The Biological Corridor Project in the Piedras Blancas National Park, Costa Rica. A project to preserve the biodiversity by reforestation and alternative culture, with support of the community La Gamba by new marketing strategies

El proyecto de corredor biológico en el Parque Nacional Piedras Blancas, Costa Rica. Un proyecto para preservar la biodiversidad mediante la reforestación y cultivos alternativos, con el apoyo de la comunidad de la Gamba de nuevas estrategias de comercialización

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Abstract: The objective of this project is to promote the establishment of biological corridors at several places around the Piedras Blancas National Park. The corridors are intended to connect existing forest islands with the national park. Thus, migration and genetic exchange of forest plants and animals will be enabled, counteracting the global loss of species. As most of the affected areas are private land, an action plan has been worked out together with the local people to develop sustainable methods of land use in the corridors, such as reforestation with native tree species and permaculture. The project is based on the conviction that the remnants of the world's rainforests can only be maintained permanently by involving the local people and by ensuring sustainable land use and adequate food supply for the families. The development of a regional marketing program for handcrafts and cosmetic products should improve the economic situation of the families. The project will contribute both to the protection of the biodiversity of the region and to the economic survival of the local people.

Key words: corridor, reforestation, native species, permaculture, regional marketing program.

Resumen: El objetivo de este proyecto es promover el establecimiento de corredores biológicos en varios lugares alrededor del Parque Nacional Piedras Blancas. Los corredores están destinados a conectar el parque nacional con las islas de bosque existentes. De esta forma, se permitirá la migración y el intercambio genético de plantas y animales del bosque, contrarrestando la pérdida mundial de especies. Como la mayoría de las zonas afectadas son de propiedad privada, se ha elaborado un plan de acción junto con la población local, para desarrollar métodos sustentables de uso del suelo en los corredores, como la reforestación con especies de árboles nativos y la permacultura. El proyecto se basa en la convicción que los remanentes de bosques lluviosos del mundo, sólo pueden ser conservados permanentemente con la participación de la población local y garantizando el uso sostenible de la tierra y un suministro adecuado de alimentos para las familias. El desarrollo de un programa regional de comercialización de artesanías y productos cosméticos debería mejorar la situación económica de las familias. El proyecto contribuirá a la protección de la biodiversidad de la región y a la supervivencia económica de la población local.

Palabras clave: corredor, reforestación, especies nativas, permacultura, programa regional de comercialización.

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Introduction

Protecting natural ecosystems in the form of national parks, biological reserves, forest reserves and others is a very effective means to conserve nature in its original form. Since the 1970s, Costa Rica has protected about 25% of its territory by law. In terms of nature conservation, this country can be regarded world-wide as exemplary. Although Central America makes up only 0.5% of the earth's land area, it possesses 5% of the world's biodiversity.

Numerous cases have revealed, however, that the indigenous fauna and flora of isolated patches of forest surrounded by agriculturally used areas (such as banana, pineapple or oil palm plantations or grassland) cannot survive in the long run. The reason is that outside of biological reserves, the genetic exchange between most plant and animal species proves impossible. This leads to a steady decline in species number (HARRIS 1984, HILTY et al. 2006). This problem becomes even more evident when taking into account that a single jaguar needs a territory of about 100 km² for living and survival, and that some species of trees have only a single individual growing in an area of several square kilometres. Studies on bats carried out in the Piedras Blancas National Park have documented the fact that forest corridors are extremely important for the survival and preservation of species (LANDMANN et al. 2008, WEINBEER 1998).

During the last few years, the concept of establishing "biological corridors" which connect isolated forest patches has received great acceptance among the experts. Initiatives such as the Mesoamerican Biological Corridor (MBS) project, supported by various institutions and associations such as the Central American Commission for Environment and Development (CCAD), NGOs and universities co-operate for implementing this concept. For Central America, it would be most important to establish corridors with varying degrees of protection, ranging from total protection to restricted land use. Such corridors would allow animals and plants to migrate between larger forest areas. In fact, the vision of implementing a green corridor between North and South America has been proposed, aiming at a biological exchange between the two continents. Such a connection indeed existed 3.5 million years ago, when the Central American land bridge was formed. First contacts at an international level have already been established in this project.

