A multidisciplinary research program to ensure sustainable coastal livelihoods in Madagascar

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A multidisciplinary research partnership :

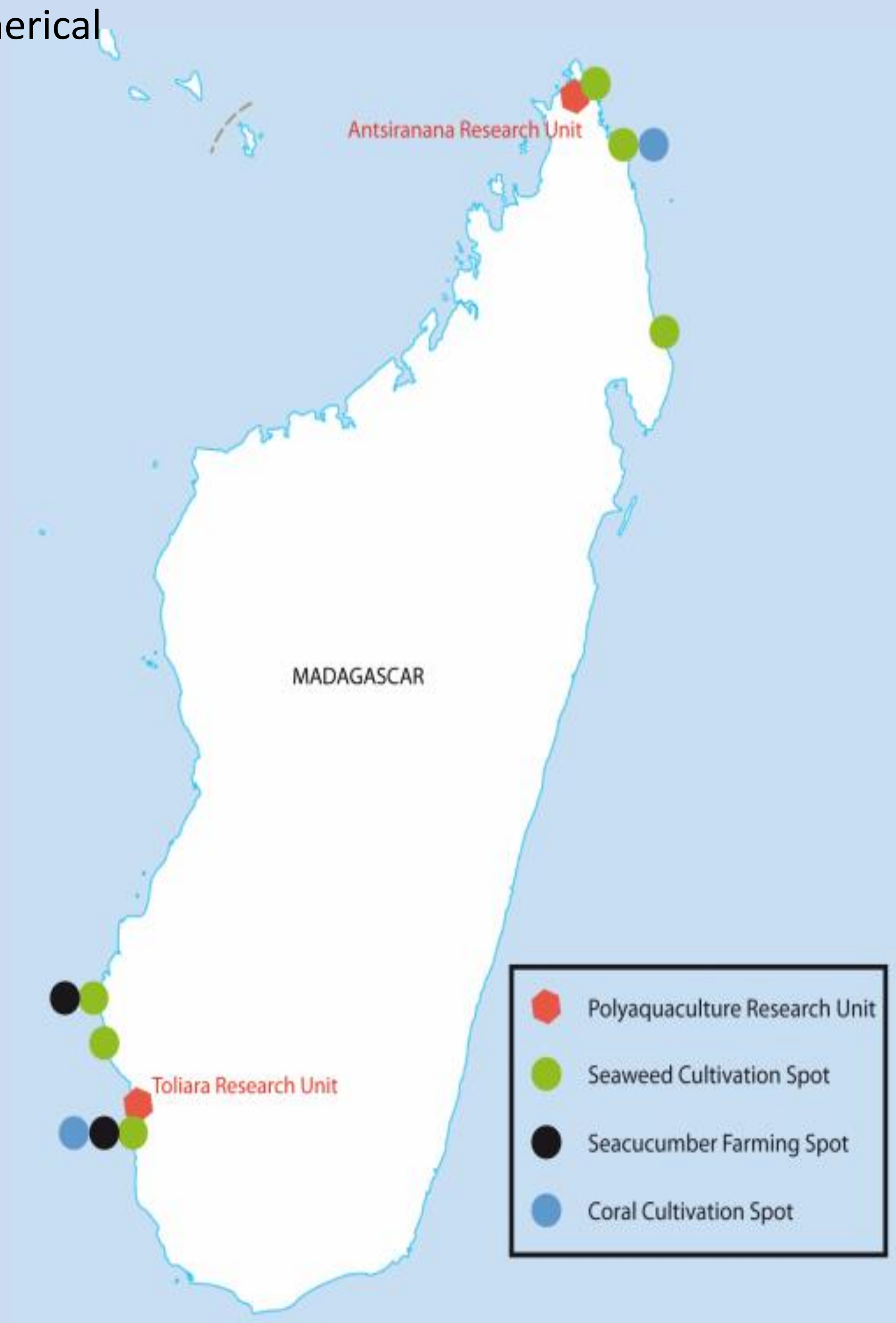
- 4-year programs financed by the ARES-CCD (Belgium)
- 3 Belgian universities, 4 laboratories :
  Lab. of Marine Organisms and Biomimetism and Lab. of Numerical Ecology of Aquatic Environment (University of Mons) ;
  Lab. of Marine Biology (Free University of Brussels) ; Lab. of Oceanology (University of Liège)
- 2 Malagasy universities : Université Nord d'Antsiranana ; Institut Halieutique et des Sciences Marines (University of Toliara)
- 2 PhDs and several Masters degrees in preparation
- Private sectors and NGOs fully involved

