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Author(s)	Bourdeix, Roland, Johnson, V., Baudouin, L., Tuia, V. S., Kete, T., Planes, S., Lusty, C., Weise, S.
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Polymotu: A new concept of island-based germplasm bank based on an old Polynesian practice

Roland BOURDEIX[1], V JOHNSON[2], L BAUDOUIN[3],
V S TUIA[4], T KETE[4], S PLANES[5], C LUSTY[6] and S WEISE[2]
1. Cefe (Centre for Evolutionary and Functional Ecology), Cirad and Bioversity International, Montpellier, France 2. Bioversity International, 3. French Agricultural Research Centre for International Development, 4. Secretariat of the Pacific Community, 5. Criobe (Centre de Recherches Insulaires Observatoire de l'Environnement) , 6. Global Crop Diversity Trust
roland.bourdeix@cefe.cnrs.fr

ABSTRACT

The Poly*motu* concept (*poly=many, motu=island*) is to use the geographical isolation of special sites for conservation and reproduction of individual varieties of plants, trees and even animals. This concept is mainly derived from previous initiatives in conservation of coconut palms by ancient Polynesians and some contemporary Thais. A quite similar concept has also been used by New Zealanders for conservation of endangered bird species. For instance, when a small island is planted with only one variety of coconut palms, breeding occurs only within this variety and certified seednuts are naturally produced. Conservation is secured by both the geographical isolation of the islands and the availability of certified seednuts. In 2009, the Poly*motu* concept was included in the global coconut conservation strategy developed by the International Coconut Genetic Resources Network (COGENT) and the Global Crop Diversity Trust. It moves this global strategy towards the involvement of more countries, sites and stakeholders. The Poly*motu* concept was enriched in 2010 during a visit in Samoa, in order for farmers to diversify their genetic resources and increase their incomes. We are presently launching initiatives to develop Poly*motu* in various regions: the Kepulauan Seribu National Park at the north of Jakarta, Indonesia; the Fakarava biosphere reserve and the Tetiaroa atoll in French Polynesia, Fiji and Samoa. Factors influencing the acceptance of Poly*motu* by the various stakeholders are discussed, together with collaborative research to be conducted during implementation of the projects. This paper discusses the origins and precursors of the Poly*motu* concept; presents the firsts initiatives to launch research actions linked to the Poly*motu* project, and discusses the need for further research to fully implementation this concept.

***Key words*:** Biodiversity, Coconut palm, Conservation, Islands, Germplasm bank

INTRODUCTION

The Poly*motu* concept (*poly=many, motu=island*) is to use the geographical isolation of dedicated sites for conservation and reproduction of individual varieties of plants, trees and even animals. This concept is derived from previous initiatives in conservation of coconut palms by ancient Polynesians and contemporary Thais. A quite similar concept has also been used by New Zealanders for conservation of endangered bird species. For instance, when a small island is planted with only one variety of coconut palms, breeding occurs only within this variety and certified seednuts are naturally produced[1]. In this case, both the geographical isolation of the islands and the availability of certified seednuts secure conservation.

The Poly*motu* conservation concept fits into a multifunctional land management policy. Many different locations can be used for conservation of genetic resources and even seed production as far as they meet the specific criteria required for biological and reproductive isolation[2]. These dedicated sites can be small islands owned by communities or private individuals, public gardens, university campuses, golf courses, the backyards of resorts or research centers, or the bottom of small valleys. Even an entire village may well serve as a place for conservation of genetic resources and seed production of coconut, if people agree to cultivate only a well-defined set of cultivars. This kind of multifunctional land management strengthens the links between people, landscape and biodiversity. It gives a special cachet to the sites, generates incomes and promotes ecotourism activities.

In this paper we will first discuss the origins and precursors of the Poly*motu* concept; then we will present the firsts initiatives to launch research actions linked to the Poly*motu* project. Research needed for the full implementation of the concept is also discussed.

ORIGINS AND PRECURSORS OF THE POLYMOTU CONCEPT

The geographical remoteness of small islands and other isolated sites can be used as a great advantage in the strategies for conservation of biodiversity. This section shows that this idea was already applied long time ago, in an empirical

[1] *Cocos nucifera* L. is mainly a cross-breeding (allogamous) species. Breeding coconut palm is indeed a difficult task. When selecting a coconut as planting material, you generally know which the mother is; but you do not know which the father is, as the pollen comes from any of the surrounding palms.

[2] For the coconut palm, one of the possible landscape design is any place where can be planted 50 to 100 coconut palms from the same varieties (1 to 3 varieties could be planted together) with no other coconut palms at a 500 m distance all around, or uniquely coconut palms from the same varieties. Various species can be conserved at the same location, but the designs will need to be adapted according to the biological requirements of each one.

manner, by the ancient Polynesians. Then two modern examples of use of conservation, using geographical isolation will be discussed.