The Piedras Blancas National Park (ca. 150 km²) in the south of Costa Rica is one of the richest forests in Central and South America, with up to 180 tree species per hectare and containing paradigmatic lowland ecosystems (WEBER et al. 2001). In 1991, this forest area ("Esquinas Forest") was protected by law. The aerial view shows a forest area which is closed and pristine in its centre, but disturbed at the periphery due to agricultural use. This clearly has a negative influence both on the genetic exchange of plants and animals and on the biological value of the region. As the affected land is privately owned, the local population must be involved in the plans of establishing corridors to ensure maximum co-operation. Initial contacts with the people of La Gamba have shown that in cases of minor land use, the corridor plans are supported. On a local scale, connecting or closing the isolated forest patches by reforested corridors will represent a first step towards expanding the forest areas.

The area of La Gamba meets all requirements for establishing biological protection zones. On the basis of aerial photos taken in 2003 (CARTA 2003), particularly important areas and their biological value were determined. At the same time, a road map has been worked out in conjunction with the local people in order to develop alternative and sustainable uses within the corridor areas (e. g., reforestation of pasture and riversides with local timber trees, and alternative cultivation methods such as organic agriculture and permaculture). Further, a regional marketing concept for products from La Gamba (e.g. hand-made shampoos, soaps, handcraft) is under development to improve the economic situation. Only by involving the local population, by partial sustainable use of their land and by a sufficient family income, can the remaining rainforests on the planet be restored in the long term (REDFORD & PADOCH 1992).

Reforestation of pasture and riversides in the area of the Piedras Blancas National Park

Legal issues

Over the past years, more than 15 hectares of land have been reforested with trees of indigenous species on 19 fincas (farms). To ensure a sufficient supply of trees, a contract has been drawn up with a local nursery, and a separate nursery for rare forest species was also set up at the Field Station La Gamba. In a series of sub-projects, research work was conducted on the germination and growth conditions of the young plants raised.

Together with Costa Rican forest and agricultural engineers, we developed an alternative reforestation plan for the area with the farmers. In collaboration with the engineers, the project participants and the La Gamba Field Station, a contract was drawn up that obliges the participants to care for the reforested areas for a period of ten years. Because this system is relatively uncomplicat-

