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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.

Membership

The annual subscription for membership of ISRS is currently US$60. Spouse membership is US$70. Under the constitution, subscriptions are due by January 31st each year. Members receive the journal *Coral Reefs,* the newsletter *Reef Encounter,* abstracts of papers of Annual Meetings and other periodic mailings.

Student membership costs US$10 and benefits include all of the above except the journal *Coral Reefs.*

Institutional subscriptions to *Coral Reefs* must be placed directly with Springer-Verlag.

Subscriptions to the Society should be addressed to the Treasurer (address given above).

EDITORIAL

This issue has been brought forward a month so that it can be out in time for the 7th International Coral Reef Symposium in Guam. Many thanks to all those who put up with our pressing for contributions at shorter notice than usual. Astute readers will notice a slightly different balance to *Reef Encounter* **11**. Reef scientists have had a busy season of meetings recently, the deliberations of which are described here in several reports. There has also been an excellent crop of books published over the past six to eight months which we have highlighted in an expanded collection of reviews. Benthic space limitation being what it is, this has caused a contraction of the announcements section, a poor competitor at the best of times!

Recent meetings have highlighted concern among the reef science community over changes, potential or actual, taking place in their favourite ecosystem due to human impacts and global climate change. However, the meetings revealed that as yet there has been little agreement over what changes are occurring or what is causing them. An important meeting in Monaco on long-term monitoring of coral reefs set an agenda for an internationally coordinated monitoring programme so that a clearer understanding can be gained of what is happening to reefs. The *Currents* section of this issue focusses on two concerns arising from the discussions: firstly, how can we determine the health of a reef, and secondly, a warning about the perils of collecting data in monitoring programmes without clearly defined objectives. Bernard Salvat sets the tone for these articles in his first message as president of ISRS, emphasising the need for all of us to become involved in tackling the global environmental crisis which is now spilling into the reef realm.

Contributors for this issue are thanked for their efforts to provide material on diskette which has helped to smooth the path from thought to print. Please keep the contributions coming; unsolicited material is especially welcome. Many thanks also to Margaret Roberts and Meriwether Wilson for cartoons and drawings.

Sue Wells
Callum Roberts

DEADLINE FOR THE NEXT ISSUE OF *REEF ENCOUNTER* IS OCTOBER 1ST 1992.

ISRS NEWS

PRESIDENT'S MESSAGE

Bernard Salvat

Since the ISRS meeting in Berkeley last December, the new ISRS Officers have worked hard to organize our Society more efficiently, and a new editorial board for *Coral Reefs* has been set up, as mentioned in the Secretary's report below. I would like to emphasise three topics on which ISRS officers and council members will be working in the coming months, hopefully with the support and active participation of all ISRS members.

First, humankind in now facing a real challenge in managing the planet. A global approach is clearly a necessity, as much with coral reefs as with other environmental issues. Knowledge is one thing, but transferring it and ensuring its appropriate use outside our own scientific community is another matter. Research on coral reefs, both fundamental and applied, is of course dependent on funding. Even though some may not wish to, we have to recognise that funding is now increasingly dictated, not so much by the need to acquire knowledge, but by the urgency of the environmental and associated economic problems found in tropical developing countries, where most reefs occur – the relationship between man and reefs now has implications for the work of all of us.

Second, ISRS must take these changed circumstances on board and expand its activities at national, regional and international levels. It must do more to ensure that meetings, symposia, workshops and task forces are organised under its auspices or are at least co-sponsored by the Society with other relevant agencies. We must participate far more actively in current reef-related issues of all kinds, and we should be seen to be promoting coral reefs in the context of other environmental and research issues where reefs may be overlooked. A more pro-active role for the Society is one positive approach that we could take and that will be discussed by the Council and at the General Assembly in Guam.

Third, ISRS must increase its credibility as a sound scientific and representative society. Increasing the membership has long been a major challenge, and we run the constant risk of 'disappearing' – taking along the journal *Coral Reefs*. This would be a loss not only at the international level, but also at the national, institutional, research team and even individual level. For all, of course, are linked. Over the last decade there has been a steady decline in the amount of money available for reef studies at the institutional level. If we can raise international consciousness of the need for reef research and management in the fields of science, economics and politics, not only will institutions benefit, but also each one of us, whether scientists or managers.

PRESIDENTS ON PARADE!

PAST AND PRESENT PRESIDENTS OF ISRS SNAPPED AT THE BERKELEY MEETING

From left: David Stoddart, Bernard Salvat, Peter Sale and Ian Macintyre

NEWS FROM THE SECRETARY

What has happened to ISRS since the Berkeley meeting? At Berkeley the presidency passed from Peter Sale to Bernard Salvat, the Coordinating Editorship of Coral Reefs moved from David Stoddart to Richard Grigg, and Daphne Fautin replaced Pat Hutchings as Treasurer. The current main objectives of the council are increasing the membership, modifying bylaws, a decision on ISRS meetings activities and resolving the relationship between ISRS and IABO. Until now only the officers have been busy with these matters but other council members will shortly become involved.

David Stoddart remained acting Coordinating Editor of Coral Reefs until Richard Grigg was formally approved by Springer-Verlag and the President. The transfer has now been agreed and was formalised in May at a meeting in Heidelberg.

A smooth transition has been achieved between Pat and Daphne as Treasurer and the financial situation of the society is now clear and is moderately good. A proposal for a Deputy Treasurer was discussed but has been rejected. Details of other ideas are outlined by Daphne in the next article.

Mailing of Society news to members is very expensive and so it has been agreed to include any news in Reef Encounter.

Council has proposed that ISRS participates in the IABO committee (International Association of Biological Oceanographers) by selecting nearly half the members of this committee. This proposal will be considered by the IABO committee at its meeting in Guam and if accepted will be effective with the new chairmanship (to be elected in Guam and, if tradition is followed, the new chairman will be the organiser of the next International Coral Reef Symposium).

The Darwin Award will be presented at the General Assembly of ISRS in Guam. Five nominations have been received and a decision as to the winner will be made in Guam.

146 members voted in the recent elections for council. Pat Hutchings became the new President-Elect, and Jorge Cortes, Peter Glynn, Terry Hughes, Jurgen Patzold and Kenneth Sebens were elected new members of council.

A proposal has been made by Jörn Geister for an Annual Meeting to be held in Luxembourg in the summer of 1994.

See you all in Guam I hope!

Rene Galzin, Secretary

SOME POINTS TO PONDER FROM THE TREASURER

As the new treasurer of ISRS, I have spent considerable time studying the Society's accounts and considering information and advice given to me by Pat Hutchings, the outgoing treasurer (to whom we should give a round of applause!). I am struck by a number of facts about our society.

MEMBERSHIP

The number of members has changed little in recent years (I have received some new memberships, but until renewals have been paid, I cannot tell if there is a net positive trend: total membership declined in some recent years); and relatively few live in countries with the most numerous or best developed coral reefs. Here is a rough tally of the country of residence of 464 individuals/couples on the list of people who are or have been members during the past two years.

203 US and possessions = 127 in non-tropical areas + 45 in the Atlantic tropics (Florida, Puerto Rico, etc.) + 31 in the Pacific tropics (Hawaii and Guam)

54 Australia (39 in the tropics)
39 UK
28 Japan
22 France
19 Germany
5 each Netherlands Antilles and Israel
50 Other Tropics
20 Other Europe
16 Other non-European, non-tropical

The composition of our membership is tightly bound to the viability – fiscal, scientific, and political – of ISRS. Your officers believe we must expand our membership now, when the *raison d'être* of our Society is gaining prominence, scientifically and politically. We need more members for fostering collaboration, exchanging ideas, and, if that is the wish of the membership, advocacy. Members from "reef-rich" countries are vital to credibility in all areas. (This is not to disparage the work of the many others but is in recognition of political reality, which we ignore at our peril.)

REVENUE

Membership fees are currently virtually the Society's only source of income. However, they barely meet the costs of printing and sending CORAL REEFS and REEF ENCOUNTER. In fact, because of variable postal charges, although enhanced membership would enrich ISRS intellectually, culturally, and politically, under the current arrangement it could actually cost more financially than it would raise. Therefore, it seems imperative that additional sources of revenue be sought. We have derived very modest amounts from sale of t-shirts and books. Page charges are requested but not required and rarely paid. We need IDEAS!!

MEMBERSHIP FEES

Obviously, one source of increased revenue would be to raise fees. But it is likely that, at least in some quarters, fees are already a barrier to membership. Raising fees might not only discourage new members from countries in which reefs are important, but it could drive away some current members. We now subsidise membership of students, presumably on the premise that they are our future and are financially strapped. Should there be subsidies for other members as well? Who would pay these? For example, we could institute graduated fees by country of residence. But this presumes that all residents of certain countries (and all students) are poor, which may not only not be true (there are certainly interested non-students in the "developed world" who cannot afford ISRS membership), but might offend some people. Moreover of course it would exacerbate our fiscal situation. Could we have a voluntary sliding scale for fees? If you knew the actual cost of servicing your membership would you be willing to pay it? And if you were able to pay more would you do so in order to subsidise the membership of someone unable to pay the full amount?

Alternatively we could consider creating other categories of membership. Two that come to mind are **corporate membership** for non-government organizations, consulting firms, etc. at a rate higher than for individuals; and **corresponding** or **associate membership** at a lower rate for individuals who would not have voting rights and would receive only *Reef Encounter* (which might attract people who want to support coral reef science but who are not themselves scientists and would not be interested in our technical publication). Please come to Guam prepared to discuss realistic and equitable courses of action.

Some of you pay your fees when first notified. Others however require additional notices which are costly to send, deprive the society of cash, and require extra mailing of missed issues of our journal and newsletter. Pat and I both advocate instituting a late charge to cover at least the added costs. Remarkably to me, a number of cheques each year are returned marked "insufficient funds"; ISRS must pay bank charges on them. We would like to create a provision requiring a reinstatement fee at least to cover that cost before such a person's membership is reactivated. Although neither of these changes would improve our fiscal situation, they would alleviate two drains that we now experience.

OFFICERS

We must ensure that our Council is truly representative of ISRS membership and our science. I am (belatedly) discovering that expenses such as postage and telephone/fax charges for Society business are borne by the institutions of the officers, and that officers pay for at least some travel on ISRS business from their own pockets. This restriction of people in authority to well-to-do individuals or employees of institutions willing to subsidise the Society greatly limits our pool of potential officers. Scholarly societies typically rely on volunteer labour; but I believe that income to ISRS should be sufficient to pay the real expenses of conducting the business of the society.

GUAM

By the time of our meeting in Guam, I will have a realistic calculation of those costs. Then you can suggest what you want ISRS to do for you and how much you are willing to pay. What do you see as the greatest benefits of membership? What are you willing to forego? What can you do to increase membership? What are the barriers to joining under current rules and practices? What can you do to persuade your colleagues who are not members to ISRS to join, and what has prevented them from doing so before now?

I look forward to seeing and talking with you in June!!! If you do not plan to attend the Coral Reef Symposium, please send me as soon as possible your opinions on my queries - suggestions for increasing membership, raising revenue, placing fees within the reach of all interested people, and encouraging participation within the government of ISRS - so that your perspective will be represented in the discussion.

Daphne Fautin, Treasurer

ISRS ANNUAL MEETING: REEFS BEYOND THE GOLDEN GATE

Berkeley, California, USA 13-16 December 1991
Chair of local organising committee: David Stoddart

On 13-16 December 1991, the University of California at Berkeley hosted the annual meeting of the ISRS. A wide variety of presentations filled split afternoon sessions on the biology and geology/geomorphology of reefs, but most of the excitement and debate was generated during combined sessions on "Coral bleaching" and "Conservation, monitoring and management of reefs". Rick Grigg kindled the fires of debate with his opening address "Coral reef environmental science: truth vs the Cassandra syndrome". In contrast to Cassandra from Greek mythology, who was fated to have her prophecies go unheeded, Grigg suggested that many scientists were false Cassandras when they prematurely predicted environmental disasters (such as the first *Acanthaster* outbreaks). Today, by linking coral reef bleaching with global warming, despite uncertain evidence, many scientists may again be playing false Cassandras.

The debate was fanned on Friday during Bob Buddemeier's plenary lecture "Victims, specimens, biosensors, or resources: the role of coral reefs in modern human history". He reviewed the roles of reefs and reef scientists in controversial problems and suggested that we need to improve cooperation to tackle large scale problems. His call for objective searches for the truth was soon countered by conservation orientated views. Responses such as those of Mark Epstein (Global Coral Reef Alliance) and Rodney Fujita (Environmental Defense Fund) reminded participants that resource managers and planners rarely have the luxury of waiting for "final" scientific opinion. The impassioned views from both sides made for lively discussion, but the schedule prevented much expansion. It could be valuable for a future meeting to host discussion on this topic.

Discussions of monitoring and management activities brought us back to a pressing problem: the collection of long-term data. Through ongoing and planned programs, current and developing technologies, the collection of long-term environmental data is an important activity. Without these data, managers and conservationists will have little on which to base their work.

Last but not least, "Teaching tropical geomorphology and biology: the UC Berkeley project at the Gump Research Station, Moorea, French Polynesia" presented experiences from the field of science education. Student-researchers presented work they performed at the station, from behaviour to geomorphology, and littoral trees to reefs. The session made clear how well field science and education can be merged to provide training for our future scientists. The entire meeeting proved a good opportunity to meet colleagues, discuss pressing problems and opinions, and get fired up for the upcoming meeting in Guam.

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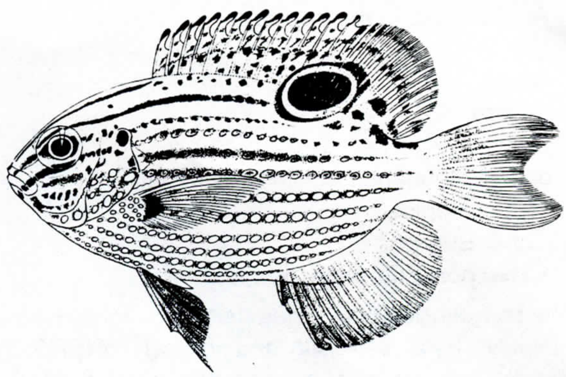

BEST PAPER AWARDS IN CORAL REEFS

In 1988 ISRS introduced a yearly best paper award for manuscripts published in its quarterly journal *Coral Reefs*. The award consists of a polished walnut plaque with a brass plate bearing a two-and-a-half-inch-diameter medallion of the Society logo created by sculptor Dan van Clapp.