POLYNESIAN TRADITIONAL CONSERVATOIRES

The oldest description of coconut varieties in French Polynesia can be found in the book "Ancient Tahiti" by Teuira Henry, published in 1928 from data collected by her grandfather in 1840. Teuira Henry reports that the Tahitians knew of the existence of particularly enormous coconuts growing the island of Niu-Fou (now known as Niuafo'ou). Niuafo'ou Island means "New coconut". It is a remote and tiny island in the Tonga group, with an area of 52 sq. km. It is located at 200km from the nearest island and at 2800 Km from Tahiti. Niuafo'ou is a very active volcano that slopes steeply down to the sea floor[3]. There is no safe anchorage for boats. The repeated eruptions of volcano [4] caused the destruction of many plantations and villages.

Another example of traditional conservatoire also comes from Tonga. In the 2000's, we visited numerous Pacific island in the framework of surveys organized by Bioversity International (formerly IPGRI). L. M. Fili and T.H. Hoponoa, from the Ministry of Agriculture and Forestry of Tonga, tell us about the traditional coconut variety called *niu utongau*. This variety belongs to rare forms of coconut, highly threatened, and known as « Sweet husk »[5]. In most coconut, this husk is harsh and not edible. But sometimes, the whole husk of the young fruit is sweet and can be chewed like sugar cane. Its taste resembles that of coconut heart. Once the fruits are ripe, the husk fibres are white and thin. There exist various names and various types, in which husk characteristics are more or less accentuated. Those varieties have yet to be scientifically described. The *niu 'utongau* coconut variety can be found in quantity only on the small coral islet of Onoiki in the Ha'apai group. Tongans are still sometimes taking seedlings from that islet, which is so small that it does not appear on most maps.

Another isolated place famous for its coconuts is Rennell, a high volcanic island located in the Solomon archipelago, with an area of 660 sq. km. Its two main features are its volcanic lake, now registered as a world heritage, and its Polynesian population, when other Solomon Islands are mainly populated with

[3] Given its unusual geography, Niuafo'ou was named « Tin can island », because of a strange way of receiving its postal communications was adopted. The mail was cast into the sea in a tin box and recovered by men in pirogues.

[4] In 1867, 1886, 1912, 1929, 1935-36, 1943, 1946, and 1985

[5] The coconut husk is the fibrous layer forming a strong, shock-absorbing mesh witch protects the seed from mechanical damage. Sweet husk varieties are described in the book « Ancient Tahiti » by Teuira Henry, and in the book « By Reef and Palm » published by Louis Becke in 1894 : « The boy returned with a young coconut, unhusked. "Behold, Tialli. This nut is a UTO GA'AU (sweet husk). When thou hast drunk the juice give it me back, that I may chew the husk which is sweet as the sugar-cane of Samoa," and he squatted down again on the gravel. »

Melanesians. Except the small island of Bellona, also populated with Polynesians, the distance from Rennell to the nearest island is 170 km.

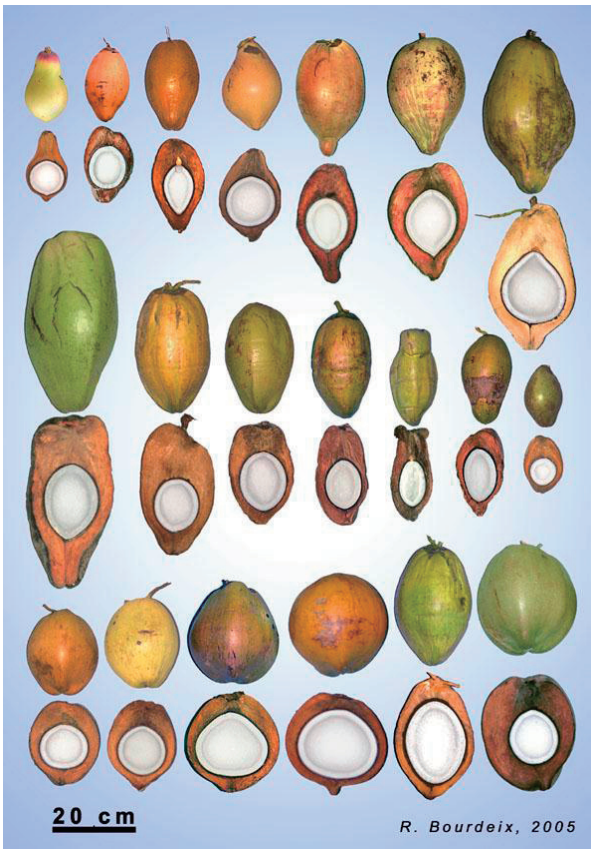

Fig. 1. Genetic diversity of the fruits of various coconut varieties (Bourdeix et al. 2005). From left to right, then top to bottom: First rank: Papua Yellow Dwarf (PNG), Tahiti Red dwarf (French Polynesia), Madang Brown Dwarf (PNG), Cameroon Red Dwarf (Cameroon), Spicata Tall Samoa (Samoa), Rotuman Tall (Fiji), Rennell Tall (Solomon Islands); Second rank: n*iu afa* Tall (Samoa), Comoro Moheli Tall (Comoro Islands), Sri Lanka Tall Ambakelle (Sri Lanka), West African Tall Akabo (Côte d'Ivoire), Tuvalu Tall Fuafatu (Tuvalu Island), West African Tall Mensah (Côte d'Ivoire), Micro Laccadives Tall (India); Third rank: Vanuatu Tall (Vanuatu), Malayan Yellow Dwarf (Malaysia), Malayan Tall (Malaysia), Tagnanan Tall (Philippines), Tampakan Tall (Philippines), Kappadam Tall (India).