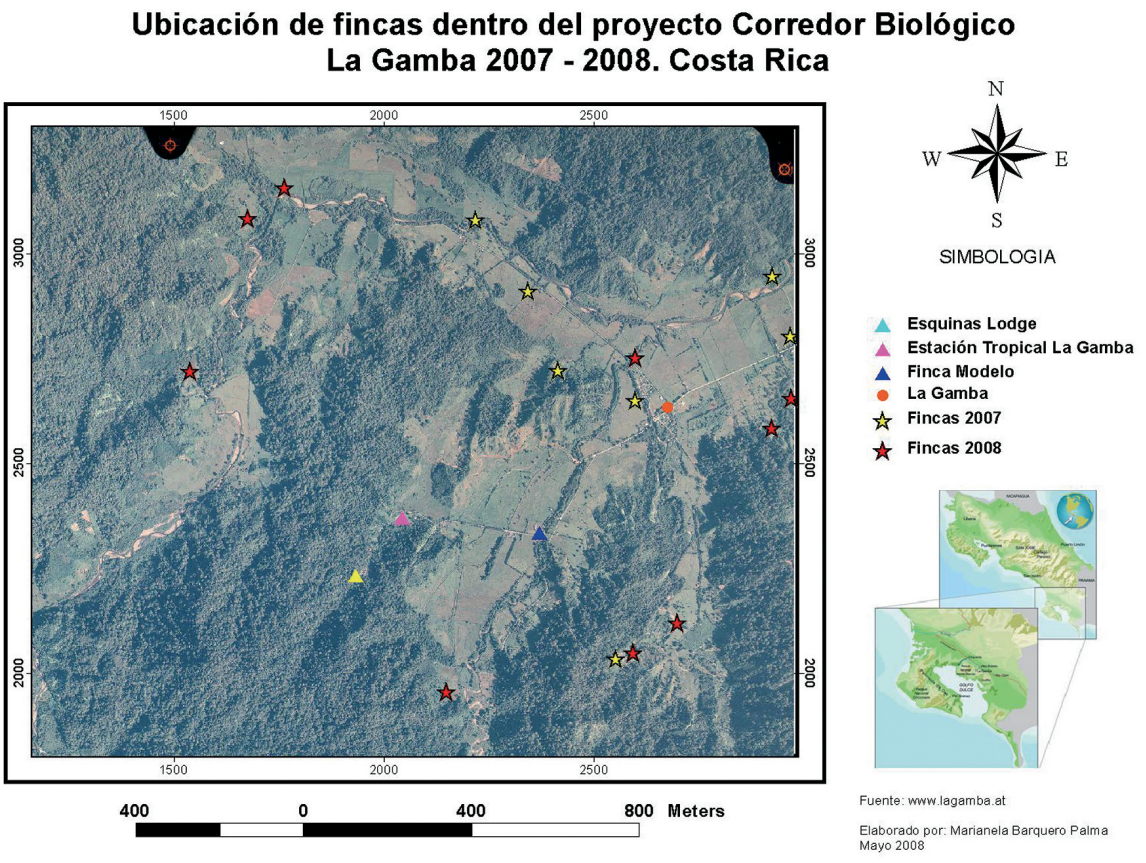

Fig. 1: Locations of the reforestation areas in La Gamba, Costa Rica. During 2007 and 2008 we could replant 15 ha.

ed, we were then able to attract finca owners for the project (Fig. 1).

Selected plant species for reforestation

The objective of the project is to restore and reforest the land using native species that have economical or ecological value. Unfortunately, forestry in the tropics generally focuses on a small number of fast-growing tree species from Africa or Asia. The best known examples are grey teak (*Gmelina arborea*) and teak (*Tectona grandis*) (both belonging to Verbenaceae). Such species are of little value in biological corridors, because they provide little food for animals. For that reason, we do not plant such species. Instead, we looked for suitable indigenous trees with valuable wood and have worked out lists in collaboration with the project participants. We also added species with a high biological value to the list, such as members of the genus *Inga* (Mimosaceae), which are an important source of food for animals such as monkeys, birds and insects. In total, we have identified roughly fifty suitable species, and the list is continually updated (Tab. 1).

Procurement of seedlings and establishment of a nursery

The procurement of suitable seeds and seedlings remains a major and general problem in the tropics, as local nurseries generally do not grow native tree species. We were able to obtain at least a part of the needed plant material for at least 15 from the 50 selected species from a nursery in Río Claro, where common indigenous species are grown in large quantities (Fig. 2).

For rare species we established a nursery at La Gamba Field Station ourselves with the help of locals and gardeners. Around 3.000 specimens of roughly 40 species have been cultivated at the station to date. In this way, we distribute tree species that have already become rare in the region and that are liked by the local people, such as Christobal (*Platymiscium curuense*, Fabaceae, Faboideae), but from which seeds are very difficult to obtain or can only be obtained from the primary rainforest. For that purpose, special botanical knowledge is indispensable. The nursery at the station is already very well known throughout the surrounding area, and farmers come to the Field Station to collect young plants for their gardens and reforestations.

Later, we succeeded in motivating the people of La Gamba to produce young plants that are then purchased with project funds. So far, two people have become involved in this work and have raised young plants of five different species. Because of the fact that many locals cannot recognise the seedlings of the desired tree species and do not know how to raise them properly, the idea was developed to create a small book with colour photographs showing how to set up a nursery.

Table 1: List of selected tree species used for the restoration and reforestation in the region.

