



Member's report on activities to ICRI

Presented by Michael Schleyer, Oceanographic Research Institute, Durban, South Africa

Reporting period: October 2005 – September 2006

Summary of Activities

Background:

1. Background to the South African coral reefs is provided in a PowerPoint Presentation on the ICRI Forum. The reefs all fall within MPAs in a World Heritage Site, are marginal in nature and appear to be undergoing temperature-related changes in community structure. Limited coral bleaching has occurred. Their conservation status is thus not in question but they are manifesting the effects of climate change.
2. Research on the reefs has yielded considerable baseline information (outlined in summary below), such that a paradigm shift towards process-orientated research has become possible during the report period. A watershed has been reached in which the management implications of the results are being addressed in a current rezoning exercise. Biodiversity targets have been set and careful consideration is being given to reef connectivity in the delineation of extant and new sanctuary areas. One of the proposed sanctuaries will include coelacanths found in recent years in submarine canyons adjacent to some of the reefs.
3. Current reef monitoring will continue and proposals are under consideration to expand the studies to assess:
 - a. The extent and consequences of climate change.
 - b. Reef accretion versus bio-erosion.
 - c. Indicators of reef health.
 - d. Coral reproductive dynamics and the epidemiology of coral diseases.
 - e. Small-scale recruitment and large scale connectivity within the major reefs (including genetic studies).
 - f. Predictive spatial modelling of reef habitats and processes.
 - g. Variability in the fish communities.
 - h. Changes in community structure upon closure of reefs (sanctuary areas), and on the usefulness of artificial reefs (opportunistic studies).

Summary of pertinent points

Corals are found in South Africa primarily at the northern end of the province of KwaZulu-Natal, being central to the Maputaland reefs in the Delagoa Bioregion. They also occur in diminishing numbers in the Natal Bioregion, right into Pondoland (Celliers et al. submitted). All of the major coral reefs lie in marine protected areas (MPAs) within the Greater St Lucia Wetland Park (GSLWP), a World Heritage Site of great value and importance. They are nodes of biodiversity that are being subjected to increasing extractive and non-extractive recreational use. Over the past 15 years, South Africa has invested considerable research funding on the reefs. Geological surveys have been undertaken by Ramsay (1996) and are presented in detail by Ramsay et al. (2006). The Oceanographic Research Institute (ORI)

has played a leading role in biological studies on the reefs (Schleyer 2000; Schleyer & Celliers 2003a; Schleyer et al. 2000, 2006). Groundbreaking work has been completed on their biodiversity and they have been surveyed, mapped and zoned for potential use (Riegl et al. 1995; Celliers & Schleyer 2001; Schleyer 2000; Schleyer & Celliers 2005; Ramsay et al. 2006). Fundamental research has been undertaken on matters such as coral systematics, reproduction, distribution and settlement (Benayahu & Schleyer 1995, 1996, 1998; Glassom et al. 2006; Monniot et al. 2001; Ofwegen & Schleyer 1997; Kruger & Schleyer 1998; Kruger et al. 1998; Schleyer et al. 1997, 2003, 2004). Integrated monitoring was initiated early in the programme and has yielded valuable information on coral community dynamics, climate-related bleaching and reef oceanography (Celliers & Schleyer 2002; Schleyer & Celliers 2003a, b, c; Schleyer et al. 2005). Surveys on diver damage have resulted in guidelines on their sustainable diving capacity (Schleyer & Tomalin 2000). Comprehensive systematic studies have been published on the algae by the Universities of Cape Town and Ghent (Anderson et al. 2005) and limited work has been undertaken on the taxonomy of the sponges and ascidians (Monniot et al. 2001).

Our studies have led us to hypothesise the probable future of the South African coral communities in the face of climate change (Schleyer & Celliers 2003a). Corals in the western Indian Ocean (WIO) were particularly affected by El Niño Southern Oscillation-related (ENSO) bleaching (Rodrigues et al. 2000; Obura et al. 2004) and, in South Africa, sea temperatures have now attained the bleaching threshold (Celliers & Schleyer 2002). Our preliminary model suggests that global warming may initially encourage hard coral growth but will adversely affect the reefs in the long-term (Schleyer & Celliers 2003a). In the latter regard, ORI monitoring has revealed diminishing recruitment and increasing mortality (Schleyer & Celliers 2003a). As our coral communities are marginal in nature, they are likely to be more sensitive to climate change and provide a predictive insight to the global future of this fauna. Planned ORI research is thus expected to yield results both of national and international importance concerning the world's valuable yet diminishing coral resources.