The fruits of the variety known as Rennell Island Tall (RIT) are among the biggest coconuts in the world[6]. RIT is now involved worldwide as parental material in many coconut breeding programmes[7].

The role of the Rennell Island as traditional conservatoire is not proven, as we did not record the information that other islanders use this place for exporting coconut seednuts. Anyway, the Rennell Lake is an example of a remote location conserving a unique coconut variety[8].

1.1 MODERN USE OF ISLAND GEOGRAPHICAL ISOLATION FOR PALM CONSERVATION

In Thailand, two islands were recently devoted to conservation and production of palms varieties. The opportunity to create a Makapuno Island in Thailand was seized 25 years ago, when the Thai government built the huge Srinakharin dam at Kanchanaburi, near the Burmese border at about 200 km North-West from Bangkok. The hills were submerged and their peaks turned into islands.

Makapuno is an economically important coconut variety. Instead of coconut water, this coconut contains a soft, white jelly-like mass which is considered a delicacy. Makapuno is preserved in heavy sugar syrup and bottled for local consumption and export. One of the islands was then planted with Makapuno embryos rescued by using *in vitro* culture. All the other coconut trees removed. No stray coconut pollen can reach the island of the because of the distance across the water barrier.

Another island on the same lake was designed for producing oil-palm seeds. As this island is completely isolated from any other pollen source, there is no need to bag the inflorescences for producing seedlings. This generates subsequent economy of manpower. During our 2010 visit, we made the remark that, according to the Poly*motu* concept, producing Makapuno coconut and oil-palm seeds could well be conducted on the same island. Furthermore, Makapuno Island is a great success story: it is a profitable business, its

[6] The fruit shapes are quite variable, from oblong to pear shaped. Some of the fruits have a long nipple at the bottom, which is very specific to the RIT. The fruits have a good composition with a high content of solid albumen and free water.

[7] RIT variety is now available in Brazil, Côte d'Ivoire, Fiji, India, Indonesia, Jamaica, Papua New Guinea, Samoa, Solomon Islands, Tanzania and Vanuatu. The coconut hybrid Malayan Red Dwarf x RIT is planted in many countries in the Pacific region. In Vanuatu, the hybrid between the Vanuatu Tall and the RIT is currently being improved. In Côte d'Ivoire, all the tall cultivars introduced are systematically crossed with the RIT. One of the two improved hybrids currently distributed to farmers is the cross between the Cameroon Red Dwarf and RIT.

[8] M.A. Foale, who visited the Rennell Island in 1964, said that the true-to-type Rennell, with big and pointed fruits, is found only around the volcanic lake on the eastern part of the island. The access from the coast to the volcanic lake is very difficult. It is needed to climb a rocky track with a hard slope, in a forest stuffed with endemic species of poisoning snakes (Laticauda sp.). But in other places, such as the coastal area, there is a mix between the Rennell Island Tall and the ordinary type, known as the Solomon Island Tall, which has smaller oblong fruits.

conservation and ecotourism values are huge; and last but not least, it could also lead to a major improvement of the Makapuno coconut variety[9].

1.2 MODERN USE OF ISLAND GEOGRAPHICAL ISOLATION FOR ENDANGERED BIRDS

We discussed Poly*motu* concept with Dr Jean-Dominique Lebreton, the director of the Centre for Functional and Evolutional Ecology at Montpellier, France. Then Dr Lebreton made a very interesting connection between Poly*motu* and what is achieved in New Zealand in the field of conservation of endangered birds. Translocations involve moving populations of threatened species into areas of suitable habitat currently unused by the species. There are several reasons for doing this; the creation of secondary populations that act as an insurance against disaster, or in many cases threats faced by the original population in its current location.

One famous translocation was of the Kakapo bird (*Strigops habroptilus*) from New Zealand. The kakapo is an endemic, large, flightless, nocturnal parrot. Once abundant throughout New Zealand, the whole population in the wild was reduced to approximately 50 individuals. In situ conservation of natural populations has proved impracticable. These large flightless parrots were unable to cope with introduced predators, such as rats and cats in their remaining habitat on Stewart Island. Between 1974 and 1992, kakapo birds were translocated to four of New Zealand's offshore islands (Maud, Little Barrier, Codfish, and Mana). Few, if any, kakapo now remain within their former range.

