolk working at the farm learned to SCUBA dive, select healthy donor colonies, attach and tend fragments in only six months. Four thousand fragments have now been deployed to rehabilitate a coral reef with low cover. Survival was 87% after four months.

At present less than 3% of the Philippine reefs are classified as being in excellent condition. Pollution, uncontrolled development and deforestation have degraded reefs. Rapid population growth (2.4 % per annum) has fueled a shift to non-selective and destructive fishing techniques. Using our methods, the cost of rehabilitating one hectare reef with 2 fragments per square meter (=12.5% cover) is US $ 2,100. Considering that the conservative estimated revenues of one hectare healthy reef range from 319 US$ to 1,113 US$ per year, reef rehabilitation may be economically viable, particularly if fisherfolk carry out the work and shift from destructive fishing techniques to sustainable utilization of natural resources.

the cost of rehabilitating one hectare reef with 2 fragments per square meter (=12.5% cover) is US $ 2,100

At present, more than 20,000 fragments of 65 coral species in 233 nursery units are ready for reef rehabilitation. The new nurseries have also increased the number of fish species around the farm. In fact some fisherfolk placed their bamboo fish traps between the nurseries and claimed to have been making good catches! Long term success will depend on alleviating the root causes of reef degradation, but coral farming is a promising tool in the promotion and conservation of coral biodiversity.

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Money Talks for Conservation

Economic well-being and economic growth are important to people. They are determining factors in political campaigns and many other conflicts. So why don't we stop destroying the foundation of many of our renewable natural resources beyond the point of no return?

For me, the answer is valuation or lack of it! We invest our money in companies with the best growth potential for the highest return. We invest in schooling to generate income. Why don't we invest more where returns are guaranteed for thousands of people for every year from now until we die? One hundred hectares of healthy coral reef produces up to 30 tons of edible fish every year, enough to provide 350 people with their daily protein needs for one year. These ecosystems bring returns both locally and wherever fish and coral larvae successfully disperse. They are storehouses of wealth unequaled in nature or in most human created businesses. This 100 ha reef can attract scuba divers and swimmers who spend about US$30,000 per annum, the average income of 30 families in Southeast Asia. The total potential annual revenue from this healthy coral reef ranges from US$32,000 to 113,000. The Philippines alone is conservatively estimated to gain about US$1.35 billion annually from its 27,000 km^2 of coral reefs in their present rather degraded state. The potential increase in this return from good management is very high but not yet attained—why not?

Too few people realize all the benefits coming from these ecosystems, and if they do, they do not know how to value the benefits properly. In the modern world, most valuation is based on monetary values. As a starter, we could value all our important coastal ecosystems, such as coral reefs, mangroves and fisheries in terms that many people understand—money. But this monetary valuation may not change human behavior as much as we would like, unless it is believable and meaningful. The trade-offs of sustainable uses must also be compared with alternative forms of development or protection.

Mangrove forests, for example, have been decimated in much of Asia primarily for quick profits from intensive shrimp farming techniques. After the rush for quick cash, many old mangrove habitats now lie idle and produce nothing except some weeds or eroded soil. Gone are the coastal protection uses and sustainable harvests of wood and fish derived from healthy mangroves. In hindsight, all economic analyses looking at shrimp farms versus protecting the natural ecological and economic functions and products of mangroves show that the best investment was to keep the mangrove forests in their natural state. Had economic valuation techniques been properly applied, believed and acted upon, the mangroves would still be around today, supplying benefits at little or no cost to people.

Too few people realize all the benefits, and if they do, they do not know how to value the benefits properly

So many proposed development projects along the coastlines of Philippines and other countries are not economically viable when put to the cost-benefit test. They will loose more than they will gain simply because natural amenities in the form of food, recreation and many useful ecological functions will be permanently gone at a tremendous loss to society and individuals. These are not wise choices because they are not sustainable. Let us use modern valuation tools and educate people about what we stand to loose or gain. The solutions are not easy. It will be an uphill battle. Data and proper analysis are not always available, and there are almost always political barriers. But this is worth fighting for if we want fish on the table and coral reefs and mangroves to survive through this new century.

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Checking Reef Check in Tanzania

Since its introduction in 1997 Reef Check has grown into the largest standardised international coral reef survey program and provides information on the health of the world's reefs on an unprecedented global scale. Reef Check surveys are conducted by volunteers with little or no prior survey or biological experience, led by a marine scientist. In Mtwara, southern Tanzania, we have examined the accuracy and precision of fish, invertebrate and habitat identification and enumeration skills to see how the quality of data collected by volunteers on a Frontier-Tanzania expedition varies with increasing duration of training.

Initial training consisted of a half day of lectures followed by underwater identification practice for target species / forms in line with the Reef Check suggested minimum. Each diver then conducted the fish, invertebrate and habitat transects. Subsequently, all volunteers repeated identical surveys after a further three weeks of training in basic marine survey techniques. Finally, surveys were repeated once more at the end of a further four-week period of daily field survey experience. Volunteer data from each phase of surveys were compared to a control set collected by experienced field researchers.

Following initial training, volunteers tended to overestimate the abundance of some species, whilst underestimating grouper numbers. For example, volunteers often included non-target 'disk shaped and brightly coloured' fish in with counts for butterfly fish. They often missed grouper, especially on structurally complex reefs. Volunteers also included individuals outside the sample area and double counted fish on occasions. Abundance of most invertebrate target groups was underestimated, particularly *Diadema* urchins and banded coral shrimp, the exceptions being sea cucumbers and giant clams, which were over-estimated. Though volunteers were encouraged to search every crevice in the reef surface, several target forms were missed entirely by a number of volunteers. Other Reef Check target species (eg. bumphead parrotfish, humphead wrasse, barramundi cod, crown-of-thorns starfish and the triton shell) are so rare in the Mtwara region that no investigation was possible.

Habitat survey results revealed volunteers recorded the correct target category for a mean of 62% of point samples. Accuracy varied, however, between target forms. Volunteers greatly overestimated the coverage of dead coral, yet live hard coral cover counts were extremely close to those collected by experienced researchers, as were sand and rubble counts. Fleshy seaweed, rock, sponge, soft coral, and 'other' categories showed much more significant errors.

After further training, deviations between volunteer and control fish counts were drastically reduced. The notable exception were grouper which continued to be missed in large numbers until volunteers had amassed considerable experience. Volunteer invertebrate counts showed marked improvement, especially for *Diadema* urchins and banded coral shrimp. Habitat survey results also improved with means of 73% and 84% point samples correctly identified after three weeks training and a further four weeks experience respectively.

These findings highlight the responsibility of the team leaders to ensure adequate training

These findings highlight the responsibility of the team leaders to ensure adequate training. A seven-week program of training and survey experience is not practical in most situations. However, we recommend identification training for both non-target and target species common to the survey area, in water practice and demonstration of the preferred hiding places for cryptic species, training in estimating the 5m transect width, an emphasis on not double counting, and finally, testing of volunteers before surveying.

We would be interested in hearing of similar experiments with Reefcheck methods. A report on the findings of this work will be available later this year.

Further information is available from Toby Roxburgh, Marine Programme, Frontier-Tanzania, PO Box 9473, Dar es Salaam, Tanzania (frontier@twiga.com).

Cladocora Caespitosa: a Colonial Zooxanthellate Mediterranean Coral Showing Constructional Ability

Introduction

Cladocora caespitosa is a colonial, zooxanthellate scleractinian coral belonging to the family Faviidae. It occurs throughout the Mediterranean from near the sea surface to more than 30m depth and can be locally abundant (Zibrowius 1980). Colonies occasionally grow to large sizes and may exhibit calcification rates of about 0.2 $mg \cdot g^{-1} \cdot d^{-1}$, similar to that of many reef corals (Rodolfo-Metalpa *et al.* 1999).

Build-ups of this species, both living and fossil (Late Pliocene throughout the Pleistocene) have been reported from several sites in the Mediterranean Sea (Bernasconi *et al.* 1997; Aguirre and Jiménez 1998; Peirano *et al.* 1998). As a fossil, *C. caespitosa* is frequent in terraced deposits of Middle to Late Pleistocene age, providing evidence that it was more abundant during warmer climatic phases.

According to Laborel (1987), the present geographical range of *Cladocora caespitosa* build-ups in the Mediterranean has decreased compared to their fossil distribution. Reasons for this impoverishment are not known but might be related to climatic change. There are also clues that such a reduction is still in progress. Augier (1982) included *C. caespitosa* in a list of marine species in danger of disappearance.

C. caespitosa appears in a list of marine species in danger of disappearance

Coral Banks Occurrence

Where abundant, *C. caespitosa* occurs in two forms, either as a number of distinct subspherical colonies (10 to 30 cm in diameter); or as large formations reaching some decimetres in height and covering several square meters in surface area. For the latter, Peirano *et al.* (1998) proposed the term "bank". For the former they preferred the rather general and inclusive term "bed". Living banks of *C. caespitosa* are known especially in the Aegean Sea, Eastern Mediterranean (Kühlmann *et al.* 1991). Laborel (1961) gave an accurate description of such banks in the Gulf of Atalanta, Greece. He reported banks 1 to 3m high covering up to 100% of the bottom 5 to 18m depth at specific sites. The only living banks of *C. caespitosa* presently known in the NW Mediterranean seem to be those discovered in 1992 in the Ligurian Sea (Morri *et al.* 1994). Banks formerly living in the Gulf of Marseilles during the 18th and 19th centuries are no longer found (Zibrowius 1980). Another bank on the French coast has recently died due to overgrowth by the invasive alga *Caulerpa taxifolia* (A. Meinesz, pers. comm.).

