From hatchery to community – Madagascar's first village-based holothurian mariculture programme

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Abstract

In the region of Toliara (Madagascar), a novel partnership has emerged between local communities, non-governmental organisations (NGOs) and private sector stakeholders. The collaboration is working to pioneer a form of village-based mariculture in which hatchery-reared juvenile sea cucumbers are raised by coastal communities in simple sea pens. The present paper describes how partners are working to demonstrate the social and economic viability of a new model for alternative livelihood creation amongst coastal people in this impoverished region.

Introduction

The sea cucumber fishery plays an important role in the economy of Madagascar. In 2002 exports were valued at an estimated USD 3.1 million, representing about 2 per cent of the total export value of all marine resources (Rasolofonirina 2007). In the Toliara region (southwest of Madagascar), the fishery is a traditional activity (Rasolofonirina et al. 2004) that is very actively pursued (Rasolofonirina and Conand 1998) by coastal communities. For Vezo fishers who inhabit this region, the collection of sea cucumbers has become an integral component of local livelihoods and provides the primary source of income for a significant proportion of the population (McVean et al. 2005). The simple fishing techniques used, such as harvesting on foot or free-diving, require minimal material investment and ensure the equal participation of men, women and children (Pascal 2008).

Since the early 1990s, fisheries scientists and local communities in southwest Madagascar have witnessed a marked decline in the abundance of holothurians. Current signs of overexploitation include declining quality, a decrease in product size, the use of illegal material for harvesting (216 diving tanks were seized in 2002), the strong competition between collectors (Conand et al. 1998), the exploitation of fishing areas out of Malagasy waters (Rasolofonirina et al. 2004) and the collection of juveniles (Conand et al. 1997; Rasolofonirina 2007). This overexploitation of the resource is associated with a transition from a traditional or family-based fishery to an artisanal, semi-industrial fishery, driven by the increased international demand for trepang (beche-de-mer) and the scarcity of sea cucumbers in shallow waters (Rasolofonirina et al. 2004).

Overexploitation of holothurians has potentially serious adverse socio-economic and ecological consequences. At a community level the increasing scarcity of a high value export product would lead to increased poverty and instability in village communities that have gradually concentrated their activities around the exploitation of trepang (Rasolofonirina et al. 2004). From an ecological viewpoint, sea cucumbers are major components for sustaining coastal ecosystems in tropical areas, as ecosystems engineers that increase the structural complexity of the habitat and as macro-detritivores that consume various organic detritus (Coleman and William 2002; Rasolofonirina et al. 2004).

It is within this regional context that a novel partnership has emerged between local communities, non-governmental organisations (NGOs) and private sector stakeholders. The collaboration is working to pioneer a form of village-based mariculture in which hatchery-reared juvenile sea cucumbers are raised by coastal communities in simple sea pens. Partners are working to demonstrate the social and economic viability of a new model for alternative livelihood creation amongst coastal people in this impoverished region. If successful the project will mark an important transition from exploitation to husbandry of a critical marine resource. In the long term this initiative will also support the regeneration of natural populations.

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Development of holothurian aquaculture in Madagascar

The complex nature of holothurian fisheries makes the implementation of fisheries management measures difficult due to the numerous levels of the supply chain that require regulation. In Madagascar, holothurian fisheries management is exacerbated by inappropriate regulations, weak enforcement and inadequate collection and management of statistics (Rasolofonirina 2007). For this reason, sea cucumber aquaculture is currently considered to be the best solution to manage exploitation (Lavitra 2008). *Holothuria scabra*, also known as the sandfish, is one of the most economically valuable sea cucumber species. It is heavily exploited throughout the Indo-Pacific region for marketing in Asia (Rasolofonirina et al. 2005). It is a suitable species for aquaculture as it has a larval development that can be controlled and is tolerant of a range of environmental conditions (Hamel et al. 2001).