Objectives :

- Improve knowledge and identify solutions to problems facing emerging aquaculture sectors
- Develop know-how and national capacities to ensure and promote polyaquaculture at the village-scale
- Increase the potential of marine artisanal aquaculture development in the coastal zones of Madagascar
- Evaluate the possibility of combining seaweed farming with other mariculture (e.g. coral farming and/or sea cucumber)

Activities implemented :

- Creation of **2 Polyaquaculture Research Units** laboratories equipped for *ex-* and *in-situ* experiments (north and south of Madagascar)
- Multidisciplinary research and experimentation combining oceanology, marine biology and physiology, numerical ecology, genetics, histology, social sciences…
- Supervision of students and improvement of training on aquaculture topics
- Leading national multi-stakeholder aquaculture platform exchange and capitalization



Polyaquaculture Research Unit (PRU) :


Seaweed cultivation :



Holothurian farming :


Coral cultivation :

Main goals :

- Multiple types of physiology and farming performance
- Main disease etiology and means of disease control
- Survival and growth parameters and patterns
- Defining quality parameters
- Socioeconomic impacts (seaweed and sea cucumber farming)
- Socioeconomic and commercial feasibility (coral farming)

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A community based seaweed aquaculture, sustainable livelihood in the south western of Madagascar

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Faced to the depletion of natural resources (i.e. overfishing), fishermen's catches decreased gradually in coastal villages in Madagascar. As a sustainable alternative, coastal villagers in the south-western region of Madagascar practice aquaculture activities as sources of alternative income and to reduce the pressure on the ecosystem. Sea cucumber and seaweed farming are already in place in a dozen of villages. In particular, seaweed farming is a form of agriculture in the marine area. The seaweed cultivated is the red algae, species *Kappaphycus alvarezii* (**A**) or "cottonii" as a trade name. This species is a source of carrageenan, polysaccharides extracted from red seaweeds and widely used as thickeners and stabilizers in food, cosmetics, and pharmaceuticals.

The methods conducted for *K. alvarezii* farming were the "off-bottom" (**D**) and "long line" (**E**): "Off bottom" is the system in which seaweed lines (**B**, **C**) (a rope of 10 m length is tied to 50 seedlings of 100 g wet weight of algae, each placed at equal intervals of 20 cm) were attached to wooden stakes at each end and suspended about 60-80 cm from the bottom. Same seaweed lines were installed in the second system but the lines were attached to a rock at both ends. This second method use plastic bottles as floats to maintaining the seaweed lines level. Farmers harvest the algae around 40 days after planting (**F**). For drying, they spread the seaweed on the table exposed to the sun between 2 to 3 days (**G**). Impurities (salt and sands) on dry algae were removed before storing them in bags (**H**). Then, the company weighs and buys the dry seaweeds before preparing the ultimate bags for export (**I**).