Role of Environmental Factors

Peirano *et al*. (1998) hypothesised that the abundance of *C. caespitosa* is primarily controlled by competition with soft frondose algae. Therefore, shallow beds only develop on rock made nearly bare by sea-urchin grazing (Herndl and Velimirov 1986). The capacity for autotrophy (thanks to the symbiotic zooxanthellae) combined with plankton ingestion, gives *C. caespitosa* an advantage over algae in deeper locations (i.e., near the compensation depth for photophilic algae) or in turbid water (Laborel 1961; Tur and Godall 1982; Kühlmann 1996). This may explain the occurrence of beds and banks at depths below 20m or near the mouth of small rivers. The formation of large banks in shallow water is probably prevented by physical disturbance from storms, as observed by Schiller (1993) in the Bay of Piran (Northern Adriatic). Conversely, building in deeper or sheltered waters might be enhanced by higher sedimentation: fine sediments fill interstices among corallites, giving the build-up more strength and compactness. This positive role of sediment in coral growth has been recently demonstrated by Rosenfeld *et al*. (1999).

Growth and Climate

Schiller (1993), using Alizarin Red S, calculated a growth rate for *C. caespitosa* of 2.9–5.2 mm/year^{-1}. In aquaria, Oliver Valls (1989) and Rodolfo-Metalpa *et al.* (1999) observed growth rates of about 5 mm/year^{-1} in constant water temperatures of 20°C and 23°C respectively. With X-radiography, Peirano *et al.* (1999) measured growth rates mostly between 1.3 and 4.0 mm/year^{-1}.

X-radiographs of corallites showed a clear banding pattern, indicating that *C. caespitosa* deposits two bands per year: a high-density band during winter (November to March), and a low-density band in summer. No differences in deposition timing were found between shallow and deep colonies. Deposition timing proved to be correlated to monthly temperature and irradiance trends (Peirano *et al.* 1999). Analysis of annual density bands in corals as a tool for understanding past climatic variations is well known. Growth over one year is represented by the above-mentioned banding pattern (Knutson *et al.* 1972; Barnes and Lough 1993). In *Porites* colonies of the Great Barrier Reef, average annual calcification provided a proxy for variations of sea surface temperature back to the 18th century (Lough and Barnes 1997), notwithstanding some distortion of environmental information during coral growth, and intrusion of information associated with skeletal architecture into the environmental signal. Being a plocoid coral and thus having distinct and separate corallites, *C. caespitosa* should provide clearer results. Another advantage of *C. caespitosa* is that the seasonal signal is stronger in the Mediterranean: in the Ligurian Sea, for example, shallow water temperatures range from winter values of less than 13°C to summer values of up to 26°C.

> increased mortality at higher temperatures apparently contradicts paleontological and retrospective growth indications that this coral is favoured by warmer conditions

On Going Studies

Both beds and banks of *Cladocora caespitosa* are common along the coasts of the region of La Spezia (eastern Ligurian Sea, Italy). They are currently under study to: 1) identify building patterns; 2) understand the influence of major environmental factors upon accretion; and 3) correlate the growth of the species with climatic data. A number of techniques have been used, including *in situ* observations through diving, photomosaic techniques on underwater photographs, X-radiography and aquarium rearing.

Underwater photography and observations showed the importance of modular growth strategies for bank accretion. Three main mechanisms were recognised: the fusion of adjacent colonies; "pouring" of the mass due to gravity; and inclusion of satellite colonies. Studying a bank at 27–29 m depth (see Figure 1), Peirano *et al.* (1998) assumed that it was of a bed origin. As neighbouring colonies grew, they came into contact with each other and thus eventually merged into a larger mass. In the absence of physical disturbances from storms (largely because of the depth), this mass continues to grow. Continued growth is primarily horizontal, i.e. "pouring" by gravity down the groove in which it is developing, with maximum accretion observed at the lower end of the groove. During this process other portions of the bank may be encountered and then added by fusion; or the bank may incorporate adjacent smaller satellite colonies. Satellite colonies derive from larvae or originate asexually through fragmentation.

Year-to-year variations in corallite band width were clearly evident on X-radiographs, and these band widths appeared to correlate with temperature data (Peirano *et al.* 2000). A large colony, more than 60 years old, exhibited higher growth rates which corresponded to a warmer period in the 1940s, and lower rates during a colder period in the

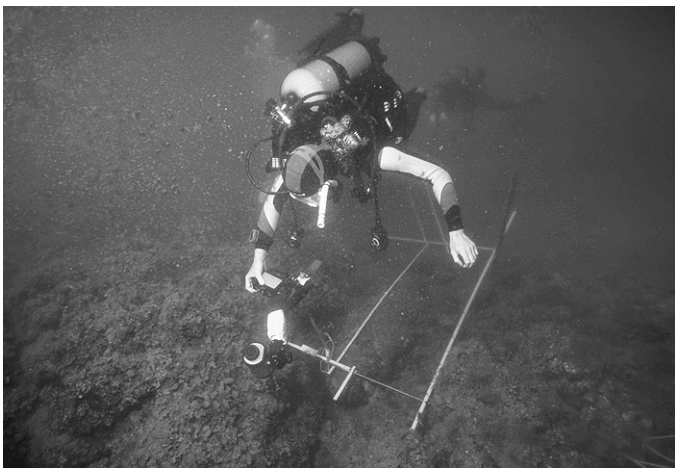

Figure 1. Mapping a Cladocora caespitosa *bank through photomosaic techniques in rather turbid water, 27–29 m depth, Ligurian Sea (NW Mediterranean).*

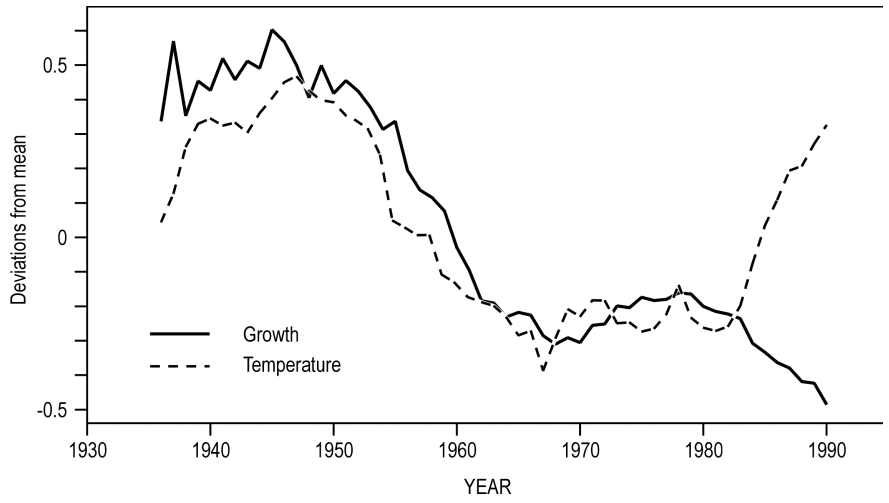

Figure 2. Trends in temperature and growth of a 60 years old colony of Cladocora caespitosa *from the Ligurian Sea (NW Mediterranean). Both lines trace the respective 11-year moving average.*

1970s (Bianchi 1997). However, decadal trends in growth and temperature started to diverge in the 1980s, characterised by low coral growth in a warm climatic phase (Figure 2). Colony senescence might be responsible for this pattern. Nonetheless, a comparable uncoupling between climate and biological response in the sea was observed in the same years by Southward (1991), who suggested that changing weather patterns and other effects of global climate shift may be involved.

As a result of a rise of 2°C in the sea surface temperature in the Ligurian Sea, populations of *C. caespitosa* underwent severe mortality in the summer of 1997 and 1998 (Rodolfo-Metalpa *et al.* 2000). This was followed by yet another mortality event occurring at the end of August 1999, again as a result of a prolonged period of abnormally high water temperature (Cerrano *et al.* 2000). Thus, increased mortality in presence of higher temperature apparently contradicts paleontological and retrospective growth indications that this coral is favoured by warmer conditions and clearly requires further investigation.

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Coral Reef Resources of the Islamic Republic of Iran

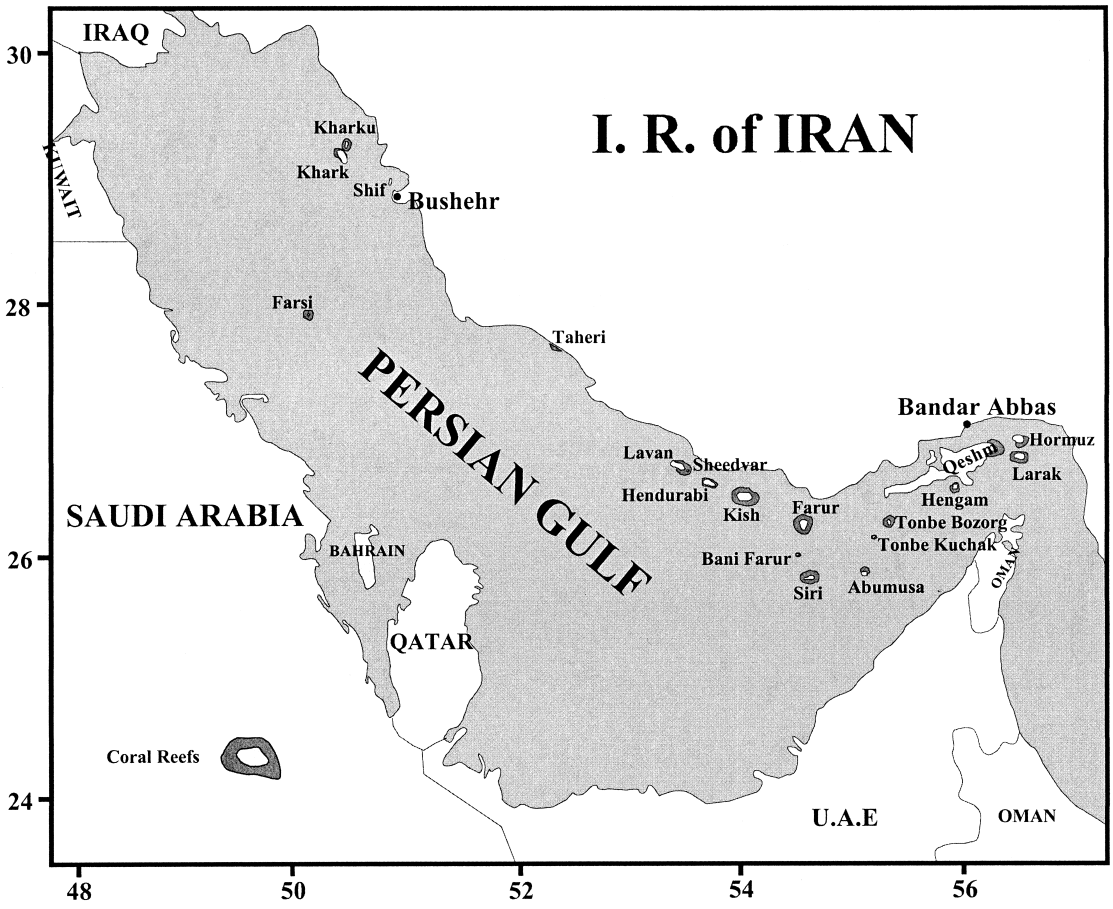
Geography

The Persian Gulf is a semi-enclosed shallow continental sea measuring 1000 km in length and varying in width from a maximum of 340 km to only 60 km in the Strait of Hormuz. Its average depth is approximately 35 m with maximum depth of 100 m on the Iranian side.