Madagascar was one of the first countries in the world to pioneer the hatchery technology to rear *H. scabra* and remains the only country in the Western Indian Ocean capable of culturing them. The project originated in Madagascar in 1999 with the launch of a sea cucumber mariculture project (Jangoux et al. 2001) funded by the Belgian University Cooperation for Development (Coopération Universitaire pour le Développement — CUD) and the government of Madagascar (Eeckhaut et al. 2008). The project linked scientists from two Belgian universities (Université de Mons-Hainaut and Université Libre de Bruxelles) and the Institut Halieutique et des Sciences Marines (IHSM) in Toliara. Over two main phases between 1999 and 2007 the project successfully developed the technology and the facilities (hatchery, nursery site and sea pens) to produce juvenile sandfish and grow them to commercial size.

In March 2008, the project evolved from its experimental roots into the commercial domain with the creation of Madagascar Holothurie SA (MHSA), the first private company based on sea cucumber aquaculture in Madagascar (Eeckhaut et al. 2008). The company was formed to incorporate representatives from the Belgian universities, the IHSM and Copefrito SA, a private fisheries collection and export company based in Toliara. The diverse actors within the new company provide the company with expertise in beche-de-mer production and export. The main objective of MHSA is to scale up the production of the current sea cucumber hatchery at IHSM and the nursery site at Belaza to commercial levels and produce 200,000 juveniles per annum over the next five years (Eeckhaut et al. 2008). MHSA identified the main bottleneck in the production of holothurians on a commercial scale as the limited space in artificial ponds. However, recognising the potential of the vast intertidal seagrass beds along Madagascar's southwest coast, coupled with the pressing need to provide viable alternative livelihoods for fishing communities, the company opted to collaborate with local NGOs to grow out sea cucumbers through village-based mariculture.

Launch of a village-based mariculture program

Two local NGOs, conservation group Blue Ventures (http://www.blueventures.org) and Trans'Mad-Développement (http://www.transmad.org), working in partnership with MHSA, have recently received support from ReCoMaP (Regional Programme for the Sustainable Management of the Coastal Zones of the Indian Ocean Countries) to develop holothurian mariculture as an alternative livelihood for communities in the region. During the two-year project, their role is to support and accompany the development of approximately 50 mariculture units along Madagascar's southwest coast. ReCoMaP funding will enable the NGOs to provide partner communities with the financial and logistical support to build and stock locally-owned pens to rear juvenile sea cucumbers purchased from MHSA to commercial size. By the end of the project, the objective is to establish the model and support mechanisms to enable the replication of this activity along the coast of Madagascar, involving new villages and community beneficiaries.

The two NGOs are operating in geographically distinct areas to ensure maximum spatial coverage for the project. Trans'Mad-Développement already runs projects in the marine domain in the Toliara region, including the establishment of a regional salt depot for iodisation (Co.Re.SEL) and the creation of a specialist marine college. For the pilot mariculture trials, the NGO has selected villages in the vicinity of Toliara, including Fiharenamasay and Andrevo-Bas to the north and Sarodrano to the south (Fig. 1). Selection criteria for villages have been based primarily on the availability of suitable grow-out sites for *H. scabra* in close proximity to the village.

Blue Ventures is based in the remote village of Andavadoaka, some 200 km north of Toliara. It works primarily in partnership with Velondriake (http://www.livewiththesea.org), a community association meaning 'to live with the sea' that unites 24 coastal villages grouped into three constituent geographic regions. Together they manage a network of community-run marine and coastal protected areas that were established in 2006 to protect over 800 km^2 of marine and coastal resources. In 2007, Blue Ventures commenced pilot studies to demonstrate the feasibility of holothurian mariculture in collaboration with IHSM, Copefrito, the Women's Association of Andavadoaka and the village of Ambolimoke. In