2. IMPLEMENTATION OF THE POLYMOTU CONCEPT

In 2009, the Poly*motu* concept was included in the global coconut conservation strategy developed by the International Coconut Genetic Resources Network (COGENT) and the Global Crop Diversity Trust. In classical coconut genebanks, coconut cultivars are conserved as accessions, generally planted close together in the same fields. Each accession generally counts 75 to 100 coconut palms from the same cultivar. For reproducing these accessions, the technique of controlled pollination with bagging of the inflorescence is used (Konan & al., 2008). In the case of coconut, this technique is very costly. It requires a well-equipped laboratory, well-trained technicians able to climb the palms and a huge amount of manpower. Not all the gene banks can afford it.

The lifespan of such accessions is only 25 to 30 years. After this period, most coconut varieties excepting dwarfs reach 15 m high or more. At this stage, it becomes difficult to make the requested controlled pollinations. It is therefore necessary to rejuvenate the accessions before the inflorescences become

[9] See http://poly*motu*.blogspot.com/2008/10/message-4.html for details

inaccessible. In the Côte d'Ivoire African genebank, workers use costly triple ladders that can reach a height of only 14 metres. In some other places, like India or Indonesia, palms are climbed mainly manually, which is risky. Rejuvenation programmes require climbing roughly 75 palms each about 15-20 times. Basically, for rejuvenating an accession, the controlled pollinations are implemented over a 6-month period; the mature seednuts are harvested one year later, also over a 6-month period; then the old accession is removed from the field and replaced by a new one. Production of the 200 seednuts requested for the duplication of an accession will demand one and half year's preparation; and it will cost more than 2000 USD. Only scientists with healthy research budgets can afford to order varieties from classical coconut genebanks. Most of farmers cannot afford this.

Alternatively, the coconut palms could be planted in geographical and reproductive isolation, according to the Poly*motu* concept. In this way, the constraints linked to the heights and ages of the palms are removed. Instead of climbing the palms for making controlled pollination, people only have to wait for the coconut to fall naturally to the ground. Open-pollination will provide true-to-type and cheap seednuts. Thus, the same accession can be kept as long as a sufficient number of palms remain alive in the field. In most cases, the duration of a coconut accession will then be extended to 75 to 100 years. Even if some of the palms die, there is no need to remove the remainder, as is done in a classical genebank. Dead palms can be replaced by new ones, without removing the old palms remaining alive. Extending the lifespan of a coconut accession from 25-30 years to 75-100 years represents a huge saving of time, manpower and money. Seednuts will be more affordable for farmers.

The Poly*motu* concept moves the Global Coconut Conservation Strategy towards the involvement of more countries, sites and stakeholders. By combining ancestral Polynesian practices with the recent progresses made in biological and social sciences, a rational strategy for the conservation of genetic resources and associated traditional knowledge can be implemented. We are presently hoping to launch Poly*motu* projects in the following countries and places:

- in French Polynesia, Tetiaroa Atoll and Fakarava reserve biosphere;
- in Samoa and Fiji Islands;
- in Indonesia, Kepulauan Seribu National Park, North of Jakarta

Tetiaroa is an atoll in the Windward group of the Society Islands of French Polynesia. The atoll is located 33 miles (53 km) north of Tahiti. The atoll stretches on a total surface of 2.3 square miles (6 square km); approximately 1,445 acres (585 hectares) of sand are divided in 13 *motu* (islets) with varying surface areas. Tetiaroa is under a long term lease by the family of the late actor Marlon Brando. We obtained the agreement of the Brando family and Beachcomber SA, a company which is building a new eco-friendly resort on

Tetiaroa, to integrate 5 locations (4 *motu* and a small peninsula) for conservation of coconut varieties using the Poly*motu* concept. Figure 2 gives an illustration of the proposed landscape design. We proposed to remove about 1500-2000 coconut palms in order to favor endemic vegetation and bird nesting; and to replant about 500 coconut palms from 5 traditional varieties.