The bathymetry has been deformed by salt intrusions and subsequently the shallower hard substrate areas adjacent to islands have been colonised by corals. On average, sea surface temperatures range from 17–18°C in the winter to 36–37°C in the summer. Salinity ranges from 35 ‰ (in-flowing water from the Sea of Oman through the Strait of Hormuz) to more than 40 ‰ (out-flowing water), but more extreme values can be observed locally (lagoons and shallow bays). The residence time of water in the Persian Gulf is estimated to vary between 2–5 years. With high salinity and sea surface temperature (SST) fluctuations, especially low winter temperatures, conditions for coral growth and development are less than optimal.

The Persian Gulf maintains one of the most extreme environments for coral

The Persian Gulf maintains one of the most extreme environments for coral growth with a relatively impoverished reef biodiversity compared to that found in the Indian Ocean (Price 1993; Tavakoli 1998). The most extensive coral reef development is found in the western part of the Persian Gulf, between Bahrain and the border of Kuwait.



The knowledge of coral reef distribution on the Iranian side of the Persian Gulf is very limited and has been approximated in the adjacent figure. Coral reefs are found encircling Iranian islands (Sharabati 1981) with fringing reef being the dominant reef structure along the coastlines (Sheppard and Salm 1988; Sheppard and Sheppard 1991) (Table 1). The best developed reefs on the Iranian side are located adjacent to Khark and Kharku Islands in the far north, and around the south-

Table 1. Coral Reefs of Iran

Reef Name	Reef Type	Latitude(°N)	Longitude (°E)	Remarks
Khark	Fringing	29° 15′	50° 18′	Oil Terminal
Kharku	Fringing	29° 19′	50° 20′	Wildlife Refuge
Farsi	Fringing	27° 59′	50° 10 ′	———-
Taheri	Patch	27° 38′	52° 31′	———-
Kish	Fringing	26° 33′	53° 57′	Free Trade Zone
Lavan	Fringing	26° 49′	53° 16′	Oil Terminal
Hendurabi	Fringing	26° 40′	53° 38′	———-
Farur	Fringing	26° 17′	54° 31′	Protected Area
Bani-Farur	Fringing	26° 07′	54° 26′	———-
Sheedvar	Fringing	26° 47′	53° 25′	Protected Area
Tonbe Bozorg	Fringing	26° 16′	55° 17′	———-
Tonbe Kuchack	Fringing	26° 14′	55° 09′	———-
Siri	Fringing	25° 54′	54° 31′	Oil Terminal
Larak	Fringing	26° 50′	56° 21′	———-
Abumusa	Fringing	25° 52′	55° 01′	———-
Hengam	Fringing	26° 40′	55° 50′	———-
Qeshm	Fringing	26° 40′	55° 44′	Free Trade Zone
Hormuz	Fringing	27° 04′	56° 25′	———-

ern islands from Lavan to Hormuz Islands (Harrington 1976; Harger 1984; IUCN/UNEP 1988; Fatemi *et al.* 1989).

Research

The distribution and status of the coral reefs remains poorly known throughout the Iranian waters. Early studies by Rosen (1971) on the northern part of the Persian Gulf and Saudi Arabia recorded only 15 genera of hard corals. Harington (1976) reported the presence of corals at the Sheedvar Island and Harger (1984) noted 19 coral species at Hormuz Island. Staghorn coral (*Acropora* sp.) is the dominant species around islands in the Persian Gulf (Sheppard and Sheppard 1991). Rezai (1994; 1996) during a two year diving and photography study examined the corals around different islands and identified 35 species of hard corals. Twelve sites were studied and for the first time observations were made of soft coral (*Sacrophyton* sp.), and hard coral (*Seratopora* sp.) around Larak Island. Rezai and Jahangard (1994) recorded Crown-of-Thorns Starfish (COTs) in the northern part of the Persian Gulf (Tonbe Kuchack Island). Sa'-dat Sadeghi (1997) surveyed hard corals around Kish Island and identified 19 species. Favidae were found to be the most biodiverse family, while Acroporidae and Poritidae occurred most frequently and Agariciidae and Dendrophyllidae occurred rarely. Haeri-Ardakani and Ghaazban (1997) used coral reefs to evaluate the extent of environmental pollution based on changes in concentrations of toxic elements. Nickel, vanadium and cadmium were considered to be good indices of anthropogenic activity.

distribution and status of the coral reefs remains poorly known throughout Iranian waters

Iranian Fisheries Research Organization (IFRO), the Department of Environment (DOE) and the Iranian National Center for Oceanography (INCO) are the three principle institutions concerned with coral reef related research in Iran. Contributions have also been made by the Persian Gulf Biotechnological Research Center and some universities which have conducted research campaigns on the coral reefs in the Persian Gulf area (Iranian side). INCO is presently carrying out a project to map the extent of reefs and to as-

sess their status in Iranian waters. INCO also monitored one site around Kish Island as part of Reef Check 1999.

Threats

Threats to the Iranian coral reefs and their associated ecosystems fall into the following two main groupings:

Anthropogenic

- Maritime transport pollution mainly from oil tankers (Anonymous 1993).
- Pollution from land based activities such as coastal construction and municipal sewage.
- Impacts related to the development of the tourism industry.
- Thermal pollution from desalination and power plants.
- Resource extraction related activities including damage from anchors, fish traps, ropes and another fishing gear as well as overexploitation of living resources used for food and decorative purposes.

Natural

- Large water temperature fluctuations.
- Coral bleaching likely due to high SSTs during the midsummer months.
- Meteorological events.

Management and Conservation

Inadequate base line studies and lack of information on Iranian coral reefs has made it difficult for management plans to be developed. Responsibility for management of reefs falls under various schemes (i.e. national protected areas and wildlife refuges) which are then administered and regulated by governmental organizations. At present, however, no specific management plan has been developed or implemented to protect the reefs in Iran.

The Iranian DOE has established some national protected areas and wildlife refuges at selected islands in the Persian Gulf, in which all activities (i.e. hunting, pollution and construction) that would destroy or damage the environment and its associated fauna and flora are prohibited. Sheedvar Island, composed of a coral conglomerate structure, and Farur Island are proposed national protected areas which are under consideration by the Government. These islands are the major nesting sites for marine turtles in Iran with up to 500 Hawksbill turtle (*Eretmochelys imbricata*) nests counted at Sheedvar Island in 1971 (IUCN/UNEP 1988). Kharku Island is a wildlife refuge surrounded by coral reefs and is at the westernmost point along the Iranian coasts where coral is found.

Education

To raise coral reef public awareness in Iran the DOE has published a number of books and posters about the importance of natural habitats as national treasures. The Ministry of Culture and Higher Education, through different courses related to marine sciences, also contributes to staff training and thus plays a major role in raising public awareness about the marine environment as a whole. In recent years a few Iranian environmental NGOs have promoted public awareness initiatives through public tours aiming to involve people in the protection of Iranian natural habitats. Furthermore, an increasing number of coral reef exhibitions, television documentaries and video films provided by the local media have been very useful in educating the public about the importance of reefs.

The Future

The unique environmental conditions of the Persian Gulf and the associated coral reef and marine communities, requires specific efforts to be made to promote an international cooperative program for protection of coral reefs in this region. At the national level, funding constraints and lack of scientific capacity are among the most serious limitations in planing a systematic management program relevant to the coral reefs. Consequently, there is a need for regional and international cooperation to obtain financial support and to train staff in appropriate fields. The development of proper monitoring and management plans in collaboration with neighboring countries and international organizations is a very attainable goal. The first step towards a monitoring program in Iran has already been taken through participation of Iranian scientists in the Reef Check 1999.

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A Sting in the Tale

With patent applications well advanced, Spyhopper can't resist revealing sketchy details of his latest secret endeavours. It all started with a slight accident in the Sulawesi Sea. While Spyhopper cruised along minding his own business, a posse of green turtles, unusual in those parts, rattled past at great pace. Rubber-necking to get a better look, Spyhopper carelessly clattered into a stand of fire coral. Not so bad if you're suited and booted, but Spyhopper was scantily attired and emerged with a coral rash the colour of an Indian Ocean sunset tattooed across his chest. Numb with pain, he fell immediately into a feverish dream filled with psychedelic images of exploding nematocysts and poison capsules. Weeks passed, and finally Spyhopper emerged, shaken *and* stirred, and with the seeds of Project Nettle sown firmly in his mind.