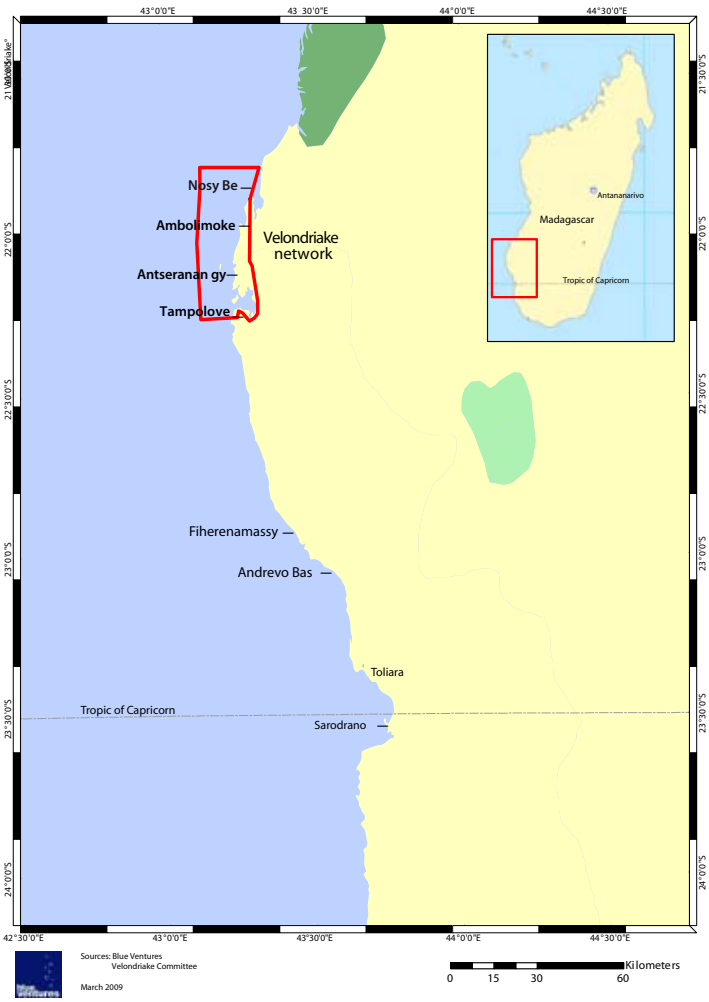

Figure 1. Locations of the pilot mariculture trials by Blue Ventures and Trans'Mad-Développement in southwest Madagascar. (Image: B. Pascal, Trans'Mad-Développement)

this new project with MHSA, holothurian mariculture will continue with the Women's Association and the villagers of Ambolimoke and will be expanded to the villages of Tampolove and Nosy Bé.

Technical and financial solutions

A number of different social models of ownership are being tested in the project including working with family lineages, associations, nuclear families and groups of families. A written agreement that specifies the conditions and responsibilities of each party is drawn up between each group and the NGO. The project aims to fund and obtain the start-up materials for a total of four pens per group and provide training and supervision to villagers during pen construction.

The pens are constructed from locally-available materials comprising nylon fishing net with a 10 mm^2 mesh, wooden stakes, and 2 mm and 4 mm rope (Figs 2 and 3). The two-meter-wide net is doubled and iron rebar is stitched into the base of the net, which is buried 25 cm deep in the sediment to prevent escape of juveniles.

The farming system has been designed to follow best-practice methods for aquaculture and simultaneously generate substantial revenues for the farmers. Different pen sizes of 12.5 m x 12.5 m and 15 m x 15 m are being tested, stocked with 300 and 450 sea cucumbers respectively. As sea cucumber growth is density dependent it is recommended that stocking densities should not exceed 2 individuals m^{-2} to allow for optimal growth (Lavitra 2008).

With financial support and technical guidance from partner NGOs, the farmers are able to buy batches of juveniles on credit from Madagascar Holothurie to rear in their pens (Figs 4–7). Once the sea cucumbers reach a commercial size of 300–350 g the adults are re-sold live to Madagascar Holothurie with the cost of the juveniles deducted. As the grow-out cycle of *H. scabra* is estimated to be 12 months, stocking and harvesting of the four pens will be spread throughout the year at three-month intervals.

This quarterly cycle of stocking and harvesting is intended to spread both the risks associated with the exploitation and the income generated from harvest evenly throughout the year. This strategy is also aimed at helping farmers understand the need for re-investment in order to pursue the activity in the long term once financial support has ended, when farmers will need to meet the costs of purchasing juveniles and maintaining pens independently of direct NGO assistance.