The selection committee responsible for choosing recipients of this award consists of the President, Secretary, Treasurer, Co-ordinating Editor, Biological Editor, and Geological Editor. This committee was intentionally kept small because publications of selection committee members are not eligible – and we always want to attract the widest field of candidates.

The overall objective in introducing this award was to encourage coral-reef scientists to submit their best work to *Coral Reefs*. Co-ordinating Editor David Stoddart, in instructing the selection committee for the first award, told the panel to consider the originality of the manuscripts and the extent to which they contributed towards a better understanding of old problems or pointed out avenues for new research. In addition, he asked the committee to keep in mind the more technical aspects of quality of style, methodology, and illustration.

The first award was announced at the 1988 ISRS Annual Meeting in Townsville, Australia. Appropriately, Australian Terry Done was presented with the plaque for the Best Paper in volume 6; this paper was entitled "Simulation of the effects of *Acanthaster planci* on the population structure of massive corals in the genus *Porites*: evidence of population resilience?" This paper proposed a quantitative model for studying the interaction between *Acanthaster planci* and *Porites* as a function of such factors as initial prey size-frequency distribution, damage characteristics, survivorship, coral recruitment and growth rates, and frequency of predator outbreaks. This was an excellent theoretical analysis of the dynamics of coral-reef systems based on a quantification of coral-reef processes.

Paulo Pirazzoli, Lucien Montaggioni, Bernard Salvat, and Gerard Faure were the next recipients of the award. This volume 7 award was presented at the Annual ISRS meeting in Marseille, France, in December 1989. The title of their paper was "Late Holocene sea level indicators from twelve atolls in the central and eastern Tuamotus (Pacific

Ocean)." In this innovative study, both biological and geological data were collected from 12 atolls to document pre-existing high sea-level positions. This information was then used to examine the overall history of the interaction of tectonic movements and sea-level fluctuations in the central Pacific during the late Holocene.

The last two Best Paper Awards for volumes 8 and 9 were announced at our most recent ISRS annual meeting in Berkeley, California, in December 1991. The paper chosen for volume 8 "Experimental evidence for high temperature stress as the cause of El Niño – coincident coral mortality," was coauthored by Peter Glynn and L. D'Croz. Through laboratory experiments, the authors illustrate that a major reef-building coral of the eastern Pacific, *Pocillopora damicornis*, may become severely weakened and eventually die when exposed to elevated sea temperatures of 30°C to 32°C. This work clearly demonstrates the reason for the devastating effects of severe El Niño events, which are now thought to be a predominant factor in limiting reef development in this region.

The Best Paper Award for volume 9 was given to Gustav Paulay and L. R. McEdward for their study, "A simulation model of island reef morphology: the effects of sea level fluctuations, growth, subsidence and erosion." This paper describes another innovative computer simulation testing the relative importance and interaction of reef growth, sea-level fluctuations, erosion and subsidence and their effects on the morphology of a mid-oceanic reef complex. The results of this study provide insight into the processes responsible for reef morphology and indicate that subaerial erosion, subsidence, and reef growth rates are all of comparable importance in determining relief. This type of study not only allows us to test ideas, but also suggests important areas for future research.

We encourage our readers to keep the Best Paper Award in mind when they feel that they have an important contribution to publish. It would be hard to find a more impressive award plaque for your office wall!

Ian G. Macintyre, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560, USA. Fax: (202) 786 2832.

THE COMPLEAT REEF ENCOUNTER No. 11

"At least 12 (30%) coral sites examined showed considerable damage attributable to fishermen and these traders [Iranian small boat traders]; at one site alone, more than 120 pairs of trousers (part of an Iranian consignment) were seen caught in and smothering coral."

From: Salm, R.V. *'Corals and Coral Reefs of the Sultanate of Oman - Scientific Results of the IUCN Coastal Management Project.'* Nov. 1991.

UPWELLINGS

Conservation and science: different views of a common reality

The polite clash between differing viewpoints at the ISRS Annual Meeting in Berkeley reminded many of us that the needs of conservation/management and of 'pure' science are often rather different. Full scientific analysis requires careful, often time consuming, accumulation of facts. The needs of managers and resource planners usually require prompt action to avoid environmental degradation that may be irreversible. Often conservationists are at odds with scientists despite their common concern for deteriorating resources. The scientist may need to allow degradation to continue in order to determine a definitive cause. At the same time, conservationists feel that the problem must be stopped long before experiments can be concluded. Scientists often ask for more time to get definitive answers; planners/politicians often demand answers in less time than adequate analysis requires.

Which viewpoint should take precedence? Is it better to be more conservative scientifically or environmentally? Viewing this within a statistical framework, a Type I error occurs when one rejects a true null hypothesis, a Type II error occurs when one fails to reject a false null hypothesis. In a problem of anthropogenic stress (e.g. nutrients, global warming), the null hypothesis is usually defined as 'environmental damage is not related to the proposed stress'. Either error is possible, but which is less desirable?

False rejection of a true null hypothesis favours conservation, potentially through unecessary economic restrictions and premature warnings of 'impending' disaster. False acceptance of a false null hypothesis provides a scientifically conservative position (that may be based on inadequate data or sampling design) but may allow continued environmental degradation. The ISRS is a scientific organisation, but its members provide much of the expertise available for managers, conservationists and politicians. Members must weigh the problems of scientific credibility against loss of the very ecosystems that we study.

Where along the continuum does the best policy fall? How do we balance scientific validity and credibility with economic and environmental trade-offs? The answers are subject to opinion and do not converge on a single truth. However, these questions are too easily forgotten when one enters the narrow focuses of scientific research or environmental activism. On one hand, scientists must often make judgements or predictions based on available evidence, despite the need for more data. On the other hand, activists need to remember that false alarms quickly diminish the credibility of the messenger. But, none of us can afford to let environmental degradation go unchecked. How far should one go out on the limb of opinion? Perhaps just far enough to keep one hand on the trunk of the data!

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CURRENTS

WHAT IS A HEALTHY REEF?

Jeremy Thomason and Callum Roberts

Faced with increasing human pressures on reefs and the looming crisis of global climate change, reef 'health' has become a hot topic. But how can we tell if a reef is healthy? To date there appear to have been no attempts to comprehensively define coral reef health. Some recent influential review papers on reefs and pollution (e.g. Brown and Howard, 1985; Brown, 1988; Hatcher *et al* 1989, Rogers, 1990) mention health but none have got to grips with the problem of definition.

In the past, perhaps the most widely used indicator of reef health has been cover of live hard corals. Assessments of health based on coral cover pervade the literature. Use of a coral cover 'index of health' probably originated with observations of decline in cover when reefs were subjected to stress, for example from sewage input into Kaneohe Bay in Hawaii. Additionally, corals are perceived as an integral and essential component of the reef ecosystem without which coral reefs would not exist. Cover of corals thus seems, superficially at least, a sensible measure of health.

Many objections have been raised to this approach. Most importantly, coral cover can vary enormously from reef to reef independently of any human action. Differences are largely due to ecological factors such as variation in sedimentation rates, wave energy, reef topography etc. Absolute levels of cover cannot be used as a linear index of health. Oceanic reefs, for example, typically have a coral cover of only 45-50% between 5 and 30m deep on the outer slope (Sheppard 1982). In the Red Sea, cover on pristine reefs is generally only 30-45% in the same zone.

The role of past history in shaping the community composition of the reef, including coral cover cannot be ignored. Major disturbances usually have large effects on coral cover. Terry Hughes elegantly showed how three major disturbances modified benthic composition in Jamaica over a 14 year monitoring study (see following article). Without knowing of their existence, simple surveys of coral cover and community structure might give a very misleading impression of the state of the reef. Paradoxically, although decreasing coral cover may be a sign of declining health, increasing cover may also indicate a disturbance to the reef.

Variation in levels of coral cover among reefs thus carries very little information about reef health. Coral cover is only likely to provide useful information on health when time series data are available from monitoring studies. However, such data can be properly interpreted only when there is a record of natural disturbances at a site as well as human influences.

The problem of defining health is not limited to marine science. Our perception of human health is also clouded, with the definition changing in relation to time, the individual and their environment. Human health is often measured by comparison with tables of "normal" values for a range of quantitative tests. The problem with such tables is that many of the parameters measured show a wide range of biological variability, changing with age, time of day, nutritional status, pregnancy and so on. However, some parameters are very specific with narrow ranges, for example temperature. These so-called physiological constants are consequently good indicators of health. The other more variable parameters are poor indicators of health in isolation, but may be useful in diagnosis when measured together.

This provides a useful starting point from which to try and define reef health. If we limit the definition to the major building block of the reef – coral – then it would be appropriate to try and define health in physiological terms, hopefully identifying readily measurable physiological constants. Unfortunately, none have yet been found although the search is on.

Consequently, a definition of health must be based upon ecological attributes that can be quantified. Ecological health could be defined as the maintenance of the community's steady state(s) in a changeable environment. A steady state does not imply that the system is static. Growth or contraction can be part of a steady state. A change in the state of a system (for example, from active growth to no growth) may be part of the natural cycle of that system and such natural changes need to be identified. The phrase 'dynamic equilibrium' is often used to describe natural fluctuations around some average state.

Terry Done remarked at a recent meeting in Australia 'Today's coral reef may be tomorrow's rubble pile, but today's rubble pile may be the next decade's or century's coral reef', reminding us that reefs are constantly undergoing change. However, what we cannot tell is what the balance of change will be. If nine tenths of today's reefs become tomorrow's rubble, and only one tenth of today's rubble tomorrow's reefs, then we are right to be concerned about reef health. Exercising the precautionary principle and trying to monitor the pathways of change is sensible.

The resilience of a system (i.e. the rate at which it can spring back from a perturbation) might seem a candidate for assessing health. This suffers from three problems. Firstly, it is very hard to measure. Secondly, resilience depends greatly on community composition and can thus vary from zone to zone within a reef. The speed at which recovery takes place depends on the size of the disturbance. Thirdly, it can only be measured after disturbance although a qualitative estimate of resilience may be possible by comparing communities which have suffered disturbances. Furthermore, major disturbances may result in shifts to different ecologically-stable states. Hence a failure to return to the state prior to perturbation cannot be considered an indication of poor health.

Measurements other than coral cover that could be (or are) used to assess reef health include: coral or fish species diversity; algal cover; fish stocks and yield; coral growth rates; bleaching effects; fish and coral recruitment patterns (if measured over long periods); percentage recently dead coral; incidence of disease (e.g. black band/white band); reef calcification vs erosion.

The problem with all these parameters is that they are highly variable, both temporally and spatially (and some are notoriously difficult to measure). Recent advances in population biology have upheld field observations of apparently chaotic fluctuations in abundance. Against this background, judgements about health based on such measurements become subjective. It is feasible to make a qualitative assessment of a reef's health from personal knowledge or by canvassing local opinion. However, such an approach does not lend itself well to scientific scrutiny.

The ecotoxicological approach of using biomarkers, bioindicators or biological early warning systems to assess reef health has been little used and might provide a clearer indication than any above-mentioned parameters. Ernie Reese proposed in the late 1970s that butterflyfish numbers could be used to determine when reefs became stressed (Reese 1977). He argued that populations of species which fed on hard corals would be affected by sub-lethal stresses acting on their prey. Unfortunately, predators are rarely so dependent on a particular prey that they cannot switch to other foods if prey quality declines. But efforts should still continue, as there has been much success with bioindicators in terrestrial and temperate marine environments (e.g. Musselwatch in the USA).

Which still leaves the problem of how to know if a reef is healthy. Perhaps the easiest approach is long term monitoring of sites with a suite of parameters [see *Reef Encounter* 10], including natural and anthropogenic impacts. However, judgements about the changes in these parameters that constitute declining health are still far from objective. As a start we suggest the following trends as signs of declining reef health: (1) increasing cover of fleshy and filamentous algae (non-seasonally); (2) increasing cover of 'bare' rock and rubble; (3) a decrease in coral diversity *combined* with decreasing cover; (4) low coral recruitment *combined* with high post-recruitment mortality; (5) net erosion of the reef; (6) decreasing coral cover; (7) increasing incidence of coral bleaching or disease; (8) outbreaks in populations of reef-associated organisms (e.g. crown-of-thorns starfish or *Diadema* sea urchins). For most of the above parameters, measurement is straightforward and can be incorporated into low-cost monitoring programmes. The case for deteriorating health will be strengthened by the simultaneous presence of several of these trends. However, the reef biologist's equivalent of the anal thermometer is still a long way off.

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MONITORING OF CORAL REEFS: A BANDWAGON?

Terry Hughes

Monitoring of coral reefs has recently been highlighted by two major meetings: 'A workshop on coral bleaching, coral reef ecosystems and global changes' in Miami in June 1991 (D'Elia *et al.*, 1991), and a UNESCO-sponsored meeting on long-term monitoring of coastal systems in Monaco in December 1991 (see page 17). Both meetings recommended establishing a global network of reef sites for future monitoring. The 7th International Coral Reef Congress in Guam has two full-day sessions on reef monitoring, although most of the talks concern future plans rather than results, and the focus seems to be on 'how to' rather than 'why'.

Why monitor?

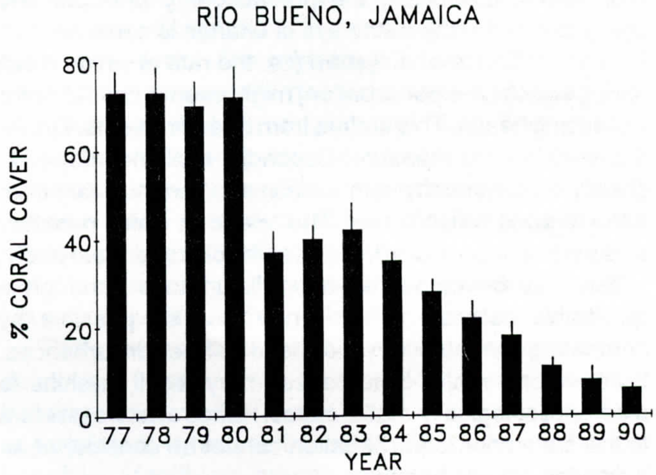
While monitoring may have become something of a bandwagon, it is not new. For example, the research programs of many reef ecologists include monitoring of coral reef populations or assemblages (e.g. work by Rolf Bak, Barbara Brown, Joe Connell, Peter Doherty, Terry Done, Phil Dustan, Peter Glynn, Nancy Knowlton, Judy Lang, Dave Liddell, Yossi Loya, Sharon Ohlhorst, Jim Porter, Don Potts, Caroline Rogers, Garry Russ, Peter Sale, Dave Williams and many others). These are all motivated (some would say stubborn!) individuals, whose long-term monitoring efforts have often evoked apathy or even hostility from their own institutions. So what have we learned from these ongoing studies? What are the strengths and limitations of a long-term approach?