Researchers have long pondered how to exploit biodiversity for excessive profit in the name of conservation, and Spyhopper proudly proclaims his own ideas here and at large. Everyone must be familiar with the sun-protective nature of some coral metabolites. Spyhopper claims he instigated this line of enquiry many years ago after adopting an *Acropora* plate as a sun-hat. He naively assumed the jostling medical executives were simply fashion conscious. Stung by these experiences, and still in shock from the fire coral episode, Spyhopper went into hiding to develop his latest novel application of coral reef by-products.

There has been much talk recently of nano-technology and the development of micromachines to service the human requirement. As Spyhopper lay writhing with the agony of nematocysts firing into his deepest dermal layers, he pondered the instrument torturing his febrile mind. And then it came in a flash—harpoons that could deliver micro-titres of drugs, detergents, surfactants, anything in fact! With a tweak to the cellular machinery—presto—a miniature hypodermic. Project Nettle has resulted in a new and revolutionary product—the Nemastoblast™. Harvested nematocysts are encapsulated in glyco-proteinated capsules coated with specific receptors. When the target is encountered, an electrical charge causes the capsules to fragment. The nematocysts then puncture their way through cell linings, membranes, materials etc., and deliver aliquots of chemicals to the desired target.

It is the ease of production that marks the Nemastoblast™ out from other drug delivery systems. Spyhopper has already set up his first production facility close to his island hideaway. Rather fortuitously, fire coral is easily cultured. It grows rapidly and is tolerant of disturbance. Not only that, Spyhopper pronounces *Millepora* amenable to genetic modification. Although a relative amateur, Spyhopper, using only a liquidiser and coffee percolator, claims to have substituted the genetic code for the nematocyst toxin with instructions for adrenaline—with invigorating success. Spyhopper also brags of a caffeine delivery system that acts instantly on brain stem cells and which is 200% more efficient than any current method. The Nemastoblast™ is currently pitched at the latest oil spill clean-up technology. Tarry balls will be a thing of the past because Nemastoblasts™ oil dispersants can get under the skin—if you'll excuse the puns. The list is as endless as your imagination.

Once again, I hear you all sigh, another example of a depressing abuse of a biological resource. But wait—there is almost no undesirable waste. All by-products of the coral 'pharming' process can simply be ground up into a powder and recycled through the system, a revolutionary and non-pollutionary production method! Because this technological leap forward requires habitat creation, rather than destruction, it can only benefit of reefs worldwide. Mark my words, coral pharming is closer than you think.

Spyhopper

Finally—a comment from our readers. "Utter gruntswollop" —Dr. R. Clupe, Ohio.

BOOK REVIEW

What is Natural? Coral Reef Crisis

Jan Sapp. Oxford University Press, New York and Oxford. 1999. 275pp. ISBN—0-19-512364-6 GBP 22.5 hardbound US$ 30

The first view of a reef under siege from a crown-of-thorns invasion is unforgettable—you see a reef, and then you experience a double take as you realize that everywhere there are huge spiky starfish, clambering over one another, the sight stretching away in every direction. Many of the corals are bright white, as if bleached, but in fact already dead, and the culprits are moving up to even the high and awkward branches of large Acroporids to devour the remaining corals. The first records of such plagues date back to the late 1960s. Prior to this the crown-of-thorns starfish (COTS or *Acanthaster planci*) had been considered an interesting, but rare, species on many reefs of the Indo-Pacific. As the plagues advanced so did concern about their cause and their long-term impacts, both on the reefs, and on the livelihoods of coastal people dependant on reefs for food or tourism income.

Politicians and managers found the scientists they wanted to justify their claims for action or inaction

The media were entranced—strange looking creatures reaching plagues of biblical proportions and destroying some of the most beautiful places on the planet—headlines were made across the globe. A debate raged as scientists failed to determine the cause of the outbreaks. Many blamed human activities including overfishing of the natural predators, but also the impacts of increased pollution and sedimentation (with nutrification) coming from land. Others were convinced these same plagues were an entirely natural phenomenon and that there was no cause for alarm. All sides produced their evidence, but the debate also became highly politicized. Politicians and managers found the scientists they wanted to justify their claims for action or inaction: massive eradication programs were begun in some areas, while elsewhere nothing was done.

Rigorous science demands high levels of certainty, conservation requires application of the precautionary principle, and action before the show is over

Jan Sapp's *What is Natural? Coral Reef Crisis* provides a detailed and fascinating study of the crown-of-thorns story, but in so doing provides a great deal more to the reader. In some ways this story is a microcosm of the development of reef science—so many of today's leading reef scientists crop up in this work as young researchers in all sorts of unexpected places. Indeed much of the story is told in their own words recorded in extensive interviews. Here too we can read about many errors of sampling, and about the development of continued monitoring as a critical tool for understanding complex and long-term processes. We realize how little we still know about the stability or instability of reef ecosystems, and about the long-term processes which may drive these systems.

This is certainly an absorbing book, and the author, who is not a reef scientist, has to be congratulated for getting around such a long and complex debate, and for presenting it to the reader with such clarity. It is a long book, not just a light read, and deserves to be read with care. It not only provides a history, but also should provoke our thoughts about how we conduct our work into the future.

The *Acanthaster* debate is still not over, and has had a major influence on how reef science operates. This debate, and the wider story it addresses, also reaches far beyond the science. How much of what the scientists observe is driven by their preconceptions, or by the limitations of their personal experience? How ready are we to face the press and the politicians? How naive are we to assume our carefully worded and objective science will remain unbiased amidst the murky politics of vested interests? The importance of *Acanthaster* is in many ways now subsumed by the new stories of

global reef degradation through direct human impacts (the cocktail of threats we summarize under pollution, sedimentation and poor fishing practices) and by the menace of coral bleaching. Perhaps we are now better prepared to provide objective science and consensus (note the **ISRS** statements on coral disease and bleaching). But when should we stand up and make our statements? Rigorous science demands high levels of certainty, conservation requires application of the precautionary principle, and action before the show is over. With the *Acanthaster* debate, a simple precautionary approach could be applied even if the scientists remained unsure. Bounties were paid to starfish collectors in some countries. Other measures, such as controlling land-based sources of nutrients could at least theoretically be developed. With coral bleaching a new issue is uncovered. Even if we can reach consensus on the role of global climate change there may be little we can actually do.

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Reef Evolution

Rachel Wood, Oxford University Press. 1999. 426pp. ISBN 0-19-857784-2 Paperback GBP 22.50, Hardback GBP 55.00

For most **ISRS** members with a biological background, the word "reef" conjures up images of colorful, spectacularly diverse, modern, tropical coral reefs. However, while such scleractinian-dominated ecosystems are certainly the most prevalent and best-developed reefs today, they are a relatively recent phenomenon. Scleractinian corals and perhaps even zooxanthellae date from the Triassic, and many of the major guilds of grazers, bioeroders, predators, etc. that shape coral reefs as we know them entered the scene well into the Cenozoic. Furthermore, many other types of reefs thrive today, and a great diversity have existed in the past — in habitats ranging from high to low latitudes and shallow to deep waters, and constructed by a diversity of microbes, algae and metazoans. A study of the variety of these manifestations through time is essential to an understanding of reefs as a phenomenon in the broad sense, and of the physical, chemical and biological processes that make them possible. Wood attempts such an overview of the history of reef building, describing not only the structure, biota, and ecology of a wide range of reef systems that have existed, but also their evolution through time, and the forces that shaped them. Delving into disciplines ranging from paleoclimatic reconstructions to theoretical ecology, the author does a commendable job in presenting a broad-brush overview of the 3.5 billion years of reef evolution, though some readers may quibble about details.

what is a reef?

Wood starts out by asking the question: what is a reef? She provides considerable rationale for opting for "the broad definition that a reef is a discrete carbonate structure formed by in-situ or bound organic components that develop topographic relief upon the sea floor." This broad definition accommodates the variety of carbonate buildups that have been recognized as reefs by various workers. After reviewing what reefs are about as biological communities and geological structures in chapter 1, the recognition and geology of ancient reefs is covered in the next. Wood then provides a romp through reef systems and their builders, from 3.5 billion years ago to today (chapter 3).

The second part of the book deals with environmental controls of reef development on a variety of scales: considering physicochemical processes through time (chapter 4) and catastrophic mass extinction events (chapter 5). Wood notes that reefs are controlled not only by the ability of reef building organisms to thrive, but also by the facility of carbonate precipitation; she places considerable emphasis on the importance of carbonate saturation levels on reef building. While reviewing the history of mass extinctions, she argues against the widely-held view that reefs are more vulnerable to mass extinctions than are other communities. She notes that reef-associated biotas have comparable survivorship to other biotas that inhabit carbonate shelves, and that stromatolitic reefs re-establish rapidly after mass extinctions, as a type of disaster flora. She argues that much of the perceived extinction propensity of reefs may be the result of the vulnerability of carbonate shelf habitats in general, rather than of reefs or reef organisms in particular.

The final section of the book considers the evolution of reef biotas and communities through time. Here, the author attempts to identify large-scale trends and shifts and the processes responsible for them, focusing especially on the role of biotic interactions. Chapter 6 surveys the evolution of modular organization, documenting the increase in modularity and the degree of integration of modular organisms through time in a diversity of sessile biota, and considering the potential driving forces behind these trends. While Wood argues here that competitive interactions play a central role in these trends, she also reviews the increasing importance through time of predation and other biological disturbances such as boring and bulldozing (Chapter 7). The last chapter considers the origin and evolution of photosymbiotic relationships. Wood argues that much of what biologists take for granted about coral reefs—such as the pivotal role of photosymbiosis, the tight adherence to the substratum and consequent invasion of high-energy habitats by reef-building macrobiota, and the crucial role of herbivorous fish—are Mesozoic and Cenozoic developments. Reefs in the Paleozoic were different indeed.

much of what biologists take for granted are Mesozoic and Cenozoic developments. Reefs in the Paleozoic were different indeed.

