

1000 tablets) and around 10 tins of Gamat oil per day (rising to 20–30 in December in the local holiday season). He employs around 15 staff members and has indicated his wish to export to other countries including Britain. The amount of Gamat imported from Adang does, however, raise serious questions as to the health of similar sea cucumber populations in Thailand.

There are numerous other smaller market outlets in Langkawi for Gamat products such as beche-de-mer, soaps, oils, lotions, water, toothpaste, tablets and cosmetics. In these forms they are offered as cures for such ailments as upset stomachs, diarrhoea, aches and pains, cuts and inflammation, ulcers, chest pain, asthma, impotence, relief of soreness after giving birth and the general 'feel good factor'. It is not our intention to test the validity of these claims. However, the University of Malaya tested 23 species of sea cucumber in a recent study (Anon. 1995), and found that one species from the *Stichopus* genus possessed pain-killing properties (lending possible verification of the purported properties of *Stichopus variegatus*). Water-soluble extracts of an active compound, when tested on laboratory mice were found to be more effective than aspirin and morphine and 6–8 times safer. An oil-soluble extract, when taken orally, including human consumption, was also found to be very effective in the treatment and healing process of wounds. The medications have been manufactured into syrup, ointment, and cream and tablets, and are still on trial.

It is uncertain, at present, what part overfishing has played in the decline of local sea cucumber populations. In Langkawi, for example, the specu-

lation is that overfishing has played a strong part in the decline of *Stichopus variegatus*. Other areas with established sea cucumber fisheries, such as the coastal waters of Sabah, will be surveyed and local fishermen and traders interviewed. It is thought that these waters may represent the main source of sea cucumber catches in Malaysia, and that Sabah itself may be an important centre for beche-de-mer trade. Over the period of research it is hoped that a clearer picture of market trading routes for sea cucumbers to and from Malaysia will be developed, with particular emphasis being placed on the trade in sea cucumbers that have originated in Malaysian waters.

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Sustainable management of the sea cucumber fishery sector in Madagascar

by C. Conand, M. De San, G. Refeno, G. Razafintseho, E. Mara & S. Andriajatovo

The history of sea cucumber exploitation in Madagascar and the problems of over-fishing were discussed in Bulletin No. 9 (Conand et al., 1997). Several programmes are under way, and the main results and prospects are addressed in this article.

In Madagascar, after reaching significant tonnages (nearly 600 metric tonnes (t), which represents more than 6000 t fresh weight) in 1991 and 1994, official trepang exports are showing a significant decline (Rafalimanana, 1997).

Other current indicators of over-exploitation are declining quality, a decrease in product size and value, and strong competition between collectors.

The sustainable development goal in national policy will require the whole sector, which is characterised by a multiple-level fishery, to be restructured, and the professionals, who are becoming a partner of government so as to introduce a system of industry control of exploitation, to organise themselves (Conand, 1997a, 1997b; Conand et al., 1997).

The sea cucumber sector in Madagascar and the various players involved in sustainable management

In Madagascar, this sector comprises five main levels as in other countries (Conand, 1997a):

1. The resource in its environment (species and stock assessment).
2. Harvesting by fishermen, which is generally carried out by hand, at low tide on the reef flats, or by free-diving (or even by scuba-diving, which is illegal but difficult to control).
3. Processing of the sea cucumbers, which may be carried out by fishermen or other people in the villages. Beche-de-mer processing greatly reduces length (by about 50%) and weight (by about 90%); a clear distinction must therefore be made in the statistics between catch figures and those corresponding to production or export of trepang.
4. Several other intermediate levels, with a variety of operators, including collectors, exporters, the national and regional governments (Fisheries Departments, Customs, etc.).
5. Export of products to international market places, then import by the consumer countries.

Concerning the resource itself, various species are collected in most tropical sea-cucumber fisheries, but the diversity depends on ecological conditions. Traditionally, a dozen species of high and medium commercial value are harvested, but with the increase in international demand and the growing scarcity of the resource, fishermen are now collecting other less valuable species (Conand, 1997b). In Madagascar, more than twenty species are collected; identification work should go ahead on an urgent basis (scientific names and vernacular names) in order to avoid confusion (Conand, 1997 and IH-SM report, 1996). This taxonomic work is essential in order to be able to formulate the study protocols.