In this regard, our studies on these resources have advanced to a point where modelling reef habitat, processes and connectivity has become possible within the context of climate and environmental change. Coral reef monitoring has been conducted on the reefs since 1993, focusing primarily on the consequences of global warming while simultaneously providing background information on representative reef condition. Process-based indicators of reef health are now needed for application on a wider spatial scale on the reefs in view of their increasing usage and of climate-related changes. In consequence, ORI is planning to take its studies into the next dimension, that of predictive modelling of the habitat, processes and dynamics on the South African reefs.

On the management side, biodiversity surveys have been completed on all the reefs in the GSLWP, a massive task that spanned seven years. These have provided the information needed on reef biodiversity and susceptibility to damage to develop a zonation plan for their sustainable use. The results indicated that, apart from obvious differences in their depth distribution, there are 18 distinct coral communities on the reefs that vary in a gradient from north to south. Recommendations were made on modifications to the current sanctuary zonation to meet the GSLWP biodiversity target, set at 40%, for the protection of representative communities. Usage zones were categorised from training and general diving areas to those suitable only for access by advanced and experienced divers, with appropriate diving limits. This information was shared with the conservation authority, Ezemvelo KwaZulu-Natal Wildlife (EKZNW), prior to completion of the integration process and salient results of the surveys were incorporated in a National Spatial Biodiversity Assessment. The combined data have also been incorporated with geophysical and socio-economic information into an interactive database (Ramsay et al. 2006), a product that will be invaluable for the conservation, planning and development of the GSLWP.

Current and completed studies are thus yielding results central to sustainable management of the reefs. Together with results of planned initiatives, they will contribute to habitat and

ecosystem models that will facilitate the development of conservation and management strategies for the reefs, including risk assessment. The combined initiatives will simultaneously contribute to the fulfilment of South Africa's commitment to international conventions such as the CBD, Nairobi Convention and Jakarta Mandate, while ensuring that it meets its obligations to UNESCO in terms of its World Heritage Act. The proposed work will also involve the use and further development of cutting-edge technology and increase South African capacity in these fields through student training.

References

- BENAYAHU, Y. & SCHLEYER, M.H. 1995. Corals of the south-west Indian Ocean II. *Eleutherobia aurea* spec. nov. (Cnidaria, Alcyonacea) from deep reefs on the KwaZulu-Natal coast, South Africa. Investigational Report, Oceanographic Research Institute, (68): 1-12.
- BENAYAHU, Y. & SCHLEYER, M.H. 1996. Corals of the south-west Indian Ocean III. Alcyonacea (Octocorallia) from Bazaruto Island, Mozambique, with a redescription of *Cladiella australis* (Macfadyen 1936) and description of *Cladiella kashmani* spec. nov. Investigational Report. Oceanographic Research Institute, (69): 1-21.
- BENAYAHU, Y. & SCHLEYER, M.H. 1998. Reproduction in *Anthelia glauca* (Octocorallia, Xeniidae). II: Transmission of algal symbionts during brooding of planulae. Marine Biology 131: 433-442.
- CELLIERS, L. & SCHLEYER, M.H. 2001. *Acropora hyacinthus* and *Acropora austera* dominance on a high-energy reef top at Kosi-Bay, South Africa. Coral Reefs 20: 244.
- CELLIERS, L. & SCHLEYER, M.H. 2002. Coral bleaching on high latitude marginal reefs at Sodwana Bay, South Africa. Marine Pollution Bulletin 44:180-187.
- CELLIERS, L., MANN, B.Q., MACDONALD, A. SCHLEYER, M.H. (submitted). Benthic survey of the rock reefs of Pondoland, South Africa.
- GLASSOM, D., CELLIERS, L. & SCHLEYER, M.H. 2006. Coral recruitment patterns at Sodwana Bay, South Africa. Coral Reefs 25: 485-492.
- KRUGER, A. & SCHLEYER, M.H. 1998. Reproduction in *Pocillopora verrucosa* (Scleractinia, Pocilloporidae) in KwaZulu-Natal, South Africa. Marine Biology.
- KRUGER, A., SCHLEYER, M.H. & BENAYAHU, Y. 1998. Reproduction in *Anthelia glauca* (Octocorallia, Xeniidae). I: Gametogenesis and Coral breeding. Marine Biology 131: 423-432.
- MONNIOT, C., MONNIOT, F., GRIFFITHS, C. & SCHLEYER, M. 2001. A monograph on South African ascidians. Annals of the South African Museum 108: 1-141.
- OBURA, D., CHURCH, J., DANIELS, C., KALOMBO, H., SCHLEYER, M. & SULEIMAN, M. 2004. Status of coral reefs in East Africa 2004: Kenya, Tanzania, Mozambique and South Africa. In: WILKINSON, C., ed. Status of coral reefs of the world: 2004, Vol 1: 171-183.
- OFWEGEN, L.P. van & SCHLEYER, M.H. 1997. Corals of the south-west Indian Ocean V. *Leptophyton benayahui* gen. nov. & spec. nov. (Cnidaria, Alcyonacea) from deep reefs at Durban and off the KwaZulu-Natal south coast, South Africa. Oceanographic Research Institute. Investigational Report (71): 1-12.
- RAMSAY, P.J. 1996. Quaternary marine geology of the Sodwana Bay continental shelf, northern KwaZulu-Natal. *Bulletin of the Geological Survey of South Africa* (117): 1-86.
- RAMSAY, P.J., SCHLEYER, M.H., LEUCI, R., MULLER, G.A., CELLIERS, L. & HARRIS, J.M. 2006. The development of an expert marine geographical information system to provide an environmental and economic decision-support system for coastal tourism and leisure developments within the Lubombo Spatial Development Initiative. DACST Innovation Fund Project – 24401 (REPORT), 93pp.
- RIEGL, B., SCHLEYER, M.H., COOK, P.J. & BRANCH, G.M. 1995. Structure of Africa's southernmost coral communities. *Bulletin of Marine Science*, 56: 676-691.
- RODRIGUES, M.J., MOTTA, H., WHITTINGTON, M.W. & SCHLEYER, M.H. 2000. Coral reefs of Mozambique. In: McCLANAHAN, T., SHEPPARD, C. & OBURA, D., eds. Coral reefs of the Indian Ocean: Their ecology and conservation. Oxford University Press, New York: 107-129.