Wood covers a lot of ground and has insightful things to say about much of it. In the tradition of modern paleobiology, she successfully applies biological insight from modern organisms to fossil taxa and communities, and thus brings ancient reef communities to life. However, like most broad-based reviews, some subjects are more up-to-date and more accurately presented than others. In some cases, the author does not consider important relevant literature or evidence, or makes generalizations based on slim evidence. For example, she notes that cidaroid echinoids are mechanically incapable of excavation, and that diadematoids are the only corallivorous urchins. Yet one of the most destructive echinoids on reefs is a cidaroid. *Eucidaris galapagensis* (formerly *E. thouarsi*) feeds heavily on living corals, and its bioerosive impact on reef carbonates is so extensive that it caused the recent collapse of reefs in the Galapagos. A search for adaptive trends and patterns pervades the book. Unfortunately, the author often selectively discusses data that support adaptive/exaptive theories, while dismissing data that do not meet expectations. Further, there is a tendency toward posthoc, adaptive/exaptive explanations for observed phenomena. For example, predation / herbivory is identified as driving coralline algae away from, and corals toward, an arborescent morphology—in part because that is the observed, historical trend in each group.

Overall, the book provides a unique and valuable reference for the history of reefs. The detail-packed, dense style, and an assumption of considerable background in both geology and biology, makes it most appropriate for graduate students and professionals. Presentations of general trends in the history of reefs are usually compelling and provide much material for discussion—the book would make great material for a seminar course. The extensive and generally up-to-date bibliography and well chosen and terrifically rendered illustrations are further assets.

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Staghorn Corals of the World, a Revision of the Genus *Acropora*

Carden Wallace. 1999. Hardbound, CSIRO Publishing, 422 pp. AUS$130. http://www.publish.csiro.au

Who among Indo-Pacific coral reef workers has not gazed on an intricately branching coral and known that it was *Acropora*, but could only dream of being able to identify the species?

Staghorn corals (genus *Acropora*) are found on most of the world's coral reefs, and dominate many of them. Their great importance for reefs means that almost everyone working on coral reefs needs at some time to know how to identify them and understand their biology. Their importance cannot be over emphasized, but the myriad variations in shape can be overwhelming.

This tome represents the 'state of the art' knowledge of the largest and most common genus of corals in the world—*Acropora*. It is partly a review of the existing understanding of the genus, and partly new contributions by the author, extending the boundaries of knowledge on this ubiquitous group.

This is not a field guidebook, but will be of great value to anyone trying to identify members of this genus. Staghorn, table, bottlebrush, bushy, etc.—in all there are 114 species of them—about twice the diversity of the entire Caribbean coral fauna (where incidentally only three members of *Acropora* are found, and once dominated in some areas).

The first part of the book provides the background and biology of the genus. It includes a review of the literature, a summary of type material, the fossil record, anatomy, physiology and biology, genetics and molecular biology, skeletal morphology, methods, revision of the biogeography, revision of the phylogeny and classification, and a synthesis of biogeography, fossils and phylogenetic data.

Wallace has examined nearly every type specimen, and over 15,000 specimens from about 800 sites

The treatment is clearly thorough. The text abounds with 64 figures (many are black and white photographs, including electron micrographs of the fine anatomy) and 19 tables, large and small, which provide tremendously useful information for anyone serious about studying this group. For instance, Table 1 lists every species name that has ever been applied to a member of this genus, the type locality, the museum the type is in, the museum number, and most importantly, the species status—whether it is a valid species or a junior synonym of another name (and what that name is). This table requires over 8 pages. Table 4 (over 4 pages long) lists all spawning records for *Acropora* around the world.

Twenty four pages of color plates follow, each with about 6–10 individual photos of living corals in nature, and with some plates illustrating reproduction or habitats dominated by *Acropora*. Although the printing job in this section was adequate, it was not up to today's standards, and does not present the beauty of the original slides, some of which I have seen.

The third section is the heart of the book, providing a two page treatment for each of the 114 species. Each group within the genus is described on its own page. Then each species is given one page of descriptive text, and a facing page of clear black and white photographs. The descriptive material includes the records of the specimens examined, skeletal characteristics, field characteristics, other information, fossil record, further literature, and a map of the locations from which the specimens came. The standard format for the description of skeletal characteristics will greatly facilitate comparison between species. The photographs on the facing page often include one or two photos of the whole living colony, photos of several pieces of colonies, close-ups of branch ends, and electron micrographs of corallites and coenosteum.

One can guess at the work that went into making this book so thorough when one reads that the author has examined nearly every type specimen, and over 15,000 specimens from about 800 sites! The totally new contributions are also significant. Five new species are described, a new type species for the genus is designated, a new analysis of the biogeography of the species, and a new cladistic analysis of the genus are presented. In addition, some taxonomic puzzles are solved, such as the distinctions between *A. elegans*, *A. magnifica*, *A. simplex*, *A. pichoni* and *A. tenella*. But the book has a few surprises for readers. The designation of *A. formosa* as a junior synonym of *A. muricata*, the type species of the genus, may be controversial since no type specimen of *A. muricata* exists and the original description is less than precise. In addition, finding a few species such as *A. azurea*, *A. akajimensis*, *A. sekisiensis*, and *A. wallacae* treated as junior synonyms may be unexpected.

Surprises such as these, however, are the exception not the rule. I am struck more by the fact that

taxonomists agree on most species, than that they differ on a few. If the species distinctions among corals were all arbitrary and merely opinion, then agreement would be rare. Agreement not only provides some taxonomic stability that will be welcomed by our colleagues who must use the names we come up with, but also provides a little reassurance that we are dealing in realities here and not just a matter of opinion. A few differences are to be expected- anyone who has worked with coral species knows just how notoriously tough they are. Which just highlights all the more the accomplishment this book represents. I predict that coral and reef workers will find this meticulous book invaluable, and that most copies will become badly worn over the years.

Agreement will be welcomed by our colleagues who must use the names we come up with

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Ecology of the Chagos Archipelago

Edited by C.R.C. Sheppard and M.R.D. Seaward 1999. Linnean Society Occasional Publications 2, Westbury Publishing; ISBN: 1841030031 GBP 49.00

The remoteness of the Chagos archipelago, absence of air connections, infrastructure or resident population (except for the 3,000 or so personnel at the Anglo-American military base on Diego Garcia) mean that scientific studies in the area have been relatively few and far between. The 1996 expedition on which this volume is based has greatly helped to redress the balance. It involved thirty scientists and technicians from Britain, America, Belgium, Germany and the Netherlands who visited the archipelago and carried out an intensive six week research program.

The aim of the program was to obtain detailed information about the islands and reefs and to determine the current environmental status and conservation needs of the Archipelago. There are 24 chapters in all, covering geology, weather patterns, reef and island fauna and flora, environmental assessment and fisheries. Many of the contributions were presented at a Conference organized by the Linnaean Society in 1997, with other papers included in order to provide a solid body of information about the area.

The review of weather patterns covers the period 1973–1997, just missing the El Niño warming event of mid-1997 to 1998. Records are based on atmospheric measurements from the Diego Garcia military base, rather than Sea Surface Temperatures, and there are gaps due to equipment failures and holiday periods, but even so, the analysis confirms that there has been a general trend of warming in the region. A mean annual temperature increase of nearly 1°C occurred over this period, together with a significant reduction in cloud cover.

The chapters on flora and fauna differ in treatment of their subjects, but each provides a solid baseline for future studies. There are species lists for hard corals, soft corals, macroalgae, foraminifera, fish, terrestrial cryptogamic flora, higher plants, insects and seabirds, and ecological information for a number of these groups.

for corals at least, Chagos provides a strong connecting link in an east-west direction

The investigation of hard corals includes a chapter on biogeography in which similarities in coral species composition between Chagos and twenty-five other well-sampled sites in or around the periphery of the Indian Ocean are computed. This study shows that from the point-of-view of corals at least, Chagos provides a strong connecting link in an east-west direction. In contrast, a study of the zoogeography of the fish fauna shows a closer similarity with the southern Maldives than areas to the west and east.

Another study of the fish fauna deals with biodiversity patterns and provides an interesting analysis of community structure which, in contrast to studies from other areas, reveals a high level of homogeneity over mesoscales (1–150km). This was put down to the relatively constant environmental conditions across the archipelago and the high degree of connectivity between sites.

Soft corals are often neglected in reef surveys, partly because of taxonomic uncertainties which make ecological studies problematic, so it was good to see a description and analysis of alcyonacean assemblages. Distribution patterns are related to predominant environmental conditions such as currents, light and sedimentation, providing interesting parallels with similar studies on scleractinian communities.

The previous major expeditions to Chagos were in the 1970s, and the findings of this recent survey illustrate that much can happen over a span of 20 years and that in the absence of continuous monitoring it is difficult to explain observed changes. For example, a repeat of the survey on benthic cover from just below the surf zone to over 30m depth showed a marked reduction in coral cover in shallow water caused by a fall in one or two species of *Acropora,* but the reasons for the decline remain elusive. The field surveys took place before the severe El Niño of 1998, so could not be attributed to bleaching from this event. However, the effect of changes in meteorological patterns is not ruled out, and a number of other possibilities for the decline are also discussed.

shark numbers have declined by as much as 86% since the surveys of 1975 and 1979

It is perhaps slightly easier to identify the reason for the observed drop in shark numbers in the Archipelago, which are estimated to have declined by as much as 86% since the surveys of 1975 and 1979. Illegal fishing is said to be the cause. In contrast, an analysis of commercial inshore fishery data from 1977 to 1997 shows that fin fish (mainly lethrinid) catch rates give no indication of overfishing. The turtle population also appears to be in a recovery phase with an increase in reproductive output. There are three informative chapters on sea turtles, one examining population fluctuations and providing information on nesting sites of hawksbills and greens, the second examining sex ratios in hawksbills through analysis of sex steroid concentration and the third looking at genetic relationships between the Chagos populations and three adjacent locations.