A: *Kappaphycus alvarezii*

B: Seedling preparation

C: Seaweed line with seed

D: Off-bottom system

E: Long line system

F: Transport of the harvested seaweed

G: Drying seaweed on tables

H: Bagged by the farmers villagers

I: Exportation preparation (company)

IH.SM - CUD - UNA Polyaquaculture Research Unit UMons - Ulg - ULB

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Sea cucumber farming : an ecological aquaculture for the sustainable development of costal populations of Indo-Pacific Ocean

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The holothuroids

The holothuroids or sea cucumbers are animals from the phylum of echinoderms found in every ocean at any depths. They have important ecological and economical interests :

- As the main coastal macro-deposit feeders, they are important actors of bioturbation of marine sediments. They play a key role in their biotope and their disappearance could lead to major problems.

Figure 1: Fishermen collecting sea cucumbers

Figure 2: The dried and smoked sea cucumbers, called trepang

- More than fifty species of sea cucumbers present a commercial interest as comestible species. As a first step, they are collected by fishermen and then their tegument is transformed in a dried and smoked form called trepang. This preparation is particularly appreciated by the Asian population where it is considered as a delicacy with various properties like anticancer, aphrodisiac and many others. As for now, 80 000 tons of sea cucumbers are fished every year and a good quality trepang can be sold at more than 400€ per kilo in Hong Kong and Shanghai. The Asian demand for these products increases more and more since the 90's and, as a consequence, the natural populations are in danger of disappearance all over the world and even more in Madagascar where an important part of the population depends on sea products. A real challenge was thus highlighted in this country and the goal of this research consists in resolving this ecological problem without putting the local population at a disadvantage.

The sea cucumber farming

The sea cucumber farming started some decades ago in the Indo-Pacific Ocean trying to create an ecological, social and economicaly viable alternative to the traditional fisheries. The most commonly farmed sea cucumber species under the tropics is *Hothuria scabra* , a widespread species with a high commercial value. The farming consists in the obtaining of juveniles sold to the local population in charge of animal's growing until marketable size. This aquaculture is ecologically sustainable because no inputs are necessary : no food is supplied to sea cucumbers which feed on organic matter found within the sediment. Moreover, it implies local fishermen during the last phases of growing, insuring an income for the particularly poor population.

Figure 3: H.scabra

The company IOT (Indian Ocean Trepang) in Toliara, Madagasdcar

In 1998, the Universities of Mons, Brussels and the « Institut Halieutique et des Sciences Marines » of Toliara in Madagascar (IHSM) collaborated for the creation of the sea cucumber farming thanks to the financial support of the ARES-CCD and authorities of Madagascar. The first step consisted in the creation of a hatchery to produce sea cucumber juveniles. Its activity started in 2003. The second step lead to the creation of pilot farm to obtain marketable sea cucumbers. The installation occurred in Belaza, at 20 km south of Toliara, in order to satisfy the ecological needs of the species. Thanks to the ARES-CCD, the Spin-Off Madagascar Holothurie S.A. emerged. Now, a company was created from this spin-off called Indian Ocean Trepang (IOT). They can produce more than 100.000 juveniles per year which are distributed to the local populations. The final objective is the production of 1000.000 animals.

The sea cucumber farming can be summarized in 4 steps :

1

Larvae obtaining
Thanks to *in vitro* fertilization and thanks to a molecule allowing oocyte maturation

2

Larvae metamorphosis into epibenthic juveniles
(length: 2cm)

3

Pre-growing stage:
Individuals grow until 6 cm and become endobenthic : they are transferred in protected external ponds filled with sediment

4

Growing stage:
Individuals bigger than 6 cm length are placed in natural fenced areas on sediment in order to achieve their development. Malagasy's farmers are trained to obtain this skill.