Long-term studies of coral reefs are useful for many reasons. First, many ecological processes are slow and cannot be detected in the short-term. An obvious example is succession, or changes in response to climatic variation. In addition, many coral reef organisms are long-lived, and it is appropriate that we scale our studies in relation to their lifetime. Second, most ecological processes have high annual variability (e.g. coral and fish recruitment), so that results from one or a few years can be misleading. Third, long-term monitoring reveals the recent history of a reef community, which can help to explain the impact of events occuring now. For example, the effect on a reef of a hurricane today depends in part on how long it has been since the previous disturbance and what effect it had. Fourth, monitoring studies are essential for investigations of rare and episodic events, such as outbreaks and die-offs of predators, or hurricanes. Fifth, long-term monitoring helps us to assess the impact of man's activities in relation to the background dynamics of a reef.

A monitoring programme will only provide useful data if the reasons for doing it are clear. New technological development such as underwater videos, image-grabbing software, and electronic storage devices make it easy to collect vast amounts of information. However, data gathered at random in the vague hope that they will be useful in the future (i.e. without a hypothesis to focus their collection or analysis) are likely to be expensive and inappropriate. It is noteworthy that all of the excellent ongoing coral reef monitoring studies mentioned earlier have been question-driven.

A Case Study

My own research in Jamaica includes the following aims: 1) to describe quantitatively long-term changes in coral populations and communities, and 2) to understand ecological processes that are important to the community structure of reefs. Monitoring is one tool that is useful towards achieving these aims. It is not realistic, however, to expect monitoring programmes to provide all the answers (see 3 below). Coral cover in permanent plots on Jamaican reefs has declined significantly at 11 sites over 14 years, coinciding with major changes in the species composition of corals (Hughes, in press). Figure 1 shows a typical result from 1977 to 1990 at a depth of 10 m. In 1977, coral abundance was very high, with an average of 73% cover recorded in transects and permanent quadrats. However, in 1980, Hurricane Allen inflicted moderately heavy damage reducing coral cover to 38%. Over the following 3-4 years it increased only slowly, reaching 44% by 1984. However, since then, coral cover has declined inexorably at every annual census, to only 5% in 1990 (Fig. 1). This is obviously a reef which has suffered serious degradation, a pattern which will probably occur more and more frequently in the future. What does this example of a long-term coral study tell us about the design of monitoring programmes?



Percent cover (mean ± S.E.) of corals at 10m depth at Rio Bueno, Jamaica from 1977-1990. Points are replicate 1m² permanent plots (Hughes, in press).

Design of future programmes

1. A uniform design will not work. Monitoring efforts have to be flexible to account for changing conditions which are certain to occur in the long-term. For example, changes in coral cover can be detected with much less sampling effort when cover is uniformly high than when it is low and patchy. Therefore, no single set of measurements will be ideal (or even workable) for all places or all times, and it is essential that the amount of replication (number of sites, transects, photo-quadrats, etc.) is responsive to change in order to avoid over- and under-sampling. In the Jamaican study, I had to gradually double the number of quadrats and transects used to follow coral cover to maintain a low variance and high precision (Fig. 1). Clearly a 10% or even 20% error in the estimate of coral cover would be acceptable if it was high (in 1977), but not when it is very low (in 1990).

At the Monaco meeting, it was suggested that monitoring sites should be established on 60 reefs worldwide using identical techniques, based on the ASEAN-Australian Living Coastal Resources Project manual of methodologies (1986).

Regarding the number of transects, that manual currently states without elaboration (p.3.3.6) that 'replication will be required'. Taxonomic inconsistencies among research teams will be reduced by lumping species into a number of coarse morphological and taxonomic groups. However, a study by Mundy (1991) indicates that among-observer error is substantial even at this coarser level and will be a serious impediment to establishing a global monitoring network. For example, he found (p.40) that one researcher tallied 17% cover by branching *Acropora*, while another found only 4%, on the same 20 m transect! Both were members of a monitoring team at the Australian Institute of Marine Science, and presumably among the best trained of the ASEAN-Australia coastal program. In view of this depressing result, perhaps the resources would be better spent at fewer locations with more stringent quality-control of the data.

In addition to varying the amount of replication, a monitoring program should have enough flexibility to add and drop variables in response to new conditions. For example, following the die-off of the sea urchin *Diadema* in Jamaica, I monitored algal biomass and densities of sea urchins and snails, in addition to coral cover (Hughes et al., 1987). While the number of variables to be followed is always limited by the resources available, it would be a mistake to slavishly gather the same data year after year if conditions warrant a change of focus. This will require local leadership and decision-making to depart from a network protocol that becomes unsuitable.

2. The data have to be analysed promptly. The ability to respond to inevitable change in abundance means that at least some information has to be analysed between every sampling period, and not allowed to accumulate to the point where analysis becomes overwhelming or occurs to late. Neither of the meetings mentioned earlier discuss this in any detail, and they give the impression that a raw data bank, rather than publishable results, is to be the end product. Similarly, the Great Barrier Reef Marine Park Authority and AIMS have announced a monitoring program on 189 reefs over the next three years at a cost of close to A$1M, almost all of which will go to cover the cost of collecting the data. In my opinion, the design of monitoring programs must take better account of the substantial effort and expense involved in analysis. My own studies in Jamaica cost approximately US$350,000 over 14 years, but only about 20% was spent on data collection. In addition, short-term results revealed by timely analysis are often interesting in their own right, and can be used to justify further financial support for long-term goals using conventional 3-year funding sources.

3. Monitoring alone will not support management decisions. Past experience has shown that monitoring on its own is often incapable of revealing the underlying mechanisms of change in abundance, and a parallel program of experimentation or demographic analysis is required to explain why these alterations occur. No matter how hard you stare at Fig. 1, you will not be able to say what caused the decline, only that it has occurred. If reef managers do not know what causes such changes in reef communities, then they can only guess at how to fix them. One approach is to augment baseline monitoring with demographic studies which address mechanisms of change in abundance. For example, an algal bloom after a *Diadema* die-off affected short-lived corals disproportionately because they rely on availability of substrate for continuous recruitment, as shown by clearance experiments (Hughes, 1989). Monitoring certainly helps to understand reef dynamics but it is not a panacea.

4. The results of monitoring studies are often biased. Finally, Fig. 1 shows a decline in coral abundance over time, a pattern common to virtually all other long-term monitoring studies of reef communities (e.g. Bak and Luckhurst, 1980; Connell *et al*., in review; Dustan and Halas, 1987; Glynn, 1990; Lidell and Ohlhorst, 1986). Some of these declines have been related to events such as hurricanes, *Acanthaster* outbreaks, the *Diadema* die-off and El Niño. However, in other cases, this pattern may simply reflect a systematic bias in some monitoring programs, where the initial surveys were carried out at locations that have unusually high coral cover or diversity. Obviously, if coral cover is, say, 80-90%, then it is much more likely that local abundances will decline over time than increase. This decline is of little concern if other nearby areas show the opposite pattern. However, we will never detect increases if we ignore areas that have the capacity to do so, and instead concentrate our efforts only at locations with high coral cover. This bias in site selection will have to be avoided in the future in order to detect any large-scale changes by coral communities due to global warming.

Conclusion

In summary, future monitoring programs will have to be question driven, have adequate replication (which will vary over time and space), allocate a major proportion of funding for training and analysis, process data quickly to optimize sampling, and avoid sampling bias. Without these the current drive for global monitoring will be a monumental waste of time and resources.

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FEATURES

ORIGIN OF THE 'CONVENTIONAL CORAL REEF': WHO ARE THE GUILTY MEN?

Brian R Rosen

Seymour Schlanger, notable for his contribution to the study of marine geology, limestones and reefs, especially in the Pacific Region, died tragically in 1990. He played an important part in establishing the significance of the Enewetak drill holes in 1952 [9,16], which conclusively fulfilled Darwin's prediction [3] of subsidence beneath oceanic atolls. As a small tribute to his work, particularly to his broad and stimulating view of its wider implications, as well as to his personal kindness, it is appropriate to include an article on reef geology in *Reef Encounter* and to dedicate this to him.

Everyone recognizes that Darwin has been a major influence on biological thinking, and no one could seriously claim that the historical importance of his work has been neglected. If Darwin's geological work, overall, has not been so fully re-appraised, his reef work at least is fully recognized. Yet there still seems to be one small corner of this reef work which isn't widely known and this concerns his thoughts on *ancient* reefs.

Darwin's coral reef book [3] is remembered especially for the elegance and simplicity of its subsidence theory, magnificently vindicated many years after his death and after much controversy, by ocean atoll drilling at Enewetak [9,16]. Ocean floor subsidence beneath atolls was later corroborated elsewhere [18] (though it is now questionable whether subsidence is also responsible for Darwin's supposed succession of fringing reefs, barrier reefs and atolls [12]). By comparisod, Darwin's much more famous idea of new species arising by natural selection has still to be demonstrated as unequivocally [10] - though,somewhat ironically, the proof he himself advanced for his subsidence theory is, in retrospect, somewhat shaky [13].

Search for ancient Darwinian reefs

Darwin's efforts were directed at modern reefs, both their geology and biology ,and above all, the implications of coral reefs for global geology. His book addresses geomorphology, geography and ecology or, in his own words, reef 'structure and distribution' [3]. Although modern reefs often have a fossil component within their own edifices, Darwin did not address fossil (or 'ancient') reefs as such. Yet the detail of his reef observations, the strength of his arguments and, in more recent years, the demonstration of subsidence, have seemingly led geologists to base much of their interpretation of ancient reefs on ideas that go back to Darwin's account of modern reefs. In this respect, they are following the time-honoured geological axiom of uniformitarianism*, advocated by Darwin's own friend and supporter, Charles Lyell. But, regardless of the quality of Darwin's observations and ideas, how useful are modern reefs as analogues for ancient ones? There are few if any clear-cut examples of ancient reefs that are direct analogues of Darwin's classic reef types, especially of his oceanic forms. Where for instance might be found ancient atolls and ancient 'encircling' barrier reefs, with clear evidence of their foundations on sea-mounts of oceanic basalt? They must be few and far between. Darwin [4] actually predicted that it would be difficult to find completely preserved fossil examples, for erosional reasons, and when later challenged to find ancient analogues, neither he nor Lyell could come up with any convincing examples [19].

With hindsight, we need not be surprised. It is not simply a question of erosion. Plate tectonics confines structures of this kind to ocean basins where they occur as 'drowned reefs' or as older integral parts of modern reef edifices [6,9,13,15,16,17]. Only exceptionally would they be incorporated 'onshore' into continental successions and in recognizable form, since their general fate is to be metamorphosed or completely destroyed by subduction along with the contiguous ocean-floor crust on which they rest. This process is tangible today in the Japan Trench (subduction zone), where the once-reefal sea mount (atoll?) of Daiichi Kashima lies at an oblique angle 6000 m below sea level [8].

'Conventional' reef growth

The implication of these tectonic factors is that we should not expect to make simple holistic comparisons between modern and ancient reefs and in a broad sense, this is now widely recognized. Can uniformitarian principles still be applied to finer details of reefs and reef processes? Perhaps there is a general model of reef growth that can be adapted to suit particular circumstances of relative sea level change, whether tectonic or eustatic in origin? To judge from the extensive literature on ancient reefs, such a model certainly exists. Colin Braithwaite [2] refers to it as the 'conventional' or 'normal' model (Fig. 1). Basically, in its simplest form, this assumes upward growth of reef-front framework organisms to a static sea-level, with simultaneous and subsequent outward growth taking place over fore-reef talus breccia (rubble) derived from the actively growing reef-front. The model can be adapted to suit various possible scenarios of relative sea-level change.

*Uniformitarianism: the principle that natural geological processes are still operating at the same rate and intensity as they have throughout geological time.

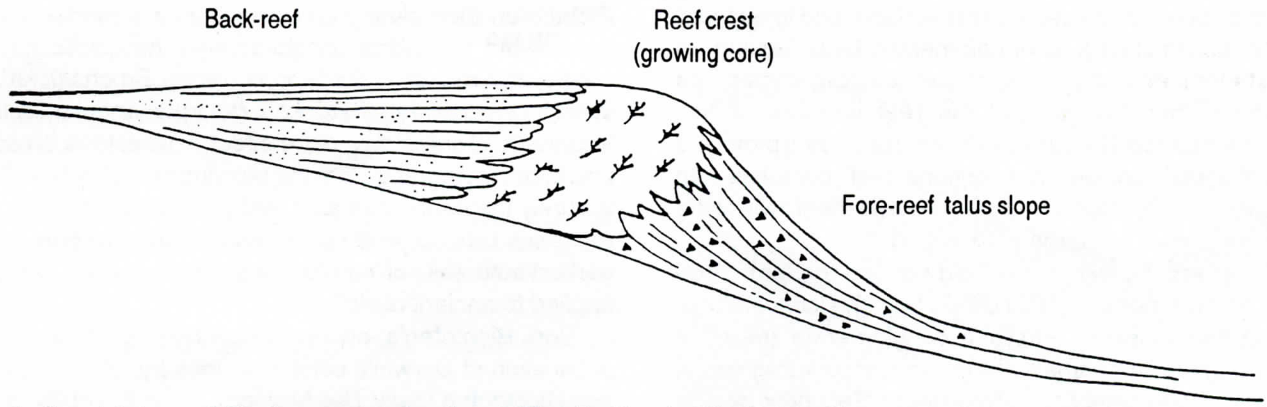

Fig. 1. Darwin's legacy? The 'conventional reef model' that Braithwaite [2] criticises. Note outwards growth of the reef over an apron of its own reef-talus breccia.