In these days of doom and gloom for coral reefs it was heartening to see that each of the three chapters dealing with the environmental health of the archipelago conclude that the marine environment is uncontaminated and virtually pristine. Litter seems to be the only major problem—a depressing find, but one which proves the point that the reefs of the archipelago are on a main thoroughfare which carries larvae as well as flotsam across the Indian Ocean.

uncontaminated and virtually pristine

The volume concentrates on individual topics most of which touch on ecological issues and my only slight disappointment (given the title of the publication) was that there was not more emphasis on drawing all the strands together to provide an overall ecological analysis. However, the Introduction makes it clear that this is covered in the forthcoming publication *Coral Reefs of the Indian Ocean*—so the full story is out there—all you need to do is buy both publications!

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Well Told Reef Stories

Silent Sentinels and **The Perils of *Plectropomus*** 1999. Both approx. 1 hour. VHS format. Written, produced, directed, filmed and narrated by R. Smith; additional footage from other individuals and institutions. Science Unit of the Australian Broadcasting Corporation (ABC) (www.abc.net.au/science). North American distributor, Bullfrog films of Pennsylvania (www.bullfrog.com).

Science is one of the few human endeavors depending primarily on the printed word. Teachers face a real challenge in bringing alive the stilted language of rigorous science. We use images where possible, but generally eschew television and film because the underlying theory and essential details are absent or incorrect. Therefore, I enthusiastically review these excellent documentaries which provide an attractive, accurate and thought-provoking coverage.

Silent Sentinels presents the scientific evidence linking coral bleaching to global warming in an informative mixture of interviews with scientists and managers, and narration over superb photography. Topics covered include marine biology, coral reefs, global warming, climate change, atmosphere, oceanography, earth science and life science. However, there is little in-depth material on atmospheric or earth science. The target groups are ages 12 to 18, college and adult. Virtually all of the topics addressed will provide intelligible information across this broad audience.

attractive, accurate and thought-provoking coverage

The essential message is that the extent and frequency of coral bleaching, and associated coral mortality and reef community dysfunction increased alarmingly in the 1990s as a result of global warming. Mechanisms and causality are explored, and the case for anthropogenic cause is made, but not proscribed. Using effective editing, evidence is provided from at least eight coral environments in three oceans, as well as six terrestrial sites, giving a broad sweep of relevant information. The key observations and conclusions are usually supported by interviews with leading research scientists. Ove Hoegh-Guldberg, Russ Jones and Chris Langdon discuss coral-algal symbiosis, coral photobiology and the effects of carbonate saturation on coral calcification. Jess Atkins, Fred Cook and Jerry Wellington consider sclerochronological data and the links to ENSO and paleoclimates. Tom Goreau, Luke Smith and Al Strong describe the nature and extent of coral community change, and the relationship to synoptic patterns of sea surface temperatures. Bill Causey provides a manager's perspective on the extent and impact of coral bleaching.

Several complex and unresolved scientific issues (eg. source-sink relationships to coral reproduction, and carbonate stoichiometry) are explained clearly and with appropriate qualification, but without disrupting the narrative thread. Diverse topics such as the thermohaline circulation and the light and dark photosynthetic reactions are covered. The challenge that shade- dependent bleaching poses to thermal stress models is also given a fair airing, but one glaring omission is no mention of the several species of zooxanthellae having different ecophysiological responses. The power of sclerochronology to test hypotheses about the ability of corals to cope with environmental stress is highlighted, but without explanation of how coral skeletons actually record paleoenvironments. The power of near-real-time satellite data to produce testable predictions of the location and intensity of coral bleaching is particularly well presented with computer graphic "movies" of evolving hotspots. The message simply could not be as well presented in any other medium.

The narrative provided by Richard Smith is generally balanced, informative and forceful. Besides the pleasant Australian accent, there is little to identify this as a national production. But a few terms are not explained adequately for a non-scientific or non-Australian audience (e.g. dinoflagellate, and CSIRO). Some phrases describing change in reef systems border on the sensational and simplistic. Reefs are "devastated" and "die" (some of which have "the highest coral cover of any reef in the world)"; habitats are "wiped out"; soft corals "dissolve"; "...reef systems will start to die at temperatures greater than 30°C". The scientists interviewed most-

ly avoid such terms, and viewers may form a less conclusively negative view based on their own qualifications.

There are some places where more hard data or verification would improve the video. For example, it is not clear how we know that "the 1998 bleaching was the most severe in 500 years". I was surprised to be told that "...more than half of the 1355 species of corals live in the deep, aphotic ocean"—such a number needs elaboration. We only once hear the actual sea temperatures that occurred at bleached sites. I suspect this reflects the difficulty of explaining bleaching as a continuous, relative and adaptive response rather than an absolute threshold response.

the case for anthropogenic cause is made, but not proscribed

The latter omission leads to my most significant scientific criticism of the video: acclimatization, adaptation and coral reef recovery are barely mentioned as responses to climate change. Although distinguishing between coral bleaching and mortality, little quantitative information is provided on the proportions of coral populations and reef communities that do recover. The impression is given that bleaching almost always results in coral death which results in reef death; and reef recovery occurs in geological rather than ecological time. Finally, there is no mention of the local, anthropogenic components of global change, such as sedimentation and fishing that are the major current causes of reef degradation. Nor is there discussion of the synergies among local and global effects that really do lead to a pessimistic outlook for coral reefs.

In summary, an exciting story rich in nature's wonders, superb visuals and with a pleasing score does not lower the high standard of science presented. Of course, one can think of other scientists' work which would have strengthened the rigor of the video, but it is hard to see how they could have made the story more interesting. The video has received at least five first- place awards at international film competitions. I know no scientist or student with an interest in coral reefs who would not appreciate the video.

the video can only touch on some of the complexities of the fish's interaction with humans.

The Perils of *Plectropomus* shares it's style with **Silent Sentinels** but focuses on the live fish trade and its impact on coral reef fish communities. Blue water footage off Lizard Island, and excellent underwater sequences from several sites portray the secret lives of the Leopard coral grouper—*Plectropomus leopardus* from post-flexion larva to gravid matriarch. The hunting and spawning scenes are superb. The life story links such diverse concepts as larval fish navigation and the effects of dynamite fishing. The fish markets of Hong Kong, and fishing activities in Komodo National Park (Indonesia), Cooktown (Australia) and Andros Island (Bahamas) are used to convey the harsh realities of the fishes' transition from the reef to the diner's plate. Some of these scenes are cruel.

The essential message is that market forces drive an intense fishery for reef species we recognise as vulnerable but for which we cannot specify sustainable fishing levels, or predict the ecosystem effects of their decimation. *P. leopardus* is a proxy for reef fish and their fisheries worldwide. The complexities of reef fish ecology are discussed with an all-Australian cast of Dave Bellwood, Peter Doherty, Jeff Leis, Melita Samoilys, Eric Wolanski and Dirk Zeller. The abilities of larval fish to buck the currents and settle to reefs, and of adult fish to feed, grow and breed are presented with due respect for areas of ignorance and controversy. The "wall of mouths" concept is very effectively presented to explain daylight avoidance of reefs by larval fish. I particularly liked the introduction to our limited understanding of the relationship between fish diversity and reef ecosystem function, although the categorization of herbivorous fish as "cleaners of the reef" is a superficial summary. Many arguments are backed up by numbers (e.g. larval fish maintain average swimming speeds of 14 times their body lengths per second for several days in laboratory flumes), while others seem to be taken on faith (e.g. "...have dispelled absolutely the notion that reefs are self-sustaining units").

Helen Fox, Josh Pet, Yvonne Sadovy, and fishermen Kim Anderson and Lyle Squires are interviewed for fishery and market information. Destructive fishing practices and their unsustainability are a focus. But the suggestion that dynamite fishing originated with the Japanese is surely untestable and probably irrelevant. Socioeconomic contexts for types of fishing are presented, and potential

benefits of the live fish trade are not ignored. However, disucssion of exploited fish population dynamics and their relationship to quantitative measures and controls for fishing mortality (e.g. yield-per-recruit and size at first capture) is virtually lacking. This omission of basic fisheries theory limits the discussion of sustainable fishing, but interestingly suggests (at least to the initiated) that classical fishery science has little to offer reef fisheries management. The need to protect spawning aggregations is clarified with fine examples, but the concept of marine protected areas (MPAs) for fishery management lacks discussion of mechanisms, assumptions and indicators. There is no distinction amongst types of MPAs, and Biosphere reserves are incorrectly labelled "the highest level of recognition and protection we give to the natural world". Similarly, attempts to reconstruct reefs levelled by dynamite fishing are highlighted without examining their success or costs.

In summary, the video does a great job of recounting the natural history of *P. leopardus*, but can only touch on some of the complexities of its interaction with humans. Throughout, however, it avoids errors of scientific convention, and effectively documents "...the pillage of coral reefs for short term gain".

Richard Smith, the ABC team and the contributors to these two videos have provided attractive, informative and thought-provoking insights to coral reef science accessible to a wide audience. We need more of this type and calibre of media for the communication of reef science to our students and employers.