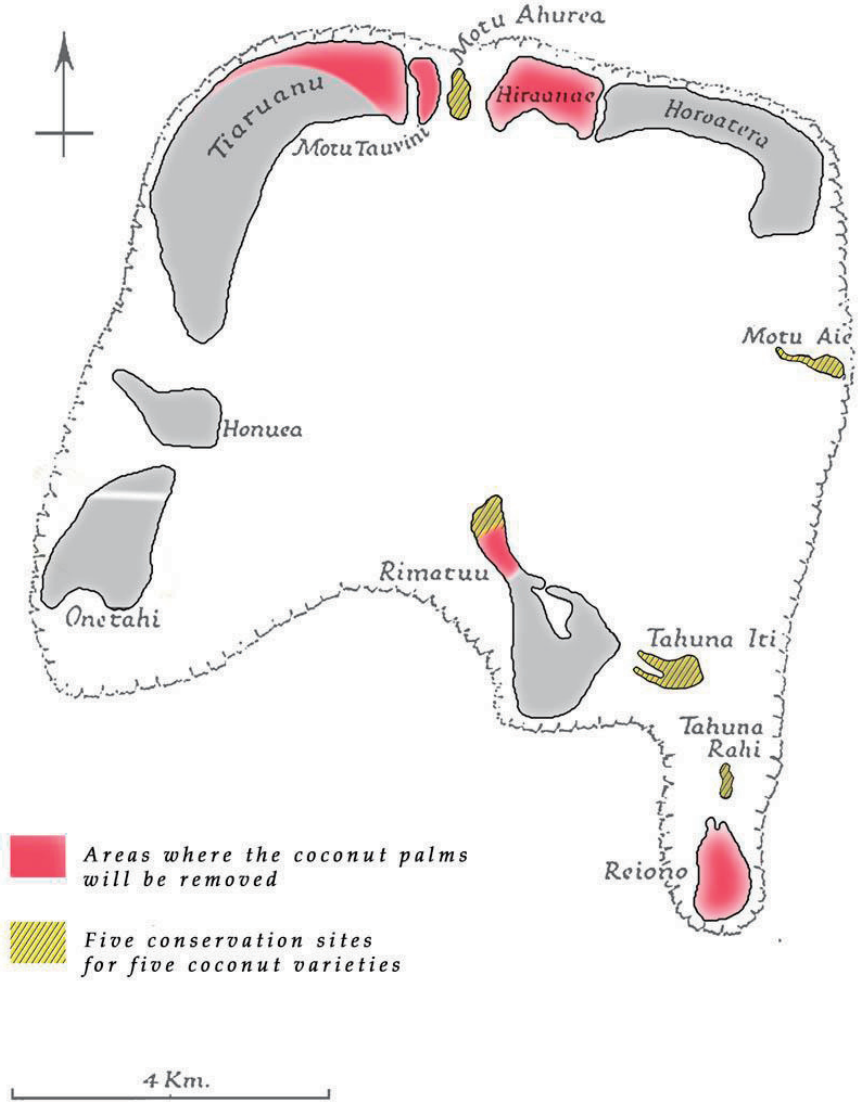

Fig. 2. Landscape design for the implementation of the Poly*motu* project on the Tetiaroa Atoll.

In 2010, we began to replant one of islands of the Tetiaroa atoll with a very rare form of horned coconut, as shown in Figure 3.

Fig. 3. A rare form of horned coconut found and being replanted on Tetiaroa Atoll.

We visited Fiji and Samoa in 2010. In Fiji, we have fruitful contacts with the Secretariat of the Pacific Community[10], the University of South Pacific and the tourism industry. Resort owners were interested to be involved in conservation and ecotourism programs[11]. We especially met Ms. Elenoa Nimacere, the manager of the South Sea Island. This small *motu* is located in the Mamanuca Group. The island is now rented by South Sea Cruises and is used to host daily about 100 cruisers. Ms. Elenoa Nimacere said the coconut tree planting project could help prevent the sand from being blown to different parts of the island. Elenoa invited the research team (Dr Tevita Kete and Dr Roland Bourdeix) to visit the island where her business is located, as shown in Figure 4. She was very keen to plant traditional coconut varieties for ecotourism, conservation and fighting against marine erosion.

[10] Valerie Saena Tuia from SPC is author of this paper.

[11] Two public lectures about coconut palm conservation were conducted in Fiji. The second lecture was held at a Regional Workshop held from 15th to 19th March 2010 at Novotel, Nadi. This last meeting was attended by 20 participants from 8 SPC member countries. We also invited stakeholders of the tourism industry to attend our lecture, and we were very happy that they came ! Thanks for coming to Mr. Viilame Ratugolea (Waya Lailai Resort), Mr. Jerry And Alumita Sovatabua (Botaira Beach Resort), and Ms Elenoa Nimacere, Hospitality Manager (South Sea Island).

Fig. 4. Searching conservation sites in Fiji - a visit to the South Sea Island. From left to right: Dr Roland Bourdeix, Dr Tevita Kete, Ms. Elenoa Nimacere and another worker.

In Samoa, we refined the Poly*motu* concept in the case of the coconut palm. Linking tourism industry and conservation of biodiversity has many advantages[12]. For instance, the prestigious Sinalei resort organizes regular visits to the small *motu* Nuusafee (Figure 5.). It is expected that more tourists and visitors would be attracted if the island is planted with the traditional *niu afa*; this variety, created long time ago in Samoa, produces the longest coconuts in the world. The uniqueness of this variety in the world combined with aspects of the Polymotu concept will sure be an attraction worldwide. Specific ecotourism activities could be developed in this island which will provide seednuts for farmers.

We also explored the possibilities of planting more than one coconut variety per location. For instance, the same location can be planted with 3 coconut varieties: 2 red dwarfs and a green tall. Distinction within the progenies could then be made by using phenotypic markers such as the colours of the sprouts when the seedlings germinate, as shown in figure 5. This allows to produces certified seedlings of both the 3 varieties and hybrids (natural crosses between varieties) in a single site.

Respect for tradition can foster economic competitiveness. The Samoan *niu afa* variety, which was until recently in danger of extinction, could generate a lucrative «niche» market. Samoan communities in Australia and elsewhere will prefer to buy products made from this variety. Making better use of their

[12] In a very competitive environment, it becomes more and more important to stand out from the standard fare that tourism offers. The coconut palms should no longer serve as symbols of anonymous and counterfeit exoticism: they tell true stories, specifically related to local cultures.

heritage varieties, Samoan farmers and small producers of virgin coconut oil could increase their incomes and improve their livelihoods.