- SCHLEYER, M.H., KRUGER, A. & BENAYAHU, Y. 1997. Reproductive strategies of South African corals: In: Proceedings of the 6th International Conference on Coelenterate Biology. Den Hartog, J.C. (ed.). The Leeuvenhorst-Noordwijkerhout, 16-21 July 1995. The Netherlands, Nationaal Natuurhistorisch Museum: 429-435.
- SCHLEYER, M.H. 2000. South African coral communities. In: McCLANAHAN, T., SHEPPARD, C. & OBURA, D., eds. Coral reefs of the Indian Ocean: Their ecology and conservation. Oxford University Press, New York: 83-105.
- SCHLEYER, M.H. & TOMALIN, B.J. 2000. Ecotourism and damage on South African coral reefs with an assessment of their carrying capacity. *Bulletin of Marine Science* 67: 1025-1042.
- SCHLEYER, M.H., BECKLEY, L.E., FENNESSY, S.T., FIELDING, P.J., GOVENDER, A., MANN, B.Q., ROBERTSON, W.D., TOMALIN, B.J. & VAN DER ELST, R.P. 2000. South African marine and estuarine resources: Status, trends and future potential. In: SHEPPARD, C. ed. *The seas at the millenium*. New York, Oxford University Press: 133-144.
- SCHLEYER, M.H. & CELLIERS, L. 2003a. Biodiversity on the marginal coral reefs of South Africa: what does the future hold? *Zoologische Verhandelingen*, 345, 387-400.
- SCHLEYER, M.H. & CELLIERS, L. 2003b. Coral dominance at the reef-sediment interface in marginal coral communities at Sodwana Bay, South Africa. *Marine and Freshwater Research*, 54, 967-972.
- SCHLEYER, M.H. & CELLIERS, L. 2003c. Coral reef monitoring in the Greater St Lucia Wetland Park. In: Wilkinson, C., Green, A., Almany, J. & Dionne, S. *Monitoring coral reef marine protected areas: a practical guide on how monitoring can support effective management of MPAs*. Australian Institute of Marine Science, Townsville & IUCN Marine Program, Gland: 14-15.
- SCHLEYER, M.H., REINICKE, G.B. & VAN OFWEGEN, L. 2003. A field guide to the soft corals of the Western Indian Ocean and Red Sea. Sida, Kalmar, Sweden. Illustrated CD with text.
- SCHLEYER, M.H., KRUGER, A. & BENAYAHU, Y. 2004. Reproduction and the unusual condition of hermaphroditism in *Sarcophyton glaucum* (Octocorallia, Alcyoniidae) in KwaZulu-Natal, South Africa. *Hydrobiologia* 530/531: 399-409.
- SCHLEYER, M.H., CELLIERS, L. & KRUGER, A. A decade of coral reef monitoring in South Africa: Implications and projections. 12th Southern African Marine Science Symposium, 4-7 July 2005, Durban, South Africa. Paper.
- SCHLEYER, M.H. & CELLIERS, L. 2005. Modelling reef zonation in the Greater St Lucia Wetland Park, South Africa. *Estuarine and Coastal Shelf Science* 63: 373-384.
- SCHLEYER, M.H., HEIKOOP, J.M. & RISK, M.J. 2006. A benthic survey of Aliwal Shoal and assessment of the effects of a wood pulp effluent on the reef. *Marine Pollution Bulletin* 52: 503-514.