Figure 4: Hatchery
Figure 5: External pond
Figure 6: Ladies collecting sea cucumbers

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Coral farming in Sarodrano (South-western Region of Madagascar): the first experimental cuttings

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ABSTRACT

Coral farming is an almost new form of aquaculture in Madagascar. In the South –western region, no village's community,no private nor public society has tried to practice the coral farming. However, in Sarodrano village, where algae and sea cucumber farming are developed, a research project is undertaken within the "Polyaquaculture Research Unit" (PRU) in order to check out the feasibility and to develop this new form of marine farming. Two iron coral farming tables have been tested to support 104 coral fragments set as cuttings. 58 coral cuttings on the first table were exposed to air (emerged) for about 5 to 10 minutes and 44 coral cuttings on the second table were exposed to air for less than 1 minute (time to fix the cuttings on their support). Coral species of *Acropora* were used for this first experiment. Physical and chemical parameters (temperature, luminosity, salinity and pH) of the water were regularly measured to find out their correlation with the survival of the corals. And any observation about disease and/or mortality is made during in-situ observations. Preliminary results show that the coral cuttings that have been exposed for more than 5 minutes were stressed (started to bleach) during the 2 first weeks, and those which has not been long exposed were not bleached. But the corals of the first table started to recover few days after launching and continue to grow. Only 4 and 3 coral cuttings (respectively) were dead after few days because of the failure of the support system. This study is continued with special focus on the measure of the stress of the cuttings using photosynthesis yield analyzer.

Fig. 1: fixation of the coral cuttings

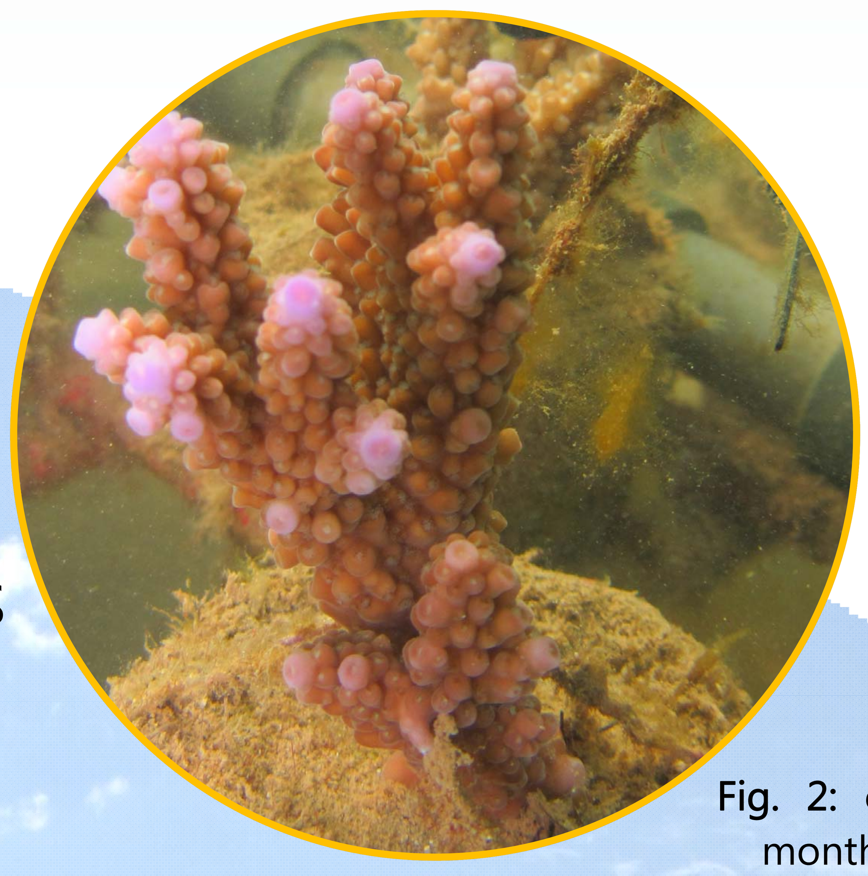

Fig. 2: cutting after 3 months

Mariculture site

- Sarodrano (coral reef of Belaza) (23°30'19.7"S 43°44'29.5")
- Depth: 1 m at low tide (of high tide)
- Current: tidal current