Nr.	Family	Genus	species	Vernacular name	Status
1	Anacardiaceae	*Anacardium*	*excelsum*	Espavel	common
2	Anacardiaceae	*Astronium*	*graveolens*	Ron ron	extincion
3	Anacardiaceae	*Spondias*	*mombin*	Jobo	common
4	Apocynaceae	*Aspidosperma*	*myristicifolium*	cara tigre	amenazada
5	Apocynaceae	*Aspidosperma*	*spruceanum*	Manglillo	common
6	Bignoniaceae	*Tabebuia*	*guayacan*	Corteza	extincion
7	Malvaceae	*Bursera*	*simarouba*	Indio desnudo	common
8	Bombacaceae	*Ceiba*	*pentandra*	Ceiba	amenazada
9	Bombacaceae	*Ochroma*	*pyramidale*	Balso	common
10	Fabaceae-Casalpinioideae	*Schizolobium*	*parahyba*	Gallinazo	common
11	Fabaceae-Casalpinioideae	*Copaifera*	*camibar*	Camibar	extincion
12	Fabaceae-Casalpinioideae	*Cynometra*	*hemitomophylla*	Cativo, guapinol negro	extincion
13	Fabaceae-Casalpinioideae	*Peltogyne*	*purpurea*	Nazareno	amenazada
14	Clusiaceae	*Calophyllum*	*brasiliense*	Maria	common
15	Combretaceae	*Terminalia*	*amazonica*	Amarillon	common
16	Euphorbiaceae	*Hyeronima*	*alchorneoides*	Pilon, zapatero	common
17	Euphorbiaceae	*Acalypha*	*diversifolia*	Gusanillo, rabo de gato	common
18	Euphorbiaceae	*Croton*	*schiedeanus*	Colpachí	common
19	Fabaceae	*Platymiscium*	*curuense*	Cristobal, Cachimbo	extincion
20	Fabaceae	*Dussia*	*discolor*	Sangregao, targuayugo	extincion
21	Salicaceae	*Tetrathylacium*	*macrophyllum*	Lengua de vaca, zapote	common
22	Humiriaceae	*Humiriastrum*	*diguense*	Chiricano alegre, lorito, nispero	extincion
23	Lauraceae	*Ocotea*	sp.	Ira	common
24	Lecythidaceae	*Couratari*	*guianensis*	Copo hediondo	extincion
25	Lecythidaceae	*Lecythis*	*ampla*	Jicaro, olla de mono	extincion
26	Meliacae	*Carapa*	*guianensis*	Cedro bateo	common
27	Meliaceae	*Cedrela*	*odorata*	Cedro amargo	common
28	Meliaceae	*Guarea*	*grandifolia*	Caobilla	common
29	Fabaceae/Mimosoideae	*Inga*	*oerstedtiana*	Cuajiniquil	common
30	Fabaceae/Mimosoideae	*Inga*	spp.	Guaba	common
31	Fabaceae/ Mimosoideae	*Parkia*	*pendula*	Tamarindo, tamarindo gigante	extincion
32	Fabaceae/Mimosoideae	*Zygia*	*longifolia*	Sotocaballo	common
33	Moraceae	*Brosimum*	*utile*	Lechoso	common
34	Moraceae	*Artocarpus*	*altilis*	Castaño, fruto de pan	no nativo
35	Moraceae	*Brosimum*	*alicastrum*	Ojoche	common
36	Moraceae	*Ficus*	*insipida*	Chilamate	common
37	Myristicaceae	*Virola*	*koschnyi*	Fruta dorada	common
38	Olacaceae	*Chaunochiton*	*kappleri*	Manglillo	extincion
39	Olacaceae	*Minquartia*	*guianensis*	Manu, manu negro, palo de piedra	extincion
40	Poaceae	*Gynerium*	*sagittatum*	Caña brava	common
41	Malvaceae	*Apeiba*	*membranacea*	Peine de mico	common
42	Malvaceae	*Apeiba*	*tibourbou*	Peine de mico	common
43	Malvaceae	*Luehea*	*semanii*	Guacimo colorado	common
44	Malvaceae	*Mortoniodendron*	*anisophyllum*	Cuero de vieja	common
45	Verbenaceae	*Vitex*	*cooperi*	Manu platano	common
46	Vochysiaceae	*Qualea*	*paraensis*	Masicaran	extincion
47	Vochysiaceae	*Vochysia*	*ferruginea*	Mayo	common
48	Vochysiaceae	*Vochysia*	*alleniii*	Mayo	common