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Fishes of Bermuda: History, zoogeography, annotated checklist, and identification keys.
W.F. Smith-Vaniz, B.B. Collette, B.E. Luckhurst. American Society of Ichthyologists and Herpetologists Special Publication No. 4. 424p. ISBN 1-891276-09-3 US$50 hardbound

Bermuda's 177km^2 of coral reefs are the most northern in the world, more than 1000 km from their nearest neighbours. They shelter only 38 of the 72 Caribbean scleractinian corals, 17 gorgonians and alcyonarians and *Millepora alcicornis*. Bermuda's ichthyofauna is similarly depauperate (comprising only 50–55% of the species found in Florida or the Bahamas) but is also unique. This book represents years of painstaking research in which the authors examined 3100 museum specimens ranging from an oarfish collected in 1860 to the first recorded stargazer in 1998—just as the manuscript was going to press. The result is the primary reference for ichthyologists, biogeographers and others who want to know which species of shore fishes have been validly reported from Bermuda. Four hundred and thirty three species are recorded, not including 13 only found as juveniles. Eighty five new species have been added, and 55 erroneous records rectified, with a special effort made to correct published misidentifications including some from widely cited works such as *Fishes of the Bahamas and Adjacent Tropical Waters* (Böhlke and Chaplin 1968), *A Field Guide to Atlantic Coast Fishes of North America* (Robbins and Ray 1986) and *National Audubon Society Field Guide to Tropical Marine Fishes: Caribbean, Gulf of Mexico, Florida, Bahamas, Bermuda* (Smith 1997). Fourteen endemics are described, including *Parasphyraenops atrimanus* known only from the stomach contents of a lesser amberjack! While the authors themselves suggest Böhlke and Chaplin's 1968 guide remains the best single reference for identifying most Bermudan inshore fishes, keys are included in *Fishes of Bermuda*, and most of the taxonomic information need to confirm species identification is cited. Each species description includes comments, information on distribution, synonyms, size and taxonomic material. The comments often include fascinating details such as the oarfish description, reproduced from *Harper's Weekly* of 1860 together with a sketch which was entitled "The great sea-serpent found at last".

If this is a glorified checklist, the emphasis is on glorified

If this is a glorified checklist, the emphasis is on glorified. The work builds on records of several eminent ichthyologists, and nine bio-sketches are in-

cluded, featuring George Brown Goode, Col. H.M. Drummond Hay and William Beebe. Forty one of Drummond Hay's watercolours grace the book. The text also includes sections on geology, biogeography, and conservation. A brief history of fisheries exploitation ranges from 1609 (when fish were so abundant that 'if a man steppe into the water they will come round about him: so that men were faine for feare of byting') to the closure of the pot fishery in 1990 and beyond. Even the oldest fisheries legislation in the New World—an act '*against the killing of over young tortoises'* (turtles) from 1620 gets a mention.

M. Watson

WCMC and NOAA (NMFS) Make Global Coral Disease Database Available
www.wcmc.org.uk/marine/coraldis/

The database contains more than 2000 records of direct observations of coral disease in the field, obtained from 155 separate sources. There is a tool which allows you to select and map records over the World Conservation Monitoring Centre global coral reef maps. Full details for mapped records may then be downloaded for personal use.

Please bear in mind that the service provided here is only as good as the data which is in the public domain. If you are aware of publications which we have omitted to include, or have personal and perhaps unpublished observations of coral disease, then we would very much like to include them. Please refer to the 'data submission page' for details: www.wcmc.org.uk/marine/coraldis/submit.htm

The Tales From Tubbataha
Natural History, Resoruce Use, and Conservation of the Tubbataha Reefs Palawan, Philippines. Y. Arquiza and A. White, 190 pages, soft-bound, Pesos 595 (US$15).

This is the only book which sumarizes the status of Tubbataha Reef National Marine Park in a comprehensive and readable manner. It tracks the changes in the coral reef environment from the many impacts of people and in relation to polictical forces.

www.oneocean.org

The Coastal Resource Management Project (CRMP) which is supported by USAID in the Philippines has a major web site that may be of interest to some readers. It is www.oneocean.org. This web site contains results of the CRMP and lists its many activities and publications.

Setting Geographic Priorities For Marie Conservation in Latin America and the Caribbean.
K Sullivan Sealey and G Bustamante, 1999, The Nature Conservancy, Arlington, Virginia. 125 pages.

This book is intended for marine biogeographers, conservation scientists, planners, practitioners and funding agencies. It sets geographic priorities for conservation investments in the coastal areas of the Mexican Pacific south to Cape Horn and north to South Florida, the Bahamas and the Gulf of Mexico, including the Caribbean Basin. Nine Coastal Biogeographic Provinces are delineated and described. Within the provinces, Coastal Biogeographic Regions are assessed and ranked. Recognizing that the marine ecoregion (100s km^2, with the outer limits extending to the boundary of the Exclusive Economic Zones) is still a large geographic unit for effective conservation measures, a finer resolution geographic analysis is applied to a pilot ecoregion, the Central Caribbean. Fifty one Coastal Systems with distinct physical attributes, ecological integrity, and manageable size (10s km^2) are defined within shelf areas. These are classified according to their dominant habitat (reef, seagrass, mangroves, rocky shores, sandy beaches, upwelling areas), and ranked using available information and expert opinion. Prioriti-

zation is based on the need to protect representatives all types of coastal systems, their location relative to the predominant ocean currents, the degree of urgency for conservation, and the capacity for implementing conservation investments. Twenty-five coastal systems were selected as priorities for conservation investments in the Central Caribbean. The book contains 125 pages, including 16 tables, nine figures, 14 GIS-generated maps, a glossary and 800 references in a consulted bibliography.

Those interested in obtaining a copy can contact Eva Vilarrubi, Editor, America Verde Publications, The Nature Conservancy, Email <americaverde@tnc.org>

Corals: A Quick Reference Guide

J. Sprung. ISBN 1-883693-09-8 Ricordea Publishing, Miami Florida, USA. 240p Hardbound

The cover of this colourful book targets 'aquarists, divers and naturalists', and this seems a fair description. Certainly, if you are a scientist with a coral to identify this is not the book for you. Go get a field guide or a weighty taxonomic tome, because this is neither. Corals (hard and soft and fire corals) are neither grouped geographically, nor comprehensively discussed within taxonomic groups. Most of the photographs are close ups, which although beautiful, don't give much of an idea of the overall 'giz'. Family names are not given, some genera are omitted, many photographs are labeled only with a generic name, and many species share the same common names. In other cases Sprung goes into detailed comparisons of similar but distinct species. He proposes some taxonomic relationships that he notes have not been scientifically established, although these are clearly indicated as his own opinion.

Diagrams show where corals might thrive in an aquarium (rather than their likely position on a reef), together with a rating for their lighting, and water flow needs, their compatibility with neighbouring organisms and their hardiness in a tank. Symbols indicate preferred food.

Sprung's stated aim is to provide a guide to species likely to turn up in the aquarium trade—corals from the Mediterranean, Caribbean, Brazil, the Red Sea, Indonesia, the Solomons, Fiji and Australia. To know whether he is successful I'm afraid you'll have to find a review in an aquarist's magazine. It's not that I didn't like the book—the images are truly spectacular—its just that as a coral reef researcher I didn't feel part of the intended audience. Even for aquarium enthusiasts this book is not the definitive guide. Others (and one by the same author, see **Reef Encounter 23** p45–46) provide more in depth coverage. However, with a few slightly out of focus exceptions, the photographs are magnificent, and include much detail of polyp structure. Many were shot in aquaria, others in diverse field locations. In summary, to a researcher the book's main value is as a collection of coral photos concentrating on aquarium species, and as such it is impressive.

M. Watson

Remote sensing handbook for tropical coastal management.

Green, E.P., Mumby, P.J., Edwards, A.J. and Clark, C.D., (Ed. A.J. Edwards) 2000, Coastal Management Sourcebooks 3, UNESCO, Paris. x + 316pp.

Available with a computer-based learning module (vi + 185pp.) and sofware (bilko for Windows) from UNESCO priced 180FF, plus 30 FF per order for postage. Contact UNESCO Publishing, 7, place de Fontenoy, 75352 PARIS 07 SP, France - Fax: +33-1-45 68 57 37 or Email <publishing.promotion@unesco.org>

A review will follow in the next **Reef Encounter**.

Meetings in the Wake of El Niño

The 1998 El Niño was the largest scale disturbance to coral reefs in the history of coral reef science (Wilkinson *et al*. 1999, Goreau *et al*. 2000). In the wake of this disturbance a number of meetings and workshops have been held to evaluate the damage and to propose recommendations for future activities to study and prevent future mass mortality events. These meetings were 1) the Conference of Parties to the Convention on Biological Diversity (CBD COP) meeting held in Manila Oct. 11–13, 1999, 2) a workshop on Coral Bleaching in the Arabian and Red Sea region held in Riyadh, 5–9th February 2000, and 3) a workshop sponsored by CORDIO (Coral Reef Degradation in the Indian Ocean—World Bank and SIDA/SAREC funded) held in Lamu, Kenya on February 12th to 14th, 2000. Each of these meetings hoped to develop an action-oriented approach to deal with the looming fate of coral reefs in this coming era of expected increases in the coral bleaching phenomenon (Hoegh-Guldberg 1999).

The more cynical observer wonders if all the activity is going to lead to meaningful human adaptation or will corals and zooxanthallae be forced to adapt to our ignorance and poor planning and post-disturbance organization

The COP meeting in Manila was a technical committee organized by the Secretariat of the Convention on Biological Diversity. It convened a group of experts, working on the coral bleaching phenomenon, in order to advise the UN Subsidiary Body on Science, Technology, and Technological Advice (SBSTTA) on future programs for coral reefs conservation. Subsequently, the Fifth Meeting of the SBSTTA was held on the 31 January—4 February in Montreal. Following a debate, recommendations to the CBD COP were to 1) fully integrate coral bleaching into the marine and coastal programs of their work, 2) to coordinate and cooperate with *GCRMN, ICRI, FCCC, Ramsar, GIWA in developing an action plan, 3) to recognize that climate change is "a primary cause of coral bleaching" and warrants remedial action by the FCCC, 4) to urge parties to identify and implement a number of responses to coral bleaching, and 5) to direct the World Bank and others to mobilize resources for this effort. In mid 2000 the CBD COP will review the conclusions and formally decide on future activities.