Malignant reef-talus

Unfortunately, this conventional reef model is also unsatisfactory. Observations on modern reefs do not support it. Yet it is almost universally accepted. If you doubt this, look at how often it has been used as a logo for publications, conferences and organizations concerned with reef geology (e.g. the cover and title page of European Fossil Reef Models [20, Fig. 2]. For this reason, Braithwaite [2] has actively waged war on it - or rather, on its proponents and uncritical users. In part, the problem is that most 'modern' reefs are composite structures of many cycles of reef growth controlled by relatively frequent changes in sea level throughout the Quaternary. However,even if we solve this

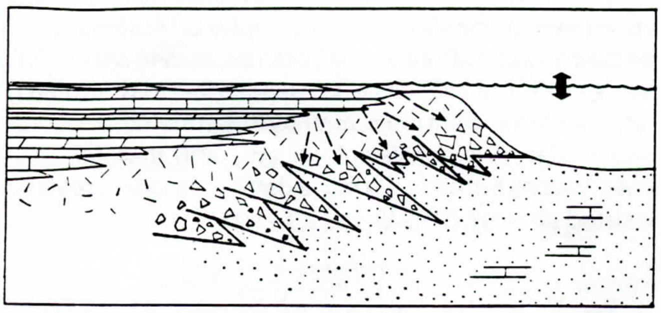

Fig. 2. Cover diagram from European Fossil Reef Models *(D. F. Toomey, ed., 1981).*

objection by restricting the model to single stillstands or single change of relative sea-level, there still remains a problem with 'reef talus'.

Contrary to the model, the bulk of coarse, eroded, reef-front material is not deposited at the fore-reef foot of the advancing reef front, but is borne across the reef into back-reef areas by prevailing waves and currents. Only exceptionally do large blocks founder from the reef front into deeper water. In time, back-reef material accumulates to the same elevation as the reef crest, and the finer material in particular then spills over or bypasses the crest (through channels) forming coalescing fans (analogous to alluvial fans) at the foot of the reef front. Neither the foundered blocks above, nor these relatively fine-grained talus fans bear resemblance to the reef-talus breccias of the 'conventional reef model'. The most likely process to produce such breccia deposits is a marked drop of relative sea-level resulting in sub-aerial (or higher energy) erosion of the reef front. New reef growth might then take place over such breccias when relative sea-level rises again. This is utterly different from the 'conventional reef model', though it might not be easy to distinguish the two in the field.

Pinning down the blame

It is mysterious how the 'conventional reef model' could have been devised without obvious observational support. For Braithwaite, it 'seems to have originated' from Darwin, but Braithwaite was evidently unable to pin down the blame more precisely, because he goes on to say, 'Darwin did not try to indicate the structure of the reef, nor is it clear who first did ....' Do we detect here the slightly ominous tones of a possible witch-hunt? Fortunately, the person who 'first did' is no longer with us, this being, as Braithwaite nearly guessed, Darwin himself. Darwin *did* indeed attempt a model of the internal structure and growth of reefs, but did so in a long and interesting, but unillustrated, digressive footnote [5] in his *Coral Reefs* [3, p116-118] ('I may take this opportunity....'). Although the footnote is there for all to see, it seems not to have been widely remarked upon. In it, he extrapolates his observations and conclusions from the surface features of modern atolls in particular, to predict their internal structure. Although his model is based on the same organisms (e.g. *Tridacna*) that occur on the living reef of Cocos-Keeling, it is the structure and growth aspects that are important here. Significantly, he prefaces his model by saying, 'This is a subject worthy of attention, *as a means of comparison with ancient coral strata*' (my italics).

Darwin's model of reef growth makes the explicit assumption (consistent with his subsidence theory) that reef growth is controlled by conditions of 'successive' rises of sea-level relative to the reef's foundations. We now know that this can occur tectonically (subsidence), or eustatically (absolute sea-level rise), or as a net effect of both tectonic and eustatic changes. More importantly here, he also emphasizes the role of blocks torn from the reef by wave action, indicating that they will contribute both to upward growth by being cast over the reef surface, and to outward growth, accumulating as conglomeratic beds 'resting on the exterior reef' and 'dipping at considerable angles.' He envisages that the base of the reef consists of this conglomerate, too. Here then, we have a promising prototype of Braithwaite's unloved 'conventional reef', complete with its malignant reef-talus and hapless 'outwards growth of the reef core ... over an apron of its own debris.' [2].

In fairness, Darwin himself did not use the term 'reef-talus', and his model notably differs from the 'conventional reef' in two respects. Firstly a conglomerate (rounded fragments) is not the same as the breccia (angular fragments) favoured by conventional reef modellers. Secondly, he also envisaged considerable amounts of fine grained material being deposited in the fore-reef area. Thus for Darwin, reef-talus should be either sandy or conglomeratic, or both, but not a breccia.

If this model has mysteriously entered and permeated the ancient reef literature as completely as Braithwaite believes, it seems that Darwin must have been directly and substantially influential, though somewhat overlooked. Yet if his model is as misleading as Braithwaite has argued, we must apparently also blame him rather than praise him (though this should not trouble Darwin unduly). Even so, the fault does not lie entirely with Darwin. Someone else must have transformed Darwin's model by substituting the less plausible breccia for Darwin's conglomerate and fine grained deposits in the fore-reef area. Moreover, Darwin did not attempt any specific application of his model to a particular ancient reef. His footnote mentions only 'a conglomerate limestone from Devonshire' which he compared with similar deposits in the Maldives.

The missing link?

Some responsibility for the 'conventional reef' must therefore also fall on those who first took up the cause of modelling for ancient reefs in particular. A proper historical investigation of this part of the story is now needed but as a start, we can follow a clue given incidentally by Judd [7]. The earliest relevant reference mentioned by him would appear to be von Richthofen's [21] famous account of the Triassic of the Italian Dolomites, an outstanding pioneering geological study in its own right. Judd was writing at a time after Darwin's death, when the well known 'coral reef controversy' was raging, and his interest in von Richthofen's work was partisan. In particular, the great thicknesses of supposedly reefal limestones observed by von Richthofen in the Dolomites apparently corroborated Darwin's subsidence theory. This is not the same thing as an *application* of Darwin's model to ancient reefs, which Judd does not discuss - though his lead is a useful one.

Turning to von Richthofen's own text, we find (p.303) him drawing an explicit analogy between Darwin's observations on modern reefs and the geological features that von Richthofen had observed in the Dolomites. In particular, he refers to certain small limestone banks and their *'Zwischenriff-Sedimenten'* (inter-reef sediments). Von Richthofen then clearly takes up Darwin's model of reef growth, but instead of conglomerates, he discusses the nature and role of *'scharfeckige, rauhe Bruchstücke'*, or sometimes *'Kalkbruchstücke'*, (sharply angular, rough fragments of limestone, or, in effect, a limestone breccia) and their incorporation into the growing reef structure. This is surely the same idea as a reef prograding over its own reef-talus breccia, and so we must have here one of the earliest outbreaks of 'conventional reef model' disease, as applied to ancient reefs.

Von Richtofen's account, however, post-dates the publication of Darwin's coral reef book by 18 years. Was von Richthofen really The Missing Link in the guilty chain between Darwin's own model and its actual application to ancient reefs? Can we push back the date beyond 1860? Answers on a postcard should reach me before the bicentenary of Darwin's birth in 2009.

Going forwards

Von Richthofen's model, for better or worse, can be traced forwards in time through the work of others in the Dolomites, particularly Mojsisovics, and he in turn influenced the interpretations by Newell and others of the great Permian reef of West Texas (Ed Purdy, pers. comm.). The breccias associated with the Dolomite reefs and those elsewhere are real enough, but are they related to growth of those reefs in the manner of the 'conventional reef model'? Recent researches suggest not [1]. It is easy to be wiser in hindsight and point out the fallibility of older models. The serious point is that other kinds of reef model are necessary, based on what has *actually* been seen, not on what *ought* to have been seen. In this respect, the work by Pomar and co-workers on the Miocene reef complex of Mallorca based on their 'sigmoidal' reef model, is an interesting alternative. While there is no reason yet to suppose that it is universally applicable to ancient reefs, any more than the 'conventional reef model', it is consistent not only with their Miocene observations but also with those details of modern reefs as insisted upon by Braithwaite.

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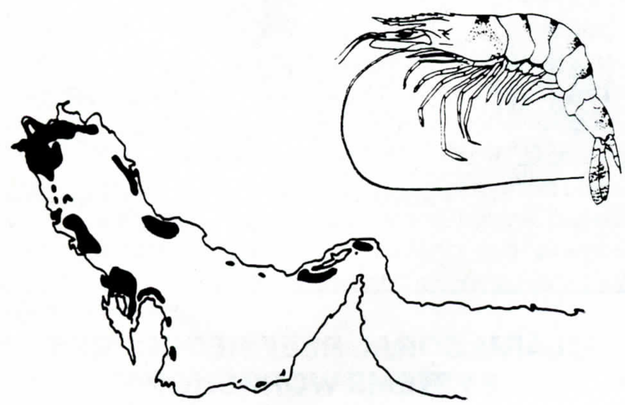


Fishing grounds for shrimp in the Arabian Gulf. From Marine Ecology of the Arabian Region, *Sheppard et al. See p. 23.*

WOMEN DO IT BETTER!

Men are a greater threat to the health of reefs than women (as half the editorship of *Reef Encounter* always suspected). Helen Talge, in a study on the reefs in the Florida Keys in 1989 (supported by the US Nature Conservancy), found that female scuba divers and snorkellers have significantly fewer interactions with the reef fauna and flora than men. She also discovered that divers without gloves touch the reef less than those with gloves, and that snorkellers touch it less than divers. However, snorkellers are the worst culprits for stirring up silt, particularly when some 60 snorkellers 'tread' water at the same time - visibility on a shallow reef can be rapidly reduced.

The 'greenest' diver is therefore a woman snorkeller without gloves who avoids treading water; and we should beware the male scuba diver with gloves! The serious message in this is of course that training that emphasises buoyancy control and encourages people to 'look' but not 'touch' can go a long way to minimising reef damage from divers.

NEWS

ENVIRONMENTAL CONSEQUENCES OF THE GULF WAR

A recent survey published by Greenpeace confirms earlier reports [see *Reef Encounter* 10] that coral reefs in the Arabian Gulf have so far survived environmental impacts of the Gulf War remarkably unscathed (Greenpeace 1991). The survey took place in August and September 1991 during a cruise by the *MV Greenpeace* around the Gulf taking in Bahrain, Iran, Kuwait, and Saudi Arabia. The survey was made primarily using rapid, manta board methods, although more detailed line transect data were obtained for a few Saudi Arabian sites, repeating an earlier study made there. Underwater video transects were also taken for later analysis.

Underwater, none of the reefs examined showed any evidence of having been affected by oil spills from the Gulf War. Unfortunately, some of the best reefs in the Gulf (surrounding islands off the Saudi Arabian coast) could not be visited due to bad weather. Beaches on these islands were affected by oil in March 1991 but no information was available for the reefs themselves. The report concludes that although there were no visible effects six to eight months after the spills, long-term effects from toxic chemicals could not be ruled out.

Work has also been underway on the northern Saudi coast. Under an EC funded project, a team from various institutes in Germany, Belgium, France and the UK has been looking at the impact of oil on nearshore coastal communities, including some sites with scattered corals. Oiling was found to be serious in many areas. Their project includes the establishment of permanent monitoring transects, although unfortunately for those interested in corals, few (if any) cross reefs. A sanctuary area being set up under this same project at Dhawhat ad-Dafi, Dhawhat al-Musalliamiya and some of the offshore islands will however include reefs.

The Greenpeace survey was made during the summer. One of the most serious concerns for the future of the reefs was that plumes of smoke from burning oil wells were reducing water temperatures below normal in the Gulf. The Gulf is already a sea subject to greater extremes of temperature than virtually any other reef-supporting area in the world. A greater than normal fall in winter temperatures was thus seen as a threat to reef survival, particularly if chemical pollution had reduced the ability of reef organisms to respond to other stresses. An unconfirmed report from a study of shrimp stocks in the western Arabian Gulf throughout the winter of 1991-2 suggests that temperatures did fall below their normal ranges (A.R.G. Price pers. comm.). However, air temperature data from two sites do not support this. Effects of the war on other Gulf fauna were evident. Spawning biomass of northern shrimp stocks was only a tenth of the value two years before, despite there having been no fishing for over six months. The future for reefs and other life in the Gulf remains uncertain.

Greenpeace (1991). *The environmental legacy of the Gulf War. A Greenpeace Report.* Greenpeace International, Amsterdam. 1992.

MEETING REPORTS

IV WORLD CONGRESS ON NATIONAL PARKS AND PROTECTED AREAS

This vast congress, attracting some 1500 participants, took place in Caracas, Venezuela in February 1992. The main outputs were the 'Caracas Declaration' and the 'Caracas Action Plan'. The former is the set of conclusions from the congress and will be presented to UNCED, the Earth Summit, in Brazil this year, by the President of Venezuela. The Action Plan consists of 12 priority tasks for improved management and development of national parks and protected areas, one of which is the launch of a major programme to establish marine protected areas.

The Congress was structured around symposia and workshops, of which three related directly to marine issues: the science of conservation in the coastal zone; regional planning, protected areas and the coastal zone; and marine protected area management tools.

The marine sessions resulted in a number of recommendations directed at international organisations, governments and NGOs, which (in summary) called for better integration of marine parks in the broader issue of coastal zone management; further research on the role of marine protected areas in protecting biological diversity and achieving ecologically sustainable use of the coastal zone; increasing integrated, multi-disciplinary, management-oriented research and monitoring programmes to provide data for the selection, planning and management of marine protected areas; improving management of marine protected areas; and increasing the involvement of local people in the planning and management of marine protected areas.

Compared with the last World Congress on protected areas, held in Bali ten years ago, this was a huge increase in the amount of time deveoted to the marine environment. There was a certain irony in spending so much time on marine protected areas *per se*, when almost all participants felt that the main priority lies in developing mechanisms for management of the coastal zone as a whole. Nevertheless, marine protected areas are key components of coastal zone management plans and, where the latter are not yet in place, they may be a first step in focussing attention on the marine environment.

There was much discussion of the criteria to be used in the selection of sites for protection, although disappointingly little theory and few case studies to back this up. Given current interest in the potential role of marine reserves in fishery management, it was a pity that this topic did not get an airing. Ian Dight of James Cook University gave one of the most interesting papers on the importance of understanding habitat connectivity through larval dispersal when designing marine park systems, and showed how this type of knowledge is starting to be used in management of the Great Barrier Reef Marine Park.