Fig. 5. Plantation of 3 coconut cultivars in the same island for harvesting seedlings of both the 3 varieties and coconut hybrids (distinction made on the colour of the sprout).

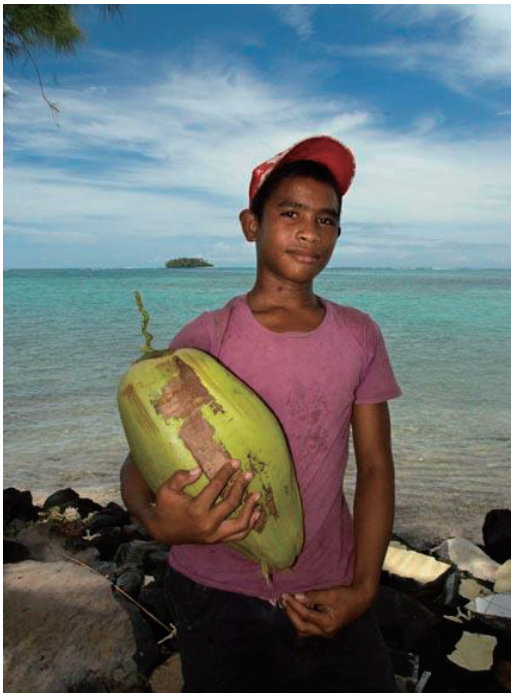

Fig. 6. A Samoan teenager, with the huge *niu afa* coconut fruit and the Nuusafee Island in the background.

An Indonesian version of the Poly*motu* project was submitted to a call from the Canadian International Development Research Centre. This project gathered research teams from Bioversity international (Italy), Cefe/Cnrs and Cirad (France), the Centre for World Trade Studies in Gadjah Mada University and the University of Pembangunan Nasional "Veteran" (Indonesia). In Indonesian Kepulauan Seribu (literally: thousand islands) is a string of 110 islands with the closest only a few kilometers off mainland Jakarta, Indonesia. In 1998, more than 16,000 people lived there; the most inhabited island is Kelapa (coconut) island. In many of these islands, people are presently cutting down the coconut palms. They believe that the palms absorb the mineral water from the ground, thus decreasing the quantity of available drinkable water. Huge imported trees (Casuarina) are often replanted, although the same problem of water consumption occurs.

Coconut palms tolerate salinity. They can be planted in selected locations, and especially along coral coasts where the water is saline. When used for beach landscaping, they tolerate flooding better than Casuarina and also serve as a buffer against marine erosion. Dwarf coconut varieties can sustain themselves with household wastewater without affecting strongly the water table; they provide shading and a sweet nutritious drink. High-valued varieties such as Makapuno/Kopyor (soft kernel, valued 10 times a normal coconut) and production of seednuts can generate income for islanders and especially for women; this will decrease the pressure on marine resources. Taking in account the 505 cottages existing in K.Seribu for tourist accommodation (Zainal, 2004), the role of coconut palms in ecotourism also needs to be greatly strengthened. Although the first proposal for this project was not endorsed, other versions will be submitted in the near future.

3. REASERCH NEEDED FOR FURTHER DEVELOPMENT OF THE POLYMOTU CONCEPT

The research packages needed for implementing Poly*motu* projects will depend upon the geographical zones and the species to which the concept will apply. Presently, the Poly*motu* initiatives are more orientated towards tropical islands. The model species is presently the coconut palm, although other species, such as Red Sandal Wood, Kofai and even Coconut Crab[13], could sometimes be conserved in the same sites. Poly*motu* projects combine multidisciplinary scientific research with immediate and participative applications that can be measured by quantitative indicators. These projects require scientific studies in numerous research fields: conservation policies, anthropology, territorial

[13] Santalum insulare, Sesbania coccinea and Birgus latro. Sesbania coccinea is an endemic leguminous plant listed as protected species under category A (Order No. 296 CM of 18 March 1996): all its sub-species are protected in French Polynesia.

management studies, geographical information systems, ecology, socio-economy, water management, genetics, reproductive biology and post-harvest technology.

In the field on conservation policies, we started to develop the concept of a networked collection, also called a virtual collection, in the framework of the Global Coconut Conservation Strategy (Bourdeix et al. 2009). A networked collection is located at more than one geographical/institutional site, spans the genetic diversity of a given species (genepool) and gathers stakeholders having a mutual interest in rationally conserving and exchanging germplasm. In the extreme application of this concept, several accessions could be conserved, each at a distinct site.

A global coconut conservation strategy (GCCS) was developed by the International Coconut Genetic Resources Network (COGENT) and the Global Crop Diversity Trust. This strategy is mainly based on *ex situ* conservation in five large regional field genebanks. The implementation of a networked collection could allow this system to involve more countries, sites and stakeholders. A challenge being faced is that of gathering (in the same legal frame, network and database) accessions held in international genebanks, as well as accessions conserved on islets owned by municipalities, islanders' families or tourism enterprises. Being an Annex 1 crop of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), coconut germplasm can be accessed by countries which have ratified the International Treaty and which have declared these collections in the public domain.