The first experimentation method

- Used species: *Acropora nasuta*
- 2 Metallic coral farming tables with 58 and 44 cuttings each
- Coral cutting (fragment) support: cement
- Fixation of the cutting: nylon wire
- The first group of cuttings (58) was exposed to air for 5 to 10 minutes during their fixation to the support, and the second for less than one minute

Temperature and light

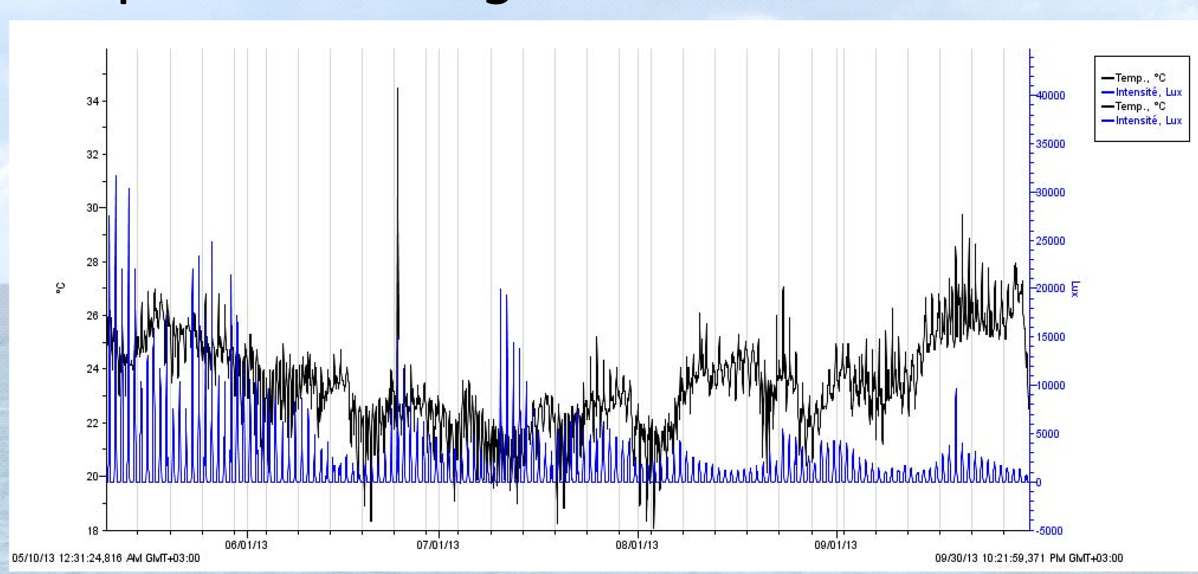

Fig. 4: temperature and light intensity variation at the experimentation site

Temperature vary from 18°C to 28°C during the experimentation
Light intensity vary from 0 lux (night) to 30 000 lux (Noon)

The scientific project

- A Polyaquaculture Research Unit with scientific staff (PhD students, technicians, Scientific supervisors, Scientific collaborators)
- A partenarship with villagers (Sarodrano as a pilot village for village based aquaculture) and private societies and NGOs as well

Objectives:

Find out the potential of village based coral farming in the South-western region of Madagascar

Fig. 3: cutting after 5 months

Survival of coral cuttings

- Cuttings that have been exposed for more than 5 minutes were stressed (started to bleach) during the 2 first weeks, not the others. But the recovery was quick after that duration, and any mortality due to the method has been observed.
- During the cool period (June-July), some filamentous algea grow and cover tables and corals. But with a little maintenance, and the help of the current, cuttings continue to grow without stress.
- Observed mortality of some coral cuttings is due to failure of the support system. Only cuttings which fall down to the substrate bleach and dead without maintenance.

Main focuses

Correlation between coral stress and growth and the water conditions.
Effect of the used system and method on the coral growth
Experiments continue with improvement of the system and the used method

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YSO Young reSearchers Organization MADAGASCAR

WIOMSA Western Indian Ocean Marine Science Association