For further information contact: *IUCN-the World Conservation Union, Ave du Mont-Blanc, CH-1196 Gland, Switzerland. Fax 41-22-642926.*

Painting by the late Sir Peter Scott. Reproduced by kind permission of Lady Philippa Scott.

ICLARM CORAL REEF RESOURCES SYSTEMS WORKSHOP

This was held at the the Australian Institute of Marine Science (AIMS) in Townsville, Australia, in March 1992 and was attended by about 40 invited participants from a range of countries. ICLARM has identified coral reefs as a major area for research in fishery management and the workshop was aimed partly at providing input into planning their programme. In addition, at the 1991 Commonwealth Heads of Government meeting in Harare, Zimbabwe, Australia announced an initiative to make available Australian expertise and funding for the management of tropical marine environments in Commonwealth and other countries. The workshop was therefore partly sponsored by AIDAB (Australian International Development Assistance Bureau) who will be administering the funds for this initiative.

Following brief presentations by all participants, four sub-workshops were convened to discuss: conservation of reef systems and their biodiversity; management, with emphasis on coral reef fisheries; aquaculture and resource enhancement; database development and modelling of coral reef systems. The results of these discussions were amalgamated as a set of recommendations directed at ICLARM and at AIDAB.

The need for international collaborative efforts in coral reef resource management, involving host country scientists in all steps, was recognised. This calls for better networking and co-ordination; roles for ICLARM were defined, other agencies with which linkages should be made were identified, and the ASEAN-Australian Marine Sciences Project: Living

Coastal Resources, proposed as a good model. It was recommended that further resources should be made available to strengthen graduate and post-graduate programmes in developing country universities. A proposal for establishing an international coral reef database at ICLARM, to be called REEFBASE, was endorsed and recommended for funding. This would complement other existing and proposed regional and international databases (e.g. the various monitoring databases, fishery databases). It would contain descriptive information on reefs at the country and individual reef levels, and a time series of data covering a variety of physical, biological, fisheries and management parameters. It would be linked to a GIS system.

Other recommendations to ICLARM included evaluating the potential social, economic, environmental and genetic impacts of aquaculture and resource enhancement programmes for reef species, as well as identifying and researching the basic biology or prospective species for these purposes, concentrating on appropriate local technologies. Other areas of research identified include ways in which fisheries management can be integrated into the broader issue of coastal zone management; the ecological, social and economic impact of tourism on reefs and its sustainable level; evaluation of marine protected areas as tools for reef management; and alternative management options for reefs such as community-based systems.

The proceedings of the meeting are scheduled to go to press by the end of May and should be available by July.

Further general information from: *John Munro, ICLARM South Pacific Office, P.O. Box 438, Honiara, Solomon Islands. Fax: (677) 22130.* Further information on REEFBASE from: *Daniel Pauly/Rainer Froese, ICLARM, MC P.O. Box 1501, Makati, Metro Manila 1299, Philippines. Fax: (63) 2-816-3183.*

MEETING ON LONG-TERM MONITORING OF CORAL REEFS

In December 1991, a meeting of 18 coral reef and mangrove research scientists was convened in Monaco at the Musée Oceanographique, to take the initial steps in developing a global monitoring system for coral reefs to detect the impact of climate change and sea level rise on these systems. The meeting was co-sponsored by UNEP (United Nations Environment Programme), IOC (Intergovernmental Oceanographic Commission of Unesco), WMO (World Meteorological Organisation) and IUCN (the World Conservation Union), as a follow-up to a meeting in December 1990 in Paris at which a 'Long-Term Global Monitoring System of Coastal and Near-shore Related Phenomena' related to climate change was formulated. Pilot phase activities to be developed through this system include: sea-level rise and coastal flooding, coastal circulation, carbon burial in coastal sediments, effects on pelagic plankton communities, coral reefs, and mangroves. These would be components of IOC's Global Ocean Observing System (GOOS). The meeting results and background information are described in IOC report UNEP-IOC-WMO-IUCN/GCNSMS-II/3.

At the Monaco meeting, the focus was on mangroves and coral reefs. For coral reefs, lists were prepared of the minimum and additional desirable sets of biological and environmental parameters that should be monitored for the detection of the effects of climate change and sea level rise on coral reefs. It was decided that the basic methodologies tested and used in the ASEAN-Australia Living Coastal Resources project would be adopted for wider use enabling regional and global comparisons to be made. To date most extensive databases for coral reefs have been collected at isolated sites, for different purposes and using different methodologies. No regional or sub-regional quantitative assessments or comparisons of the state of coral reefs have yet been undertaken. Collection of data under the proposed programme using the same methodologies will allow a comparison of the status of reefs in defined regions and sub-regions of the tropics and identification of trends over time.

Participants developed scientific criteria for site selection, and identified a number of possible representative sites for monitoring to cover the geographic range and conditions under which reefs are found. This however is only a preliminary list and many other sites will be substituted or added depending on the interest of governments and institutions in participating in the programme. Pilot projects are planned to commence as early as late 1992, with initial site descriptions being prepared during 1992 and 1993. Depending on the results and the degree of successful collaboration, the programme could be extended to cover a wider number of countries and sites.

The meeting recognised that mechanisms for handling, storing and quality control of data need to be established early in the programme. Data will need to be maintained in regional databases and shared and co-ordinated globally. A possible role for the World Conservation Monitoring Centre (Cambridge, U.K) in overall data storage and distribution was discussed.

As an initial step in development of the programme IOC and UNEP propose to publish and distribute the manuals for the approved methodologies in the first half of 1992. The proposed programme for coral reef monitoring will be presented to an IOC/IUCN sponsored workshop to be convened during the 7th International Coral Reef Symposium in Guam. The interest and possible contributions of the wider scientific community involved in coral reef studies will be assessed at the meeting.

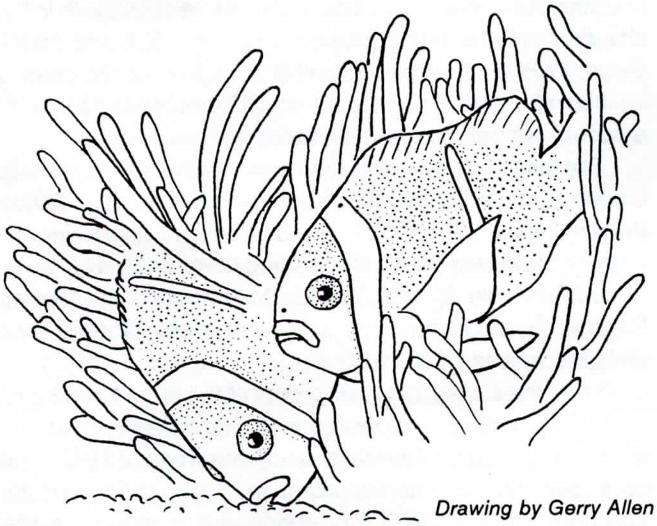
IOC and UNEP, in co-operation with the Association of South Pacific Environmental Institutions (ASPEI) have also established a Global Task Team on the Implications of Climate Change on Coral Reefs. Its charge is to prepare a global overview of the potential impacts of climate change on coral reefs, to identify selected case studies for specific sites, and to advise on scientific and technical aspects of proposed long-term global monitoring activities. The first meeting of the Task Team will be held 26-27 June, also during the Guam Congress, and will be chaired by Dr Clive

Wilkinson, Chief Technical Advisor to the ASEAN-Australia Living Coastal Resources Project. The work of the task team will be closely linked to monitoring programme developments although the exact relationship between the two initiatives is not yet clear.

Further information from: *J.C. Pernetta, IOC/IUCN Consultant, The Smithy, Blacksmith's Row, Gayton, Norfolk PE32 IQJ, U.K. Fax/ phone: 44-553-636832.*

INTERNATIONAL SYMBIOSIS CONGRESS

This was held in Jerusalem, Israel, on the 17th to 20th November 1991 and organised by Margalith Galun. Sir David Smith, the first plenary speaker, estimated that 61% of the 165 contributions dealt with symbioses of terrestrial plants or fungi. The largest marine component concerned the cnidarian-algal relationship (16% of contributions, including hydra). Subject matter ranged from chemical analyses (e.g. papers by Titlyanov on carbon pathways of zooxanthellae and by Lipschultz and Cook on nitrogen assimilation in sea anemones), to autecology, (e.g. symbiont translocation during planulae development in an octocoral by Benayahu). Systems analysis also featured with a presentation by Erez *et al.* on the REEFLUX project which is investigating biogeochemical interactions of coral reefs



Drawing by Gerry Allen

with the adjacent sea.

Symbiosis of fish with invertebrates was also well represented. Ilan Karplus described an interaction between a shrimp and two gobies whilst pearlfish and echinoderm interactions were the subject of a study by Dgebuadze and Britayev. Anemonefish, the classic symbionts, also featured with a study by Daphne Fautin on choice of anemones and control of recruitment. Evelyn Cox described effects of partial predation by butterflyfishes on a Hawaiian coral. There were also papers on mollusc and echinoderm symbioses, some of them reef-related.

Papers were organised topically rather than taxonomically. This strategy worked well to merge land and sea in sessions on "Nutritional interactions, carbon and nitrogen metabolism", "Symbiosis and development of new structures and functions" and "Ecological adaptation". Sessions on "Behavioural symbiosis" and "Transport mechanisms" were less successful in fostering cross-disciplinary mutualism, the former being mostly marine and the latter terrestrial.

The congress proved to be a valuable meeting ground for people working at many levels of analysis on a variety of systems. So enthusiastic was the response to it that an *ad hoc* group assembled on the last day to plan the next one, tentatively scheduled in around four years for Dundee in Scotland or Santa Cruz in California, USA. I hope that more marine biologists will attend future meetings to call the attention of "mainstream" symbiology to the variety of relationships in the sea and the degree to which they are understood.

Daphne Fautin, Dept Systematics & Ecology, Univ. of Kansas, Lawrence, Kansas 66045-2106, USA. Fax. (913) 864-5317

COUNTRY PROFILE

PROGRESS IN CORAL REEF CONSERVATION IN INDONESIA

T. Tomascik, R. H. Djohani, and H. Uktolseya

Background

Indonesia has recently become a focus of international attention as a result of over-exploitation of marine turtles, molluscs and a variety of other natural products derived from its great diversity of shallow water marine and coastal ecosystems. By far the world's largest archipelago, with over 17,000 islands and a coastline of approximately 81,000 km, it is without doubt one of the richest ASEAN (Association of South East Asian Nations) countries in terms of its natural marine and coastal resource base. Despite this, relatively little has been done to date to meet the many challenges, although a good general framework has been established. A major problem is the lack of information on the size and distribution of marine resources. While Indonesia has been identified as a centre of biodiversity in the Indo-Pacific region, there are few databases to provide specific information. Even for coral reefs, the information available is largely too sketchy for the development of appropriate management plans.

Research

In recent years, Indonesia has experienced a boom in research. Perhaps the most noteworthy event of the 1980s was the *Snellius-II* Expedition which was organized and financed by the Indonesian Institute of Sciences and the Netherlands Council for Oceanic Research. It clearly pointed out major gaps in our understanding of tropical marine shallow-water benthic systems; Indonesia offers a great opportunity to plug some of these. The diversity of natural systems that abound in the archipelago are a researcher's dream, and there are still reefs that are totally pristine as well as ones that have been impacted by human use for centuries. Comparative experimental field research should therefore be a focal theme for researchers in Indonesia. The fact that the archipelago lies outside the cyclone belt provides an excellent chance to study other natural phenomena, such as earthquakes and seismic activity, that may play a significant role in the structuring of benthic assemblages.

The results of the *Snellius* expedition were published in the *Netherlands Journal of Sea Research*, but have failed to find a large audience in Indonesia mainly because of poor distribution. Equally important therefore, is the growing amount of reef-related research underway at Indonesian universities, which is being published locally. This will be reviewed in a future issue of *Reef Encounter*.

Conservation Efforts

In the early 1980s, a co-operative program between the World Wide Fund for Nature (WWF) and the Indonesian conservation authority (the Director General of Forest Protection and Nature Conservation (PHPA)) led to the preparation of the 'National Marine Protected Areas System' plan. This provided a basis for the selection and establishment of a system of marine protected areas that would maintain the value of fisheries, tourism, research, education, threatened species and habitats in each province.

Realizing that coral reefs, as well as other benthic ecosystems such as seagrass beds and mudflats, play a key role in national development, the Ministry of State for Population and Environment (KLH) in association with other agencies, has taken the initiative to assist PHPA in the implemention of Law (Undang-Undang) No.5, 1990 on the Conservation of Natural Resources and Ecosystems, which was passed in August 1991. This law, in conjunction with the Environmental Act of 1982, gives KLH the means to co-ordinate all sectoral departments relating to marine and coastal environmental management. To facilitate implementation, two conservation strategies are being developed: one for turtles, with the assistance of the Environmental Management Development in Indonesia (EMDI) project (a joint project of KLH and Dalhousie University, with funding from CIDA [Canadian International Development Agency]), and one for coral reefs, with assistance from EMDI and WWF Indonesia.

The National Conservation Strategy for Coral Reef Ecosystems covers a wide brief: management of conservation areas; conservation and management in general of reefs; public awareness and participation of local communities in reef management; fisheries; tourism; terrestrial and marine-based development; environmental impact assessment; education and training; and research and development. The following provides a brief summary of some of the issues now being tackled.

1. Management of conservation areas

One immediate target for the Indonesian government is to establish 10,000,000 ha of marine conservation areas distributed throughout the country in 85 reserves by 1993, with a long term aim of protecting 30,000,000 ha by the year 2000. At present, 23 sites have been established as Strict Nature Reserves (covering c. 2,800,000 ha), including five reserves with the status of National Park (Pulau Seribu in Jakarta Bay, Karimun Jawa in Java, Teluk Cenderawasih in Irian Jaya, Bunaken in Sulawesi and Taka Bonarate in the Flores Sea). A further 7.2 million ha must be gazetted if the government is to reach its objective for 1993.