Anthropological issues arise in two distinct areas. Although there is abundant anthropological literature on insularity, no study has focused specifically on what we call “insularity within insularity”. What is an islet for an islander? It is a matter of studying the perceptions, representations, practices and right of access of islanders with regard to islets, which are generally uninhabited and satellites of a larger inhabited island, along with anthropological factors affecting decisions relative to the management of those islets. The second anthropological issue involves seednut networks. Many studies conducted in tropical countries on food crop seed exchanges highlight that more than 80% of seeds come from the informal network. But the typology used in distinguishing between "formal" and "informal" generally neglects the fact that the "informal" network is itself structured by social organization. One hypothesis is that the structuring of genetic diversity and its distribution depends not only on the type of plant reproduction and selective practices, but also on associated social distinctions.

In the fields of territorial management studies and geographical information systems, the focus will be to identify the numerous conservation sites requested for implementing Poly*motu* projects. In Polynesia, the conservatoire is to be integrated into a complex system of joint possession that varies depending on

the island groups, which has been in place since the beginning of the 19th century. That system of joint possession, which backs up an effective social organization, is not acknowledged by official law. To that is added the regulation of land leases (introduced in 1984 in French Polynesia) which has considerably slowed down land rentals.

Socio-economics studies will estimate the value of biodiversity and ecosystems services provided by the conservation sites, including agriculture and ecotourism. As underlined in the Convention on Biological Diversity, ecotourism is increasingly viewed as an important tool for promoting sustainable livelihoods, cultural preservation, and biodiversity conservation. Post-harvest technologies and market studies will assess how traditional coconut varieties and other conserved species could be used to diversify products and create niche markets.

As partial replanting will be conducted on the conservation sites, their ecology will need to be studied. The biodiversity available on these sites will be assessed. Research questions would include: How could this biodiversity be increased using the Poly*motu* concept? and which other species could be conserved in the same locations than the coconut palms for an economy of scale?. In the Indonesian islands Kepulauan Seribu, a key point will be to document the links between plantation of trees and water management in small coral islands: influence of trees on the water table and drinkable water, assessment and management of coastal erosion using trees and especially the coconut palm, in link to climate change mitigation.

Genetic surveys will have to be conducted to identify the coconut varieties and other species to be conserved in the Polymotu sites. These participative surveys will include interactions with local stakeholders in order to select and to obtain the germplasm to be conserved. In Indonesia, a research package will be specifically dedicated to the creation of islands to be planted with m*akapuno/kopior* coconut variety; analysing the available diversity for k*opyor* coconut germplasm in Indonesia, collecting k*opyor* seednuts and develop them through *in vitro* culture of embryos.

4. AS A CONCLUSION

Implementing the Poly*motu* concept will strengthen the links between people, landscape and biodiversity. We expect 50 to 100 islands and other sites to be partially replanted as conservatoire during the next 15 years. A significant outcome will be the safe conservation of the representative biodiversity of coconuts (*Cocos nucifera*), and the availability of certified coconut seednuts for mainland farmers. Beneficiaries will be all those stakeholders who rely on coconuts for their livelihoods. A main impact will be enhanced livelihood for islanders.

Historically and culturally, Japan has a strong influence in the Pacific Region. It will be a great opportunity for Japanese research to invest more for conservation of biodiversity in the Pacific Islands, and more specifically for conservation of the coconut palm. Indeed, coconut remains one of the crops most neglected by scientists, in regards of its economic value and cultural importance. Despite the enormous potential of the crop, coconut farmers often scrap a living below the poverty line. About 96% of the farmers, who collectively grow coconuts on 12 million hectares worldwide, are smallholders tending less than four hectares (Frison, 2006). Coconut farmers were marginalized. Many do not own the land they work, lack the resources to invest in technologies that would improve production, and are considered non-bankable by the formal banking sector. Many traditional varieties of coconut palms are presently disappearing and there is a huge and urgent need to safeguard the remaining. From this point of view, projects based on the Poly*motu* concept could be implemented in collaboration between Japan and the few International and French institutions that are already involved in this research field.

Fig. 7. A disappearing coconut palm – a strange evocation of the Japanese flag?

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6. RELATED WEB SITES (confirmed on April 30, 2011)

1. International Coconut Genetic Resource Network: http://www.inibap.org/cogent/
2. Global Coconut Conservation Strategy: http://www.croptrust.org/documents/web/Coconut-Strategy-FINAl-22aug07.pdf
3. The Poly*motu* concept: http://poly*motu*.blogspot.com
4. Coconut palms of Samoa: http://coconutsamoa.blogspot.com

5. Coconut palms of French Polynesia (in French): http://cocotierpolynesie.blogspot.com/
6. Coconut lecture and press release: http://conferencecocotier.blogspot.com/
7. Diversiflora Editions and the coconut palm: http://diversiflora.blogspot.com/

COMMENTS AND QUESTIONS AT THE WORKSHOP

Long: I understood that you are trying to avoid cross pollination. But is there danger that too many other varieties of coconuts floating to the island??