Fig. 2: Señor Bolívar's nursery, which produces 15 different species for reforestation.

Fig. 3: Transport of seedlings to the fincas is often very difficult and sometimes large rivers must be crossed.

Fig. 4: Reforestation along rivers is difficult due to the heavy rains and flooding, which may wash seedlings away.

Fig. 5: The so called SAF (Sístema Agroforestal) means that timber trees are planted together with crops and fruit trees.

Forest protection and reforestation of the fincas

Up to 2008, we have been able to involve 19 farmers from the area for our project. An impression of the selected fincas and farmers can be seen in Fig. 3-6. We have ensured that the finca owners will protect a total of 85.5 hectares of forest in the future. A further 15 hectares could be reforested. When selecting the fincas, we attached special importance to the following criteria: (1) the closing of gaps to create a continuous forest area to the greatest possible extent, and (2) the forestation of river banks for water protection and corridor formation reasons. The exact locations of the fincas can be seen in Fig. 1. Our local forest engineers also have instructions to look for further fincas, and experience has shown that additional participants can often be attracted after a project has started.

Fig. 6: Forestry engineer Marianela Barquero talking with the farmer (fincero) Oscar Viatoro Pineda (alias Camacho).

It is most desirable for future projects to extend the corridor to other primary forest areas. At present, this would still be possible as there are some remaining forest areas in the vicinity of the Piedras Blancas National Park. It would be wise to establish corridors in the west (to the Osa Peninsula) and northwards (to the Fila Costeña and the Talamanca mountains). The latter corridor would connect the lowlands with forests at higher altitudes.

Organic agriculture and permaculture in the form of mixed cultures with fruit and timber trees and vegetables

Farmers and home gardeners in the tropics play an important part in protecting the natural environment with their work, and also help to preserve important genetic resources by maintaining and increasing agrarian biodiversity. Biodiverse mixed cultures consisting of wood and fruit trees and vegetables are also an important part of biological corridors. As the majority of the population in La Gamba does not come from families with a farming tradition, but from families of former banana plantation workers, most have relatively little knowledge of successful farming methods under La Gamba's extreme climatic conditions (roughly 6.000 mm of rain per year, average annual temperature 27.5°C). For this reason, the objective of this part of the project is to show by means of a model finca how the food supply can be secured and how the economic situation of the local population can be improved through sustainable farming with vegetables and fruit and wood trees.

Fig. 7: Agricultural engineer Julio Nájera Umaña at the entrance to the model finca (Finca Modelo).

Fig. 8: Recently planted fruit trees in front of the buildings of the former elementary school of La Gamba.

A roughly 1-hectare plot of land and the two buildings of the former primary school of La Gamba were leased in August 2006 as the site for the model finca (Finca Modelo, Fig. 7). The site is very close to the centre of La Gamba, is easily accessible from the new school and also has a large room for meetings and workshops. To ensure good communication with the local population, a Costa Rican agricultural engineer was hired who is now a respected contact person and source of advice for the members of the community.

Soil Improvement

The first step on the model farm was the improvement of the soils. The poor condition of the soil became apparent when various fruit trees (papaya, mangosteen, caimito, rambutan, zapote, mamón, lemon, jobo, cashew, water apple, carambola, guava, etc.) were planted in August 2006 (Fig. 8). Due to former monocultures of rice or banana in this region and because of the intensive use of synthetic fertilisers and pesticides in the past, the soil is leached, extremely compact and has very little biological activity at many places. Therefore, an important goal is to improve the natural soil mineralisation processes by introducing micro-organisms (tilling compost into the soil), introducing oxygen (by loosening the soil) and increasing soil fertility by establishing a suitable carbon/nitrogen (C/N) ratio.