Equally important is the development and implementation of management plans for existing marine protected areas. The EMDI project is currently funding a KLH sponsored Marine Parks Planning Project with PHPA, to develop an appropriate management plan for the recently gazetted Taka Bonarate National Marine Park. This is the largest atoll in Indonesia (and the third largest in the world) and supports an important regional fishery. Phase I (socio-economic evaluation) of the project has been completed, and currently the atoll is being inventoried using remote sensing techniques. A 2-month survey of the atoll is planned for August-September 1992 to obtain environmental and ecological data and to carry out ground truthing. Zoning and management plans will be developed on the basis of the information gathered.

In 1989, WWF revived its Marine Conservation Development Program to assist with the establishment of marine protected areas. Joint PHPA/WWF surveys were carried out at priority sites and the results led to certain projects being developed and funded under the WWF program: implementation of management plans for Bunaken, Aru Islands, and Teluk Cenderawasih; marine activities in the protected areas of Ujung Kulon, Bali Barat and Karimun Jawa; and donors are now interested in the Togian Islands and the Tukang Besi Islands.

2. Environmental Impact Assessment

To assist the government in reviewing and planning EIA studies, the EMDI project has produced a set of environmental management guidelines for development projects in coral reef areas.

3. Coastal development

Eutrophication of coastal waters and increasing sediment input from poor land management is of great concern to

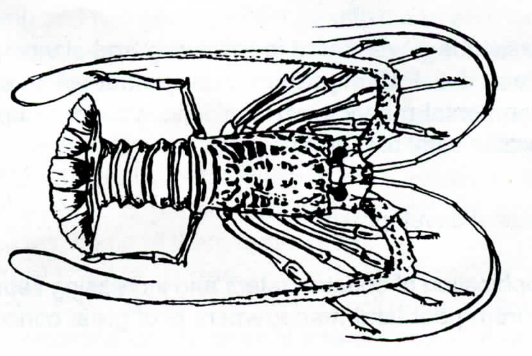
KLH and other government agencies. The EMDI project is therefore supporting a 2-year environmental monitoring project in Ambon Bay in the Moluccas. The aims are to: identify all anthropogenic impacts (both land- and marine-based), assess the status of the benthic communities, monitor key chemical and physical parameters, identify cause-and-effect mechanisms, develop appropriate mitigating responses, provide information to the government and assist local NGOs, and the university and national oceanography laboratory in environmental research. This study represents the first comprehensive research effort in the Moluccas and provides an opportunity for researchers from overseas universities to participate.

4. Education and training

The importance of coral reefs has not yet been adequately realised in Indonesia, despite their visible widespread deterioration. Until this is rectified, progress towards successful management of reefs will remain slow. As a start, EMDI and KLH have produced a wall poster to attract the attention of the general public, the vast majority of whom have never seen a coral reef or its inhabitants, and WWF are developing a national marine conservation awareness campaign. The main outputs of this will be a range of outreach materials, a training manual and other materials on conservation techniques, and the training of a permanent team of WWF, government and NGO personnel who will be responsible for communications relating to marine conservation issues.

A major constraint is the lack of skilled personnel to implement sound management practices in coral reef areas. Formal and informal training programs for specific groups such as park managers, rangers, nature-lover groups, community leaders and tourism developers are required. The EMDI project is currently funding the writing of *The Ecology of the Moluccas and Lesser Sundas* and *The Ecology of Indonesian Seas*. These books are orientated towards a wide audience, with a primary objective of providing baseline information about marine and coastal ecosystems, resources and human activity and development.

Tomas Tomascik and Henk Uktolseya, EMDI Project, Kantor Menteri Negara, Kependudukan dan Lingkungan Hidup, Jl. Merdeka Barat 15, Jakarta 10110, Indonesia; Fax: 62-21-570-5321. Rili Hawari Djohani, WWF-Indonesia Program, Jl. Pela No. 3 Gandaria Utara, P.O. Box 7928 JKSKM, Jakarta Selatan 12079. Fax: 62-21-739-5907.



ANNOUNCEMENTS

SURVEY ON REEF DEGRADATION

Improved knowledge about human activities that endanger reefs is essential for mobilization of government and public concern and development of better conservation measures. Scientists who conduct research on reefs and related biota possess the best data and most informed opinions on the sources of reef degradation. Yet, few mechanisms enable reef scientists to present their knowledge effectively in a manner useful for environmental policy-makers. As an American environmental law professor (currently on a Fulbright scholarship in Australia) I am distributing a policy-oriented questionnaire on sources of reef degradation intended to assemble diverse scientific observations in a manner that will support reef protection efforts. Scientists can help compile a more extensive database on worldwide reef problems by completing this for areas with which they are familiar. The questionnaire is concise and relatively straightforward as it was designed with policy goals in mind; and filling out the questionaire form should not prove an excessive burden.

Forms will be distributed at the 7th International Coral Reef Symposium in Guam this June and by mail, on request. The results will be published in a scientific periodical and these and the raw data will be made available to interested parties. The survey is intended to serve several purposes: identification of worldwide trends and frequent sources of reef damage; provision of information on reef issues to international environmental organisations and national governments; compilation of data that may be useful in scientific research projects and may help redirect some research agendas toward severe marine problems; and the generation of greater publicity and popular concern about reef degradation. It offers an opportunity for scientists to provide more support for reef conservation initiatives and to provide better information on reef conditions to environmental policymakers.

Please write for forms to: *Professor H.A. Latin, Faculty of Law, University of New South Wales, P.O. Box 1, Kensington, NSW 2033, Australia. Phone: (02) 697-2752; Fax (02) 313-7209*

PRACTICAL GUIDE TO CORAL REEF IMPACT STUDIES

In June 1992, the French Ministry of the Environment will publish a guide on methodology for carrying out environmental impact studies in tropical coastal and reef environments. The document has been designed to provide decision-makers, developers and those responsible for environmental assessment with practical information on:

— site reconnaissance;

— the use of thematic cartography in development problems;

— methods of eliminating or reducing the effects of projects on the coastline or on reefs;
— techniques for the restoration of degraded sea floor.

The impact of different types of development (construction projects, land reclamation, dredging, mining and dredging of coral material, discharge of waste water, coastal defenses, tourist complexes) on coral reefs is summarised and analysed. The guide has numerous illustrations (photos, plans, thematic maps) relating to case studies in the Pacific and Indian Oceans. The different methodologies recommended are based on a pragmatic approach to the problems, adapted to the constraints encountered in the tropics, particularly in developing countries.

The preliminary version of this document was presented at the annual meeting of the ISRS at Berkeley in December 1991. The French version of the manual will be published in June 1992 and presented at the 7th International Coral Reef Congress in Guam. An English version is planned for the end of 1992.

Michel Porcher, the editor of the guide and an environmental engineer at CETE Mediterranee in France, is planning a workshop, in collaboration with SPREP (South Pacific Regional Environment Programme), on the environmental problems of development in coral reef areas, at the Guam congress. The aim is to bring together specialists working in this applied field, in order to compare methodologies and techniques, and to reach an agreement on a common approach, particularly in mapping and techniques for the protection of reefs of use in development projects. Those interested in this workshop should contact Michel Porcher or Paul Holthus (from SPREP) at the congress.

Further information from: *Michel Porcher, CETE Mediterranee, B.P. 37000, 13791 Aix en Provence Cedex 3, France. Tel 42 24 76 76 - Fax 42.24 77 98.*

THE MARINE CURIO TRADE — CONSERVATION GUIDELINES AND LEGISLATION

The UK-based Marine Conservation Society has produced a 23-page booklet aimed at helping importers and retailers of marine curios make informed decisions about the species they trade in and encouraging them to support efforts to run the trade on a sustainable basis. Thousands of species are collected for the trade, in most cases without any knowledge of the consequences. Scientifically run management programmes are the exception rather than the rule. The booklet is not a comprehensive guide to curios that can or cannot be traded on a sustainable basis, but outlines relevant legislation and gives recommendations concerning the main groups of animals involved. Regulations under CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, are described, and examples of national legislation relating to marine curios are given. Importers and retailers are urged to act like some some importers and users of tropical timber who actively campaign for materials that have been harvested on a sustainable basis. The booklet is currently being distributed within the UK to retailers, but provides useful information for other countries as well.

The Marine Curio Trade – conservation guidelines and legislation is available from: The Marine Conservation Society, 9 Gloucester Road, Ross-on-Wye, Herefordshire, HR9 5BU, UK. A donation of US$5.00 (£2) to cover postage and packing would be appreciated.

CLARIFICATION OF CITES PERMITS FOR CORAL SPECIMENS

Recently there have been a few cases of researchers having problems taking coral specimens out of some countries. As described in *Reef Encounter* 6, December 1989, the orders Scleractinia and Coenothecalia, and the families Milleporidae and Stylasteridae are listed in Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). CITES is aimed at commercial trade in wildlife: Appendix II-listed species may still be traded (provided such trade is legal under national legislation in the country concerned) but an export permit is required from the country of origin and, for imports into countries of the European Community, an import permit is required.

Unfortunately for scientists (but essential for the effective implementation of the convention) CITES regulations apply to scientific as well as commercial specimens. Export permits are obtained from the CITES Management Authority of the country of export; where import permits are also required, as for EC countries, these are also available from the Management Authority of the country of import. There should be no problem obtaining these, unless of course the country concerned has stricter measures in place. Thus, for example, between 22 April 1991 and 2 April 1992, trade in all specimens of CITES listed species was banned with Thailand (because of non-compliance with regulations). As this ban has now been rescinded, it should once again be possible to obtain permits to take corals out of Thailand.

Scientists and scientific institutions can also apply for registration for 'non-commercial' exchange of CITES-listed species with other registered bodies. Registration is through their own CITES Management Authority. For example, the Smithsonian Tropical Research Institute in Panama is currently applying for registration with the Panamanian CITES Management Authority.

Addresses of CITES Management Authorities should be available from government wildlife departments of the country concerned. If you have problems, further information can be obtained from: *CITES Secretariat, 6, Rue de Maupas, Case Postale 78, CH – 1000 Lausanne 9, Switzerland (Fax: 21-20-00-84) or Traffic International, 219c Huntingdon Road, Cambridge, CB3 ODL, UK (Fax: 223 277136).*

INFORMATION NEEDED TO ASSIST IN PLANNING FOR THE BAY ISLANDS MARINE PARK, HONDURAS

The government of Honduras is in the process of conducting a feasibility study for the establishment of a National Marine Park for the Bay Islands (Islas de la Bahia). The Inter-American Development Bank has expressed strong interest in supporting the full development of a National Marine Park and coastal management programme.

The Bay Islands are approximately 50 kilometres north of Honduras' Caribbean coast. There are three major islands: Roatan, Guanaja and Utila, and three smaller islands and numerous offshore keys. The intertidal and coastal waters consist of a rich variety of coral reefs, beaches, subtidal bars, seagrass beds and mangroves - an area of approximately 355 km^2.

The resident human population of 25,000 is growing quickly, largely in response to the rapid increase in tourism and associated developments. Last year approximately 30,000 tourists visited the islands. The greatest attractions by far are diving and snorkelling on the extensive and varied coral reef systems that surround nearly all the islands.

According to diving magazines the coral reefs of the Bay Islands are among the best diving sites in the Caribbean. The most popular sites offer a broad variety of hard corals, gorgonians, sponges, and fish life in combination with attractive walls, caves, arches, channels and crevasses.

To aid in the analyses needed for this feasibility study we ask readers to help us find the following information:

Quantitative assessments of (1) the impact of sediments generated by land use practices (particularly conversion of forests into rangeland, or dredge-and-fill projects) on coral reef systems (particularly Atlantic reefs); and (2) of the impact of sewage discharges on coral reefs. We also seek economic data concerning (1) the effects on coral reefs of land-based projects designed to protect reefs (e.g. watershed protection, sewage treatment and solid waste disposal); (2) the costs and benefits (direct expenses and revenues and indirect benefits) associated with the establishment of marine parks; (3) figures of leakage and multipliers of coral reef-related tourism expenditures, (4) the impact of marine parks on actual and projected tourism; and (5) the receipt of international non-profit financial support for marine parks.

Please send information or offers of help to: *Jens Sorensen or Linwood Pendleton, Ordenamiento Ambiental del Desarrollo de las Islas de Bahia, PNUD/HON/91/001, Colonia Palmira, Calle Republica de Venezuela, No 2109, Tegucigalpa, M.D.C. Honduras. Telephone and fax: 504 45 10-42.*

BOOK REVIEWS

THE ECOLOGY OF FISHES ON CORAL REEFS

P.F. Sale (editor)

Academic Press, San Diego, USA. 1991. ISBN 0-12-615180-6. Price: US$69.95, £42.50.

This book has had a long gestation. It was first conceived early in 1987. By the time of the Townsville symposium in 1988 it was being mentioned in conversation among fish ecologists at large. I first saw the complete draft of one chapter in late 1989. However, the book has only just come out early in 1992. For many books such a delay between writing and publication would render the contents rather out of date and of limited use. Not so for this one. There are two reasons for this. Firstly, all of the contributors are leading workers in the field and therefore privy to the results of work under way or in review. This means that there is a healthy smattering of 1991 references inculded and even one or two still in press. Secondly, Peter Sale has encouraged authors to speculate and identify future research needs, creating a book which will mould the path of reef fish research for perhaps the next decade.

It is never easy to produce a coherent book from a diverse group of contributors but Peter Sale has done a remarkably good job. Not only has he kept overlap among chapters to a necessary minimum, but he has also managed to squeeze the best out of virtually all of the authors. The book begins with a 'crash course' on reef fishes for non-specialists by Sale. One of Sale's stated aims with the book was to make the wealth of information on reef fishes available to those working on other systems, fostering exchange of ideas and countering the ever-narrowing taxonomic focus of ecologists. Whilst a worthy aim, I am uncertain that it will be achieved here. I think that a shorter, more focussed work by a single author would reach this audience more effectively. Whilst the chapters are all easily accessible to those with a background in reef fish ecology, the division of labour among authors makes it difficult for a single theme to be followed through the book.