The meeting in Riyadh was largely a scientific meeting where investigators from the region presented their findings from coral reef bleaching studies in the Red Sea, Persian Gulf and western Indian Ocean. The region was not well prepared to study this bleaching event, with only a few quantitative monitoring programs in place, but a few good observers were in the water by fortuitous circumstances, and the presentations did result in a reasonable overview of coral damage from this bleaching. Basically, most of the southern Red Sea and Persian Gulf were severely damaged with greater than 90% hard coral mortality in most areas. Much of the northern Red Sea and Persian Gulf were spared this damage and this fits reasonably with the hot spot images and predictions of NOAA (Goreau *et al.* 2000). The meeting ended with the drafting of a Regional Action Plan where programs for marine protected areas, long-term monitoring, capacity building, training and education, and the economic valuation of coral reefs were discussed and formalized into a proposal for future action.

The meeting in Lamu reviewed coral reef projects in the western Indian Ocean focusing on the biological and socio-economic effects of the bleaching, but largely to develop CORDIO proposals to the major donors. CORDIO was organized as a response to the 1998 El Niño, so most of their funded studies were completed after the bleaching event and had no or poor baseline information which makes conclusions concerning this impact difficult. A few of the non-CORDIO funded studies such as the Chagos (C. Sheppard) and Kenya (T. McClanahan) had good 'before' data on coral cover and species composition and these studies show strong and convincing influences of the El Niño. A combination of data and observations from various sources taken before and

after the disturbance suggest between 50 and 99% coral mortality for this region (Goreau *et al*. 2000), the interesting exception being the more temperate South Africa where a 10% increase in coral cover was measured (Samway, unpublished data). The effects of this disturbance on tourism have yet to be fully felt as most tourists are not sophisticated observers of the coral reef environment and ecology, and until the big fish that attract divers feel the influence, if at all, the effect of El Niño may be considerably less important than the political and economic environments of these tourist destinations.

These meetings are a hopeful sign that the scientific and conservation communities can organize around large-scale disturbances to coral reefs. There was generally sincere concern about the effects of this bleaching and a recognition that something must be going wrong, and that coral reefs, a system dependent on warm water, may be foretelling other large-scale disturbances associated with global warming. The proposals and plans generated from these meetings were not considerably different from other meetings where marine parks, reef monitoring, and socio-economic studies and site intervention have been proposed. It often takes disasters such as these to speed up the implementation of these dormant paper programs and hopefully this will be the case for this disaster. Unfortunately, like most environmental problems, the organization occurred after a disaster and so it is often hard to distinguish forces and facts from hyperbole and environmentalist opportunism.

Much of the response may be poorly planned and unrealistic opportunism to access 'throw-money-at-the problem' funding, rather than a more sober look at the facts and the truly attainable and helpful conservation and research activities. Such an approach is even more troublesome in the case of large-scale problems such as global warming, where all of us are part of the problem, because much of the carbon that will be released has been already, and few of us are truly willing to reduce our energy consumption. This leaves the more cynical observer wondering if all the activity is going to lead to meaningful human adaptation or will corals and zooxanthallae be forced to adapt to our ignorance and poor planning and post-disturbance organization. Hopefully, this disaster will force a keener vision for improved human organization and coral reef management.

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* *GCRMN—Global Coral Reef Monitoring Network, ICRI—International Coral Reef Initiative, Ramsar—Ramsar Convention on Preservation of Wetlands, GIWA—Global International Water Assessment, FCCC—U.N. Framework Convention on Climate Change.*

Coral Reef Degradation in the Indian Ocean (CORDIO)

Progress to Date and Directions for 2000. February 10 to 12, 2000; Lamu, Kenya.

Region-wide monitoring of coral reefs in 1999 recorded generally high levels of coral mortality and reef degradation and confirmed early reports immediately following the El Niño (see **Reef Encounter 26**). Reef degradation was most pronounced on the reefs of mainland East Africa, Socotra, Comoros, Mayotte and the Seychelles granitics and the islands of South Asia. The more southerly islands of Mauritius (see **News** this issue), Reunion, and also Zanzibar and Pemba off Tanzania suffered

less bleaching and coral mortality. According to Christopher Muhando, Zanzibar was spared because of the influx of deep cooler waters on the west coast. Similarly, researcher John Turner reports high cloud cover and water column mixing due to cyclone activity reduced sea surface heating off Mauritius. Up to 18 months after the bleaching event, there was little evidence of recovery or coral recruitment to the majority of reefs surveyed. However, early in 2000, CORDIO's David Obura noted significant coral recruitment in some Kenyan reefs, and Hassan Maniku reported remnant populations of *Acropora* in the Maldives .

little evidence of recovery or coral recruitment to the majority of reefs surveyed

A rapid assessment into the socio-economic impacts of the coral bleaching and mortality focused on the impacts on tourism and reef-fisheries, utilising existing data and in-depth case studies. The impacts of the bleaching on tourism in Tanzania, Kenya, Maldives and Sri Lanka depended on tourist awareness of the issue, and may have economic consequences. Tourist losses may be minimized in the Maldives where hotels are full to capacity, whereas in East Africa losses of discerning tourists are less likely to be compensated by other arrivals. The assessment looked into the dependence of national fisheries on reef-fish stocks as a source of food and employment in India, Madagascar, Tanzania, Kenya and the Comoros. As yet, there is no demonstrable decline in reef fisheries following the mass coral mortality. The full socio- economic impacts of the bleaching are likely to unfold gradually.

CORDIO participants felt future research should be directed at:

a) *Climate change and long term trends*—issues of climate change and the need for innovative ways to measure and interpret effects on ecological systems, and the problem of "shifting baselines" (Charles Sheppard);
b) *Regional research integration*—the need for regional integration among individual research projects, with new emphasis on ecological processes such as coral recruitment and bioerosion, and changes in fish community structure;
c) *Socio-economic considerations*—the need to closely link socio-economic and bio-physical research to understand fully the effect of changes in the status of reefs on resource use and economic activity;
d) *Management and awareness*—the need for clear recommendations for management of bleached and degraded reefs, to assist and assure coral reef managers that recovery is possible and indicate practises that might assist in rehabilitation;
e) *Monitoring and Databases*—the need to develop use of practical database techniques for data archiving and analysis in biophysical, fishery and socio-economic monitoring; the need to identify, describe and disseminate the common methodologies and databases in use in the region.

The range of CORDIO projects presented at the workshop highlighted the differences in technical and human resources in the respective countries, emphasising the need for continued capacity building and training. The promotion of collaboration across the region and cross-fertilisation of projects from one country to another, thus building regional integration and 'home-grown' capacity, is a potential remedy for this situation.

References and resources

Linden O and Sporrong N (1999) Coral Reef Degradation in the Indian Ocean: Status Report and Project Presentations. CORDIO/SAREC Marine Science, Sweden.

Souter D, Obura D and Linden O (2000) Coral Reef Degradation in the Indian Ocean: Status Report 2000. CORDIO/SAREC Marine Science, Sweden.

Further information from http:// www.cordio.org,
David Obura Email <dobura@africaonline.co.ke>
David Souter Email <souter@pi.se>
Olof Linden: Email <olof@timmermon.se>.
CORDIO-East Africa. P.O.BOX 10135 Mombasa,
Kenya. Tel: +254-11-486473. Fax: 486292.

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

5–9 February 2000, Riyadh, Saudi Arabia

The main findings of the meeting will be available in the workshop proceedings prepared by the National Commision for Wildlife Conservation and Development (NCWCD), P.O. Box 61681, Riyadh 11575, Kingdom of Saudi Arabia, Fax: ++966 1 441 0797, Email <ncwcd@zajil.net>.

DIARY

5th Congress on Marine Sciences— Marcuba 2000. Havana International Conference Center, Cuba.

This UNESCO, IOI and UNEP sponsored meeting will be held from 4– 8 December 2000. The Scientific Program will comprise keynote lectures, round table discussions, open topics (poster, videos and oral presentations). Posters are suggested as the most appropriate medium for open topics. The Organizing Committee will select the most relevant submitted abstracts to be presented orally.

The main themes include Integrated Coastal Zones Management (ICZM); Marine Resources Management and Conservation of Marine Biodiversity; Ocean Processes and Global Change, Marine Biotechnology; Marine Aquariology, Marine Mammals; Marine Environmental Education. Abstract deadline is 15th September 2000. Working languages are Spanish and English. Registration fees are US$300 participants, US$100 students, US$50 companions.

Further information from Lic. Argelia Fernández, Secretaria Ejecutiva, V Congreso de Ciencias del Mar, Calle 18-A No. 4114 e/ 41 y 47, Playa, Ciudad de La Habana, Cuba, Tel: (537)29-6014, Fax: (537)24-1442, E-mail <marcuba@unepnet.inf.cu>

Mombasa Mangrove Symposium 7–11 September 2000.

A meeting will be held in Mombasa in September on Mangrove Macrobenthos and Macrofauna. Any paper dealing directly or indirectly with mangrove fish, birds, mammals, crustaceans, insects, mollusks, annelids and other invertebrates is more than welcome. Further information and a pre-registration form is available at: http://www.specola.unifi.it/MMM/.

Compleat Reef Encounter

Back in 1998 self styled Prince Lazarus Long announced his plan to build a New Utopia on the Misteriosa Bank—a group of reefs to the southwest of the Caymans in the Caribbean. More than 100 miles from his nearest neighbour, he hopes to found a new country of 4000 citizens. The tax haven plans to attract banking and insurance agencies, and a state of the art anti-ageing medical centre. Construction was to have started in 1999, but a civil complaint filed by the Securities and Exchange Commission in the United States has delayed progress. Following this complaint, New Utopia's website states that the $1500 Bond which potential residents are required to buy before being invited to become citizens will not be automatically returnable. Citizens may make a contribution to their new country, but if bonds are returned, SEC trading rules apply. Prince Lazarus' (formerly Howard Turney's) previous business ventures include intensive shrimp farming, the used-generator business, and anti-ageing clinics dispensing human growth hormone. Will New Utopia succeed? Prince L. applied to join the United Nations, but the U.N. prefers to defer recognition until construction has commenced. The 400 plus paid up citizens do not seem to share this view.