The soil is improved with:

(1) Organic fertiliser with earthworms (lombricultura). The genus *Eisenia foetida* (redworm or brandling worm) is a common and appreciated helper to organic farmers in the tropics, as faeces from farm animals and organic kitchen waste are turned into high-quality fertiliser in a short time. Earthworm faeces contains up to 5 times more plant-available nitrogen, 7 times more soluble phosphate, 11 times more potassium, 2-3 times more exchangeable magnesium and 1½ times more calcium than normal soil and is a very important source of nutrients for plants. Earthworm faeces is also an ideal substrate for the reproduction of micro-organisms.

(2) Compost from organic material. Cuttings (such as mown grass, which is rich in carbon), cow dung from the neighbouring pasture (rich in nitrogen), a small amount of fertile soil with micro-organisms for inoculation and molasses to encourage the rapid reproduction of the microbes was mixed at a C/N ratio of approximately 2:1, covered with a plastic tarp to increase the reaction temperature and then left to work for six to eight weeks until homogenous humus forms. Nearly ten cubic metres of compost was created in this manner last year.

Additionally, different substrates such as sand, different mixtures of soil and sand, and different amounts of humus were tested to improve germination and the growth of the young plants. The germination rate for good seeds is now between 60% and 100%, and the mortality rate for young plants has fallen by 50%. Attention was paid to ensuring that all materials used in cultivation are inexpensive and recyclable.

Experiments with different species and cultivation methods

Seeds of many vegetable varieties were collected (having been received partly through MAOCO – Movimiento Agricultura Organica Costa Rica and its network of organic farmers) and different cultivation methods tested with the plants under the hot, humid climatic conditions in La Gamba. With respect to the lack of agricultural traditions in most families living in La Gamba, we focus on easily applied methods, for example **"**agricultura minima**".** The methods of "agricultura minima" call for minimal working of the soil; holes for the seeds are made with sticks, and the seeds are dropped in. This planting method saves time and energy. Various test beds were set up with beans, soy beans, and manioc. Another method easy to apply are the "mixed cultures". Mixed cultures comprising fruit trees (papaya) and vegetables (chayote, tiquisque, chili, tomatoes, corn, manioc, string beans and beans) and support plants (*Cassia* sp.) for creeping plants such as string beans and chayote were planted and the incidence of pests and the vitality of the plants is regularly documented.

A major aim in the "Finca Modelo" is the selection of vegetable varieties which are easy to grow in the extreme climatic conditions of La Gamba. Therefore, tests of suitable varieties of string beans, chili and tomatoes for cultivation in the open are made. For all for cultures that are sensitive to rain, such as lettuce and some chili varieties, and for the seedlings of many herbs and vegetable plants, a simple, low-cost rain protection ("ambiente protegido") was constructed.

Fig. 9: Students of the elementary school visit the Finca Modelo once a week to learn about the methods of organic agriculture.

Regular meetings with interested community members, MAOCO representatives and students of the elementary school

To exchange knowledge, regular meetings were arranged with interested community members and representatives from MAOCO. Seeds and plantable pieces of starchy roots (such as malanga, tiquisque, taro, etc.) were also exchanged at these meetings. The village residents' initial skepsis has disappeared entirely, and has been replaced by increasing interest. An important factor was repeatedly communicating to the village members that we value a mutual exchange of experiences and knowledge. One of the most important goals is to introduce this knowledge to the students of the elementary school. Due to the co-operation with the school teacher they visit the "Finca Modelo" once a week to learn more about the methods of organic agriculture, for example the conditions for the germination of seeds, or the improvement of soil fertility (Fig. 9).