The national PRE/COI/UE programme co-ordinating body in Madagascar (CN-MAD), with European Union funds, has helped the efforts of the Fishery Ministry and the profession, through a pilot operation to implement the sustainable management of sea cucumber resources. In order to reduce over-exploitation of sea cucumbers (extremely heavy at the current time), shared management of this resource is being introduced, involving the organised profession (exporters, harvesters), the fisheries administration, the scientific research interests and local communities; these have yet to get more involved through the research of a better quality of product and a more selective fishery. This operation could be extended to other countries in the area and other resources in cases where commercial pressure has adversely affected management methods, as for example shark fishery for dried fins, which are exported to the same markets, often by the same exporters.

The National Association of Sea Cucumber Producers (ONET) has now been legally established and has held its general meeting and regional meetings. Objectives have been set.

Sustainable management requires that scientific knowledge about the fisheries biology of the various species be acquired as quickly as possible.

Current progress on the various programmes

Research is currently being carried out by the Institute of Fisheries and Marine Sciences (IH-SM) of the University of Toliara and the Centre for Oceanographic Research in Nosy Bé (CNRO).

At IH-SM, a programme funded by the World Bank—BM/ONE/IH-SM—is now being completed. It will provide an update on fisheries in the Toliara region. It will also yield interesting information about catches and their variability, both spatially and in terms of species. R. Rasolofonirina (1997) has completed a post-Master's-level thesis on the fishery, ecology and biology of two commercial species, *Bohadaschia vitiensis* and *Holothuria scabra versicolor*. His results represent the first in-depth information about these species, as common as they are, and their fishery (see article in this Bulletin).

At CNRO, the PATMAD programme included a sea cucumber (*Holothuria scabra*) component.

Within the environmental programme (PRE/COI/UE) of the IOC (Indian Ocean Commission), the pilot operation of the Madagascar national co-ordinating body (CN-MAD) has targeted the integration of participants and, through this mechanism, the implementation of sustainable management techniques for this resource. The regional environmental programme intends to support the implementation of the following objectives:

- study of the current status of the resource by professionals;
- formulation of a monitoring and joint management system for this resource; definition of simple assessment method for the resource and its fluctuation, which could be used by professionals;
- support for the creation of a quality management manual for this product; and
- sea cucumber farming experiments.

This entire process is being carried out as a joint Administration/ONET operation with the involvement of field participants (technical departments, communities, local governments) in order to show the favourable effect of involving the players in sustainable management of the resource.

Plan of action

The various stages of implementation of sustainable management of the sea cucumber resource are now clearly identified and relevant. They have been defined for Madagascar, but could easily be transferred to the other countries in the region where necessary. Joint management, as a preliminary stage, is now effective; ONET functions.

The plan of action has four main components for gradual implementation; they are presented in a more-or-less chronological order:

1. Assessment and monitoring of stocks

Over-exploitation was noted on the basis of subjective observations. It is now necessary to mobilise the means needed to monitor the resource. This will be done in collaboration with scientists.

2. Production and export statistics

The complexity of this fishery system emerges here. Various proposals can provide the answer for monitoring. Some activities are already in progress, such as the Fisheries Service's historical survey, and the IH-SM work for the south-west region. Here again, it is necessary to introduce systems to monitor the amounts of sea cucumbers caught, processed and exported. These systems will be implemented in collaboration with the various participants.

3. Quality manual

As its need has become clearly apparent, this will be a basic tool for improving the quality of products and so controlling poor exploitation (harvesting of juveniles). Its production must be considered to be a priority issue, and it could be used on a regional basis.

4. Farming

In spite of the scarcity of information, this is a way to remedy over-exploitation, particularly evident through fishing for juveniles (Conand, 1997b). It is now necessary to undertake a feasibility operation. If the experiment gives good results, one activity, which has been postponed for the moment, should be envisaged, that is creation of a hatchery to provide juveniles in sufficient numbers for farming. This could also be of regional interest.

Conclusion

It is thus clearly apparent that this pilot operation has stimulated the interest of the professional and the Fishery Administration and has already given

tangible results. While the fishery is currently having problems world-wide (Conand, 1997b), Madagascar is one of the few countries where analysis of the 'fishery system' in its entirety has allowed a truly integrated activity to be planned; collaboration between the various participants is healthy and efficient.

This is in the context of a national industry, which, due to exports of processed products to international markets where they are re-exported to Asian consumers, is part of a world-wide 'sea cucumber system' of which various levels and participants are still inaccurately known. This system could be a good example of a multi-thematic and multi-disciplinary context of integrated management of a multi-specific resource. Better organisation has become necessary due to the urgency of activities needed to limit current over-exploitation. This will lead to sustainable protection of the resource and integrated management of the coastal zone. By providing a practical example of the relevance and efficiency of solving resource management problems, when there is very strong commercial pressure, through the industry itself, it could act as a model for the Indian Ocean region, as well as for other regions.

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