For the specialist, the book is a gem! It is divided into five parts: I Basics; II Trophic Ecology; III Larval and Juvenile Ecology; IV Reproductive and Life History Patterns; V Community Organisation; and VI Fisheries and Management. All of the twenty chapters are good but many were outstanding. The following is a grab-bag of personal favourites. Chapter 3 by Howard Choat and Dave Bellwood plunges us into the deep history of fishes on reefs. I particularly enjoyed learning about the magnificent Eocene faunas so beautifully preserved in Italy. Entire communities frozen in time, from huge rays to the tiniest gobies, perhaps killed by algal blooms 50 million years ago. Jeff Leis reviews the pelagic stage of reef fishes (yet again) in Chapter 8 but saves his best for this book. In a thoroughly enjoyable account he throws out the notion that larvae can be treated as passive particles transported at the whim of the ocean. If this were the case we would find it pretty difficult to explain why patterns of larval distribution show such clear structures. Leis, Ben Victor and Peter Doherty in the next two chapters offer tantalising glimpses into the mysteries of larval life. Leis concludes that we should look closely at ecological factors acting on the larval stage for better insights into patterns of settlement onto reefs.

The history of reef fish ecology has been one of intense debate over the past twenty years, reflecting debates taking place in the wider field of ecology. Although generally amicable, the argument has generated a fair amount of froth. Geoff Jones in Chapter 11 can be relied upon to ladle a large helping of Antipodean 'good sense' into the debate when shirt sleeves start to get rolled up and the atmosphere turns ugly. Jones concludes that there is life after recruitment. Perceptively, he notes that we have been overconcerned with studies of similar species, such as damselfish, restricting our ability to detect patterns which will form the basis of useful generalisations.

Ronald Thresher, as always, provides a stimulating account of patterns and processes in the 'might-be' realm which lies between not much data and none at all. However, for the uninitiated he is good enough to suggest three ways of 'destroying' the hypotheses he erects. To be fair, science would be much the poorer without these 'ideas' people to enliven the mind when orthogonal and multi-factorial designs become too much to bear.

Dave Williams provides a fine summary of processes generating patterns in assemblages from small to very large scales in Chapter 16. Mark Hixon in Chapter 17 builds on material in earlier chapters with an excellent synthesis of the relative importance of multiple factors operating at different times during the lifespan of a fish. He extends an earlier graphical model of Ben Victor's providing an elegant summary of interactions among pre- and post-settlement processes. Peter Sale sums it all up in Chapter 19, concentrating on processes operating at small scales. One of Sale's main quests over the past few years has been to make us more aware of how our interpretations of data are coloured by preconceptions. This is a lesson we can all learn much by heeding.

What emerges from this book is a clear message that all aspects of a fish's life are important. How important varies among species, from place to place and time to time. The search for simple explanatory principles which cross broad taxonomic boundaries is not necessarily futile but reality is as complex as the reef community itself. Such complexity should not dishearten or perplex. It would be more surprising if simplicity were the norm. Millions of years of evolution, divergence, interaction among species and plain chance have shaped the communities we see today. Understanding those communities is an exciting challenge which will tax the minds of ecologists for generations to come.

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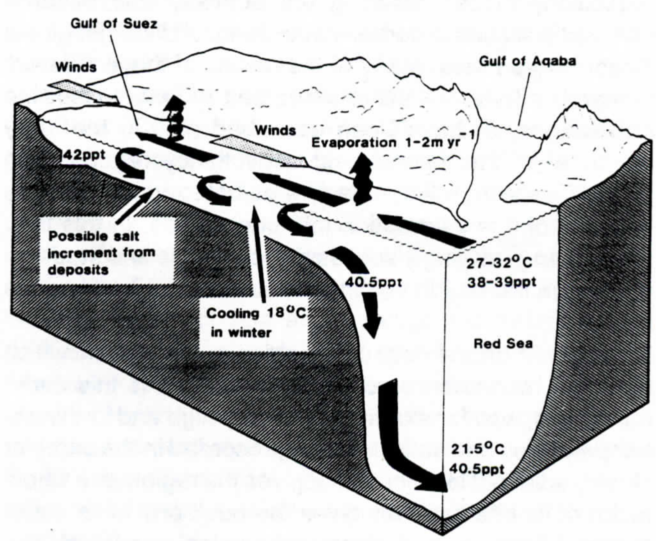

MARINE ECOLOGY OF THE ARABIAN REGION: PATTERNS AND PROCESSES IN EXTREME TROPICAL ENVIRONMENTS

C.R.C. Sheppard, A.R.G. Price & C.M. Roberts

Academic Press, London, UK. 1992. ISBN 0-12-639490-3. Price: £29.50

The seas surrounding the Arabian Peninsula (the Red Sea, Arabian Sea and Arabian Gulf) are best known by both amateur divers and marine biologists for the rich and spectacular coral reefs that, as this interesting and stimulating book explains, are principally characteristic of only the northern and central Red Sea. But coral reefs are only one in a varied mosaic of marine environments that characterise the region. It also contains well-developed mangrove stands, marshes, seagrass beds, algal communities (including the little-known seasonal kelp forests of southern Oman), and a range of soft substrata such as sabkha (salt pans), beaches and mud-flats, as well as a varied pelagic environment. This book introduces each of them, considering the factors and processes that account for their distribution, and of the species which inhabit them.

The marine flora and fauna of the Arabian region were amongst the earliest sampled by European scientists and explorers, beginning with Forsskal's ill-fated *Arabia Felix* expedition (1761-67), which first described so many Indo-Pacific species. The region was also host to a number of eminent 19th century taxonomists, such as Ehrenberg and Klunzinger, from whose writings are taken many of the apt quotations interspersed among the text. But because of the harshness of the region's climate, and the difficulty of working there, only very recently has the overall picture of the distribution and variation of its marine habitats and communities emerged.

This emerging picture is partly due to the work of the increasing number of marine laboratories located in the region, and partly to renewed interest of visiting scientists, particularly those, including the authors, who became involved in studies undertaken with the local UNEP Regional Seas Programmes. Many of the results of these different research efforts are either dispersed in less accessible publications, or have been described only in the 'grey literature' of institutional and consultancy reports. The authors state their first objective as collating as much as possible of this information into one source. In this they have been gratifyingly successful; scientists and students working in the region will find this an invaluable reference book.

If it was the harshness of the region's environment which hindered marine research, paradoxically it is this same harshness, with for example both very high and low water temperatures and salinities being recorded in the same or closely adjacent locations, that gives the region as a whole much of its interest. This gives the book one of its major themes. Climatic and geomorphological gradients and variation, which are described in the first section of the book, are related to the ecological and biogeographical patterns and trends that the second section considers in turn for each of the region's principal habitats and communities. It is the review of these patterns and other processes within intertidal and shallow-water ecosystems that is the second objective of the book. The main chapters resist the temptation to collate extensive species lists of uncertain value or interest, or to rely on comparison with accounts of similar habitats from outside the region. Rather they concentrate on emphasising previously little-appreciated patterns in habitat development and species composition.

The chapters by Charles Sheppard on 'Reefs and Coral Communities' and by Callum Roberts on 'Coral Reef Fish Assemblages' are most relevant in the present context. Sheppard provides the first comprehensive account of variation in reef distribution and development throughout the region and reviews ecological patterns in the coral fauna. Coral diversity is lowest in the Arabian Gulf and highest in the Red Sea, the latter having a particularly rich fauna even for the Indian Ocean region. In the Red Sea 13 coral assemblages may be recognised, the result of gradients from favourable to unfavourable environmental conditions. In areas where conditions are unfavourable, despite a low species diversity, coral cover may still be high.

Roberts' chapter on fish assemblages emphasises the discontinuity (occurring at about 20°N) in species composition and abundance evident in all dominant reef fish families. This matches the change in inshore environment from the well-developed reefs of the north and central Red Sea to the poorly developed reefs further south. Habitat change seems a likely explanation for differences in fish assemblages. However, other hypotheses are also considered depending on differential survival or distribution of larvae. Similarities in fauna of the Gulf of Suez and of a large sandy bay (Aynunah Bay) in the north-eastern Red Sea with reef fish assemblages of the southern Red Sea suggest habitat differences as a predominant factor, although Roberts favours an explanation based on larval processes. Clear patterns of variation in fish abundance and diversity with depth are also discussed.

The third section of the book, entitled 'Synthesis', draws together, in one chapter, biogeographic patterns frequently common to different habitats and communities and, in a second, patterns in ecosystem response to the extreme natural stresses of the region. Demonstration of the way in which the distribution patterns of different coral species, especially within the Arabian Sea and Gulf, appear to be controlled by gradients in extremes of salinity and temperature are especially interesting; recent work in Bahrain considerably extends the range of species known to tolerate high salinities, and three species live in salinities up to 50°/oo. Here especially the book lives up to its subtitle of *'Patterns and processes in extreme tropical environments'*.

The fourth section tackles the authors' third theme, that of the human use of the region's marine environment, and of its environmental consequences. Separate chapters consider fisheries, human uses and environmental pressures, and coastal zone management. The account based on Andrew Price's personal experience of the extent, apparent effects of, and management responses to the Gulf War oil spill (at 6 million barrels still the largest known) provides an interesting and topical finale to the work.

In summary, this is a stimulating and valuable book that all scientists and students of marine ecology are likely to find indispensable, both as a reference book summarising current ideas on the shallow water ecology of the region, and as a starting point for further investigation. The text is well and clearly written, and relevant data are summarised in clear and attractive figures. The single black and white photographs prefacing each section hint at the interest and diversity of the region; it is a pity that a series of colour plates could not have been included since they would have had scientific and educational value as well as increasing the attractiveness of the volume. This small reservation apart, the main weakness of the book is probably also its greatest strength. The authors assemble exciting new ideas on patterns and processes, but parts of the text are of necessity speculative, and sometimes discussion of alternative hypotheses seems protracted. But these ideas will give scientists and students plenty to get their teeth into and much to stimulate future research.

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DYNAMICS OF MARINE ECOSYSTEMS: BIOLOGICAL–PHYSICAL INTERACTIONS IN THE OCEANS

K.H. Mann and J.R.N. Lazier.

Blackwell Scientific Publications, Oxford, UK. 1991. ISBN 0-86542-082-3. £24.95, paperback.

Seldom does a book lives up to the publisher's hype. This one does. It synthesises advances in marine ecosytem research made by physicists, biogeochemists and biologists in the 1970s and 1980s into a coherent and proselytisingly interdisciplinary whole. The book is directed at readers with their roots in biology rather than physics and presentation of the physical side is fairly elementary, emphasizing important physical processes so that the biologist can understand how these influence biological processes. The presentation assumes a substantial knowledge of biology and concentrates on recent exciting developments particularly those cutting across disciplines. In an effort to make the physics more manageable and to stop it destroying the flow of the argument in the text, details of physical processes are separated off in boxes which can be sidestepped on initial reading and tackled piecemeal later. This works well and the contents of most of the boxes, unlike Pandora's, are found on opening to be innocuous.

The book is divided into 4 parts. Part A deals with processes operating on a scale of less than one kilometre and explores viscous boundary layers, turbulent motion, vertical structure and the influence of small-scale properties of seawater on the life of plankton. Part B deals with processes on a scale of 1-1000 kilometres and continues discussion of vertical structure providing a clear exposition of the physics of coastal upwelling. It also deals with fronts in coastal waters, tides, tidal mixing, internal waves and their biological significance. Part C explores processes on a scale of thousands of kilometres, discussing circulation of major ocean currents and complexities such as meanders, cold-core and warm-core rings, and mesoscale eddies. The El Niño-southern oscillation (ENSO), and its effects on primary productivity, zooplankton, fish stocks and coral reefs (finally getting a mention!) in the Pacific are also described.

There follows a timely exploration of the physical and biological roles of the oceans in global climate change. Coral reefs briefly feature in an all too brief discussion of the significance of biological fixation of carbon in calcium carbonate skeletons. Apparently over time volcanoes have released around 50 x 10^6 giga tonnes of CO_2 into the atmosphere and some 50 x 10^6 giga tonnes of carbonate sediments (and 20 x 10^6 giga tonnes of organic matter) have been deposited in the oceans. Without oceans to form these sediments, CO_2 concentrations would be so high that Earth would be as hot as Venus (+400°C), we are told. However, unfortunately alkalinity changes associated with $CaCO_3$ deposition increase the partial pressure of CO_2 in surface waters so that contrary to intuition reefs and the carbonate skeletons of planktonic organisms (e.g. coccolithophores and foraminiferans), although removing carbon, are not the sinks for atmospheric CO_2 we might at first think (Kinsey and Hopley 1991). I still have difficulty reconciling these scenarios of apparent historical alleviation of the greenhouse effect with present day aggravation of it or neutrality. Presumably it is all a question of time scales? Perhaps someone can explain what the various scales are.

Finally, Part D of the book looks to the future. As marine ecology comes of age as an integrated discipline, the authors see the search for a generalised theoretical framework revolving around three questions. 1. Is there a common mechanism to account for the occurrence of high biological productivity in a variety of physical environments? 2. To what extent are events in marine ecosystems determined by the physical processes? (Do physical factors feed fish?). 3. How can we develop concepts and models that span the enormous range of scales in marine ecology, from the microscopic to the global and from seconds to geological ages?