Creation of a regional marketing program for products from La Gamba

To improve the life situations of the families in La Gamba through additional income, the La Gamba Field Station has supported the community of La Gamba and the "Orbe-Natural" (formerly "Mujeres Visionarias") with the establishment and expansion of improved marketing structures for their handcrafts and cosmetic products since the year 2005. In addition to shampoos and hair gels manufactured by the "Orbe Natural", more and more women in La Gamba also produce hand-crafted art.

Handcrafts from La Gamba

The La Gamba Field Station and the Esquinas Rainforest Lodge have existed since 1993. Many foreign guests have come to La Gamba since then. In addition

Fig. 10: Bracelets made of seeds.

Fig. 11: Shampoos and gels with their plant ingredients. A new package design has been used for the shampoos since February 2008.

Fig. 12: Tuna (*Opuntia* sp.), a cactus variety, in the ORBE Natural garden. The juice of the opuntia cactus is used against hair loss.

to experiencing the beautiful natural landscape, many visitors also want to bring back home souvenirs. For that reason, work was started to motivate the people of the area to produce handcrafts. The diversity of handcrafts being manufactured has increased in recent years. Many people (especially women) have taken part in the courses and excursions that we have organised. The handcrafts that they produce are offered for sale at public events at the Esquinas Rainforest Lodge and in the La Gamba Field Station. In the meantime, a number of "souvenir shops" have opened in the village. The women from La Gamba produce earrings, chains, bracelets, and similar items, made preferably from seeds, fruits, and wood from the region. The black and red seeds of the nene tree (*Ormosia coccinea*) are particularly popular with foreign guests. The sale of handcrafts has become an important source of additional income for many families.

ORBE NATURAL (formerly Mujeres Visionarias) at La Gamba

"Orbe Natural" (formerly "Mujeres Visionarias"), is an organisation that was founded by single women in La Gamba in 2001. The organisation began with the manufacture of shampoos with plant additives. The Costa Rican organisation "Fundacion Neotropica" was initially able to provide considerable assistance with establishment, production and marketing using Austrian development aid. This assistance came to an end in 2003, and the seven "visionary women" who are currently in the group are now trying to tap new marketing channels for their products and to increase their range of products with the help of the La Gamba Field Station. From the beginning, the main product was shampoo. Since February 2008, the group has also produced plant-based soaps. The authors initiated the expansion of the product range, assisted in the production and certification of these new products and with the production of the new labels. Diana Arroyo from San José held various courses for ORBE Natural at the La Gamba Field Station. Further training and the exchange of experiences are very important for the future of the company. One course covered how to establish a company, how to manage a company and how to solve problems in the company. Another course imparted knowledge about the production of soaps from natural ingredients and more in-depth knowledge about producing natural shampoos. The aim of this training and exchange of experience is, that the women of the project "Orbe-Natural" should derive a self-employed income.

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References

Harris L.D. (1984): The fragmented forest. Island Biogeography theory and the preservation of biotic diversity. — Univ. of Chicago press.

Hilty J., Lidicker Z. & A. Merenlender (2006): Corridor Ecology. The science and practice of linking landscapes for biodiversity conservation. — Island presss. London.

Landmann A., Walder C., Vorauer A., Bohn S. & M. Weinbeer (2008): Bats of the La Gamba region, Esquinas Rain Forest, Costa Rica: species diversity, guild structure and niche segregation. — In this volume.

Redford K.H. & C. Padoch (1992): Conservation of Neotropical Forests. Working from traditional resource use. — Columbia Univ. Press.

Weber A. Huber W., Weissenhofer A., Zamora N. & G. Zimmermann (2001): An introductory field guide to the flowering plants of the Golfo Dulce rainforests, Costa Rica. — Stapfia **78**.

Weinbeer M. (1998): Vergleich von Fledermausgemeinschaften in Primärwald, Sekundärwald und Weide im Piedras Blancas Nationalpark ("Regenwald der Österreicher") im Südwesten Costa Ricas. — Diploma thesis, Univ. Ulm.

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