Although sea cucumber farming is a relatively straightforward activity requiring minimal labour and no input of additional feed, there are a number of regular supervision activities that need to be undertaken to assure maintenance of pens and security of the stock. Loss of individuals through theft currently poses a major risk to the project. Sandfish are a high value sea cucumber species and there are currently numerous beche-de-mer traders operating in the region. Locally, top-grade sandfish are valued at USD 2.5–3 per individual (Lavitra 2008); therefore for people in Madagascar, where 60 per cent of the population has an income level below USD 1 per day, poaching — even on a small scale — is a tempting prospect. For this reason, farmers are obliged to undertake nightly surveillance in order

Figure 2. Wild sea cucumbers drying in a Vezo village. (Image: B. Pascal, Trans'Mad-Développement)

Figure 3. The sea cucumber nursery at Belaza, southwest Madagascar. (Image: B. Pascal, Trans'Mad-Développement)

Figure 4. Hatchery-reared juvenile *H. scabra*. (Image: G. Robinson, Blue Ventures)

Figure 5. The Women's Association of Andavadoaka building their first pen. (Image: G. Cripps, Blue Ventures)

Figure 6. Commercial size *H. scabra* reared by the Women's Association. (Image: G. Cripps, Blue Ventures)

Figure 7. Families in Ambolimoke preparing nets and building their pens. (Image: G. Robinson, Blue Ventures)

to guarantee the integrity of their stock over the entire grow-out cycle. In addition, the pens require regular attention and maintenance, including the removal of predators such as crabs (*Thalamita crenata*) and sea stars (*Culcita* spp.), checking net integrity and removing net fouling to ensure adequate water exchange. However compared to the challenge of ensuring nightly surveillance these tasks are a small consideration. Monthly monitoring of growth rates is carried out at night during spring tides with the assistance of NGO workers to allow better understanding and evaluation of the factors affecting growth and mortality.

Conclusion

This new model for initiating community-based holothurian aquaculture in southwest Madagascar provides a novel approach to developing new alternative livelihoods for Vezo communities in the region. The project clearly has enormous potential for revenue generation for local communities and MHSA, however the initiative currently faces diverse challenges spanning a range of social, economic and biological issues.

Given the minimum 12-month grow-out time required to accrue the first economic benefits of this activity, it is necessary for families to continue their former daily working and economic activities in parallel with this mariculture initiative. As such the success of the project will rely on finding a means of effectively integrating this activity alongside current livelihoods in order that aquaculture tasks are not abandoned or neglected. It should be recognised however that this new venture is not intended to replace fishing, which remains critical to the subsistence needs of families. Rather, objectives for holothurian mariculture in the region are to provide a complementary activity, intended to provide communities with a supplementary source of income and to decrease the economic incentive of fishing.

In the long term it is hoped that the effective initiation of holothurian mariculture will slow the local overexploitation of wild stocks. This may come about as a result of income generated from mariculture activity reducing the need to exploit sea cucumbers as a cash commodity, as well as by farmed adults supplying recruits needed to replenish local fisheries. In southwest Madagascar, stocks of *H. scabra* are severely overexploited. Depletion of breeding adults may have already diminished the reproductive success of wild populations beyond the threshold needed for natural recovery. Studies from elsewhere in the Indo-Pacific region have postulated that the threshold for this so-called 'allele effect' for tropical sea cucumbers may be between 10 and 50 individuals ha^{-1} depending on species and location (Bell et al. 2008).

Research on the abundance and distribution of exploited holothurians carried out on Toliara's Grand Récif barrier reef in 1997 showed the average biomass of *H. scabra* in seagrass beds to be 3.774 kg ha^{-1}. These data indicate that even 10 years ago, wild stocks of sandfish were close to the threshold for the allele effect. As sandfish reach sexual maturity at a size of 150–200 g (Conand 1990; Hamel et al. 2001), the majority of sea cucumbers reared in pens will have the opportunity to reproduce before they are harvested at a size of 300–350 g. The pens therefore constitute a 'spawning biomass' of sandfish. The planned creation of 50 mariculture units along Madagascar's southwest coast will establish a network of protected spawning aggregations which may be of sufficient size and density to allow for successful reproduction and fertilisation of the species, thus providing a means of supporting recruitment for severely overexploited wild populations of *H. scabra*.

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