Roland: In fact, most of the coconut palms are now planted by men. I know very few coconuts growing naturally. Because the ecology of the islands change and when the coconuts arrive on the beach most of the time the rats come and eat them.

Long: So floating is not really a danger.

Roland: No. It's not. Most of the islands, the people visit, they rest when they fish or they would spend the weekend, there are always people coming to the island. So, if there's a coconut growing by the sea, you just remove it.

Ohmae: So, your main concern is to have a gene bank of coconuts?

Roland: No. I'm involved in conservation of coconut genetic resources but the Polymotu concept is not only about coconut. It can be used otherwise. I showed an example of birds in New Zealand which is mostly the same concept. The idea is to in fact, strengthen the link between people, biodiversity and small islands. If people know that this small island is producing this kind of special legume or fruit or special coconut or whatever, the people will… It's like what we call in French for the wine, *Effet terroir* … For example, Bordeaux wine. We have special place, special people and special wine. So we can have that on many small islands.

Long: So a kind of a branding?

Roland: Yes, branding.

Ohmae: So if Mother Nature goes without your help, will you see any problems?

Roland: The problem is that. This is about 200 years of coconut history in three minutes. At the beginning it was like that. Only a few coconut palms are moved,

most coconut palms are moved by people not by nature, and you bring one coconut at a go, so because of the genetic drift, here you have a special population, here you have a special population, here also. Because only a few coconuts, you have distance between populations so no pollination was possible. After 1830-1850, coconuts became a big business. It was gold. And under colonization they began to plant coconuts absolutely everywhere. All the traditional variety they had was mixed because they were only interested in copra. Before Polynesians had plenty varieties for plenty of different uses. Now most of these varieties are mixed in the coconut groves. Sometimes you see one coconut with big fruit here, one coconut with sweet husk here and the middle of a coconut plantation made only for producing copra. Recently the number of coconut palm was reduced. And I will say that at least half of the traditional coconut varieties are definitely lost, because all was mixed by colonial and industrial cultivation. In the framework of the Polymotu project, what I would like to do is re-create populations maintained in geographical and reproductive isolation.

Ohmae: So your initiative is not just to use all the small islands as gene banks.

Roland: Not all the small islands, for example in French Polynesia you must have something like 700-800 small islands, I would use maybe 25-30. In Olkeriil's presentation, I saw an island full of rocks and a coconut on the top. So people bring it there, it's not possible for the coconut to move itself.

Kazuo: Actually, it is one coconut on top of the second tallest mountain and it's the only coconut sticking there. Did people bring it there? Yes, absolutely.

Matsuda: In the famous text book of island biogeography, the species diversity of small islands is balanced between introduction and local extinction. I'm not sure of the exact rate of such species introduction…

Roland: This must have been studied... For a long time we have said that traditional coconut varieties are endangered. So the coconut which are on most of the small islands, first of all there are too many coconuts, second there are no more harvested so the coconut often fall and are eaten by rats, there are plenty of rats. Rats make holes in the coconut, water gets in and mosquito's breeds on that. So in some of the islands, relative to coconut palm, I will fully agree with completely keeping the existing coconut palm and to replace with traditional variety. Not covering the whole island but maybe, for conserving one coconut variety with 100 coconuts, 0.7ha is enough. This is a reserve action, I don't want to just study but I want to act.

Shikida: I understand you're promoting eco-tourism. I have a question about eco-tours. Do you provide eco-tour programs by yourself or are you just getting people to come over.

Roland: For the moment, what I suggested to Samoan people, they have a very famous variety which has the biggest coconut in the world. There is the Sinalei resort which is one of the biggest resorts of Samoa. The family owning the resort is also managing a small island (Nuusafee Island), planted with about 1.5ha of coconut palms for copra production. Nowadays, nobody is making anymore copra on this island. I suggested these people to replant this small island with the traditional variety *niu afa*, the longest coconuts in the world. So when they bring the tourist to the islands, in the future they can say "Oh look at the coconut. This is a famous traditional variety." And by this way this island which could be used as eco-tourism can also provide seed nuts to farmers in land. The farmers can plant this variety and make a product or niche market for the special virgin oil of coconut made with this coconut variety. That would give added values to these kinds of products.

Shikida: Is there any chance of cash flow from the tourist sector to the conservation sector?

Roland: Yes. If we succeed to do that, I would say that conservation will be partially supported by tourism.

Shikida: Do you have exact cash flow from the tourist sector?

Roland: No. For this aspect, we need to develop a research package to make an assessment of the whole process.

Shikida: So what type of eco-tour do you have? For example, people are coming over to participate in planting or conservation activity.

Roland: For the moment, this is not decided. I just went for the first time in Samoa last year and just discussed with the owner of the resort. He was very interested.