Throughout, the book is well-written and highly readable and, as the publisher's blurb says, 'captures the excitement of current developments in the field'. This latter quality is important as it is the one which is most likely to inspire the

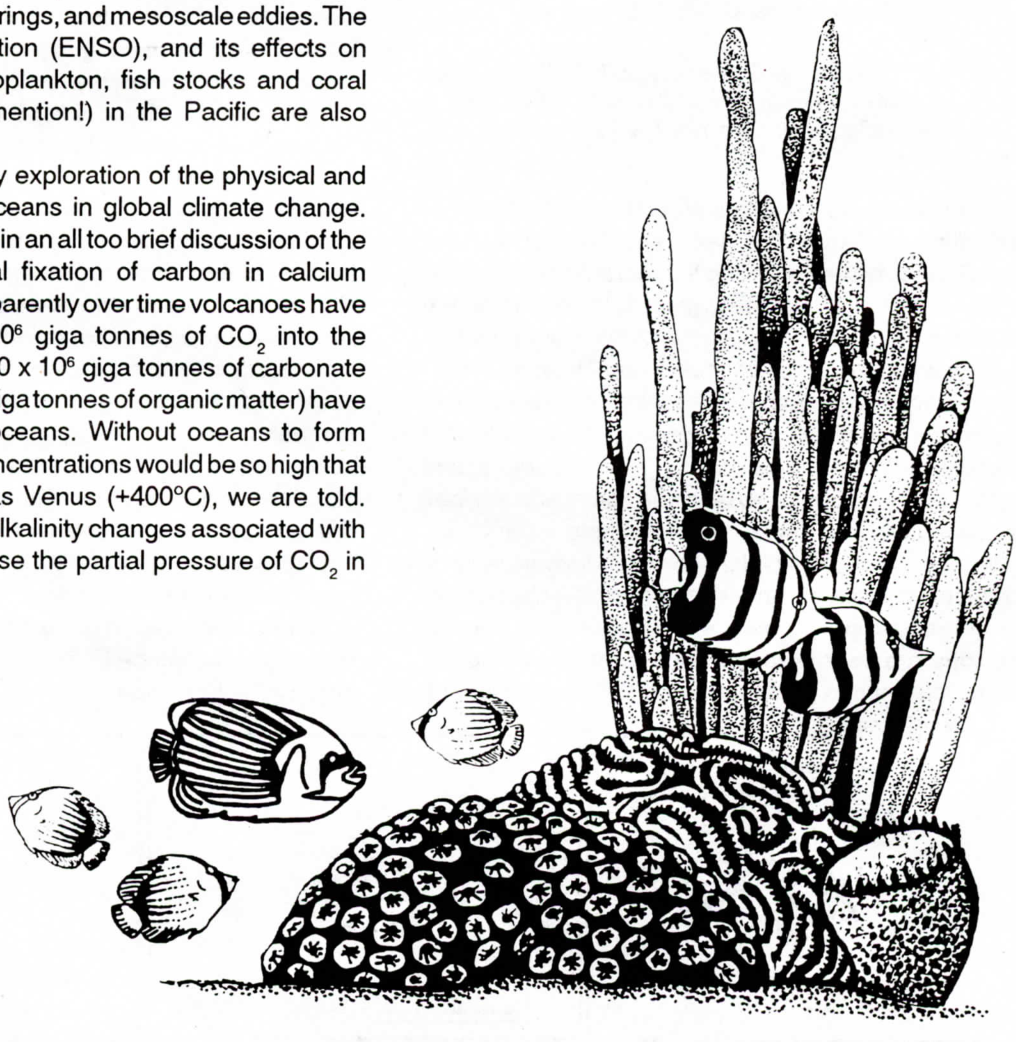
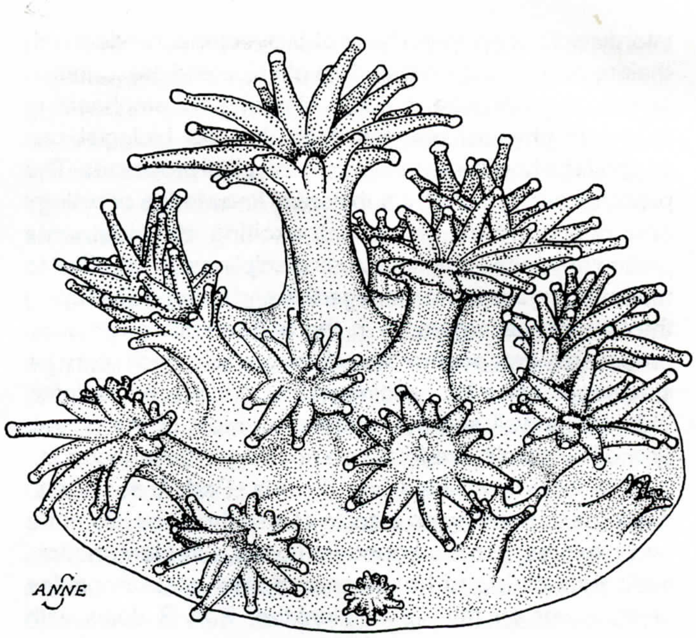


Figure borrowed from 'A National Coral Reef Strategy for Thailand' next generation of marine ecologists. The book plugs a gap in the college text-book market in its cross-disciplinary approach and I hope it will be widely adopted in marine biology and biological oceanography undergraduate courses to bridge the unfortunate divide which still tends to persist in the teaching of marine physics and marine biology. If this book cannot dispel the feeling prevalent among many marine biology students that the physics and chemistry of the marine environment are somehow peripheral to their primarily biological interests (where equations are an endangered species), nothing will. For professional marine biologists the book is a great broadener of the mind allowing relatively painless sorties into uncharted territories as and when desired.

Kinsey, D.W. and Hopley, D. 1991. The significance of coral reefs as global carbon sinks – response to Greenhouse. *Palaeogeog. Palaeoclimatol. Palaeoecol.* 89: 363-377.

Alasdair Edwards, Dept of Marine Sciences and Coastal Management, The University, Newcastle, NE1 7RU, UK. Fax: 91 222 7891.



CORALS AND CORAL COMMUNITIES OF ARABIA

C.R.C Sheppard and A.L.S. Sheppard

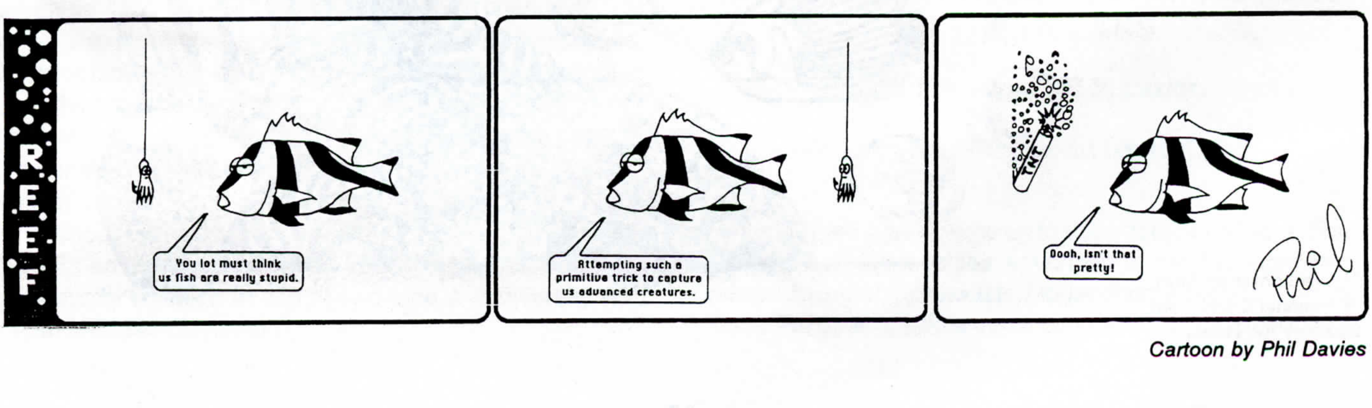
Reprinted from Fauna of Saudi Arabia *12:3-170. 1991. Copies available at a cost of £10 sterling from Dr Charles Sheppard, Dept of Marine Sciences and Coastal Management, The University, Newcastle, NE1 7RU, UK.*

Corals and Coral Communities of Arabia is exactly what reef scientists working in the Red Sea, The Gulf, and the Arabian Sea have been awaiting for years! At last we have a beautifully illustrated taxonomic guide to the region written by field biologists, who have supplemented toil over museum specimens with thousands of underwater observations.

All of the shallow water corals known from Arabian seas are described and illustrated: a total of 220 species. 212 black and white plates show detailed calice structure, and 117 colour photographs show what the corals actually look like underwater. The latter are extremely useful, nay essential, for accurate field identification. Making the jump from skeleton to live coral underwater has never been easy but is greatly simplified here. The genus and species descriptions are very readable, and after absorbing the additional information presented on distribution (obtained from 50,000 presence-absence records), habitat, depth range, and abundance, you begin to feel that you might now be able to accurately identify corals. As one who has tried, this is no mean achievement.

A useful appendix summarises the distribution data and, instead of long lists of synonyms, a few recent references are cited pertaining to the present name in use. Several species and genera are reinstated or newly described and synonymy is extended in many genera. In the past there has been much fiddling around with species designations, often based on remarkably few specimens. Since coral morphology is generally very plastic, the museum specimen approach sometimes results in a proliferation of species where only one or a few are present. The great strength of the revisions presented in this work is that they are solidly based on extensive field observations of corals under a wide range of conditions.

In addition to taxonomic work, the authors also address questions concerning coral community composition. Throughout the review particular emphasis is placed on the effect which environmental gradients have on coral morphology and ecology. The authors briefly outline the different reef systems and non-reef communities occuring throughout Arabia; and then go on to describe 13 basic coral communities identified using cluster analysis. Those wishing to see an even more detailed ecological treatment should refer to *Marine Ecology of the Arabian Region*, also reviewed in this issue.



Cartoon by Phil Davies

Since the Arabian area shows considerable taxonomic affinities with the Indian Ocean, the work will provide a very useful reference to people working throughout this region, and should be of general interest to all coral biologists. I highly recommend it.

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BOOK SHELF

MONITORING ECOLOGICAL CHANGE
Ian F. Spellerberg
Cambridge University Press, Cambridge, UK. 1991. 334 pp. ISBN 0-521-42407-0. £15.95 (paperback), £45 (hardback).

There is now great interest in monitoring amongst reef scientists and so Ian Spellerberg's book provides a timely overview of what the subject is about and how monitoring is being used. He explores these themes with copious examples, primarily from terrestrial disciplines but also including a few marine.

The first section of the book introduces local, national and international organisations involved in monitoring programmes. This followed by a review of ecological theory relating to sampling design and interpretation of results. The final section focuses on some important applications of ecological monitoring such as pollution control and conservation.

Although there is very little specific information about reefs this is a useful, well written, general text which should be of interest to anyone involved in monitoring studies.

WORLD ATLAS OF HOLOCENE SEA LEVEL CHANGES
P.A. Pirazzoli
assisted by J. Pluet
Elsevier Oceanography Series Volume 58, Elsevier, Amsterdam. 1991. 300pp. ISBN 0-444-89086-6. Price: US$ 100/Dfl 195.00.

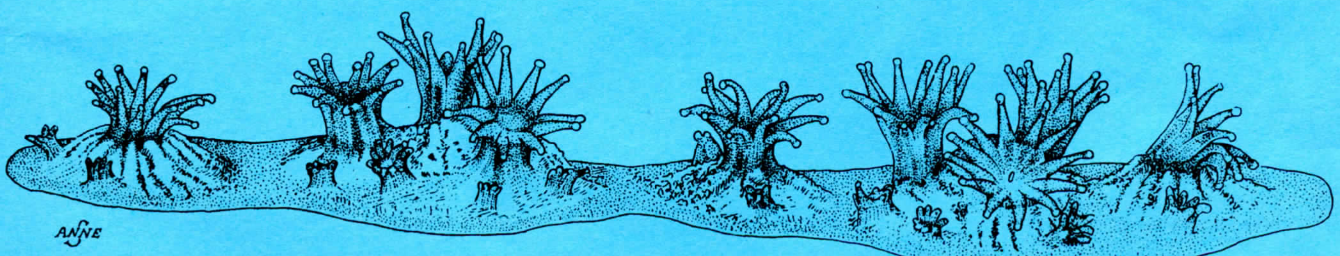
Changes in sea level throughout the Holocene are of particular interest to coral reef scientists and this book will be welcomed by the many who have wrestled with incomplete and scattered information in the primary literature. The atlas assembles some 800 local relative sea-level curves deduced from field data from thoughout the world and compares them with over 100 curves predicted by geophysical models. The data have been compiled into 77 regional plates, indexed geographically, each with 4-20 curves drawn to the same scale. The book concludes with a critical review in which improvements to methodology are outlined and future research directions suggested. The book should prove to be a valuable reference work for a wide variety of scientific pursuits involving coral reefs.

FISHES OF THE GREAT BARRIER REEF AND CORAL SEA
J.E. Randall, G.R. Allen and R.C. Steene
Crawford House Press, Bathurst, Australia. 1991. 508pp. ISBN 1-86333-012-7. Price: A$59.95. Available from the publisher at P.O. Box 143, Bathurst, NSW 2795, Australia. Fax: (61) 63 322654.

Here is a long-awaited identification guide to the fishes of one of the most diverse regions of the globe by two of the most respected coral reef fish taxonomists and one of the world's best underwater photographers. With such a combination of talent, who can fail to be impressed? The book covers 1,111 species, more than 90% of the Great Barrier Reef's known fish fauna. Most are illustrated with underwater photographs, and where possible, juvenile or sex-related colour phases are shown. Species for which there are no photographs available are shown in beautifully detailed paintings by Roger Swainston. Scientists beware: with the wealth of identification material presented here and in other recent books on fish there should be no excuse for getting species names wrong in future!

... A couple of days ago I read Reef Encounter for the first time and found it to be a brilliant source of information ... I'd like to apply for full membership of ISRS.

From the editors' postbag!



DAMSELFISHES OF THE WORLD

G.R. Allen

Mergus Publishers Hans A. Baensch, Melle, Germany. 1991. 271pp. ISBN 3-88244-008-2. Price: £33. Distributed by Aquarium Systems.

It may surprise some to learn that the best studied family of reef fishes has only now been given a full taxonomic treatment. However, the reality is that the vast majority of studies have covered only a tiny fraction of this highly diverse family. Gerry Allen's latest book builds on two earlier books he wrote on damselfishes: *Damselfishes of the South Seas* and *Anemonefishes*. It covers all of the more than 300 species of damselfishes described to date (including 16 new species). Most are illustrated in colour in underwater photographs but dead specimens are shown for a few and some are illustrated in paintings by Roger Swainston. Although species accounts provide only enough information for identification, text and tables elsewhere cover systematics, zoogeography, feeding habits, ecology, behaviour and notes for aquarists. Despite one or two inconsistencies between text and tables, the book is an excellent reference for everyone interested in damselfishes.

CRITIQUE FOR ECOLOGY

R.H. Peters

Cambridge University Press, Cambridge, UK. 1991. 366pp. ISBN 0-521-40017-1 Hardback, 0-521-39588-7 Paperback. Price: Hardback US$79.50, £45.00; paperback US$29.95, £17.95.

Here is a book to stimulate the critical faculties. Peters strikes at the heart of thinking in contemporary ecology with a clear and well-argued critique of the way in which ecologists do their science. The crux of the thesis presented is that science is a process used to reach conclusions about our world through prediction but that ecology generally lacks predictive power and therefore is unscientific. Peters reveals the weaknesses in the way ecologists think and in doing so shows how ecology can become a more useful science with which to tackle the huge environmental problems which face us now or loom in the future. Although directed at ecologists, this book has many lessons for those in other branches of biology and is a very worthwhile read.

NOTES FOR CONTRIBUTORS

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

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

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

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