DARWIN INITIATIVE FOR THE SURVIVAL OF SPECIES

Biodiversity, conservation and sustentable use in a Mexican cloud forest

FINAL REPORT

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Final Report

Introduction

This report is a description and an outline of the main achievements of the project *Biodiversity, conservation and sustentable use in a Mexican cloud forest*, and provides the titles and addresses of the *in extenso* documentation of the outputs of the project.

The major outputs of the project were grouped as training, scientific manuscripts submitted or published, other kinds of dissemination, reports, biodiversity listings, and soil surveys.

Training

Darwin Initiative funding was instrumental in the training of both European and Mexican students and coworkers. Two types of training were accomplished: (a) Long-term training for a period of at least 12 months. This kind of training included, in most of the cases, the design, execution, writing, and completion of a thesis project. (b) Short- term training included short visits to UK by Mexican students and coworkers and short visits to Mexico, by European students and researchers.

Thesis projects (long term- training)
Darwin Initiative funding contributed to the design, execution and writing of seven thesis projects, most of them concluded (**Table 1**). All of them consisted of a training period of at least one year. Training included field and laboratory work, data analysis and writing. In addition to the trainees listed in **Table 1**, Janette Cordova, an undergraduate student, worked for us conducting a research which used epiphytes as bioindicators of the cloud forest. The results of such an investigation were already published (see papers and manuscripts). She received training for 18 months including sampling design, fieldwork, plant identification, data analysis and writing.

Table 1. Thesis projects funded by the Darwin Initiative for the Survival of Species through the project Biodiversity, conservation and sustentable use in a Mexican cloud forest.

Thesis	Author	Status	File attached
The multivariate relationship between the diversity of soil macrofauna community and changing environmental conditions along a chronosequence of Cloud Forest in Oaxaca, Mexico	SIMONETA NEGRETE Y	In progress	thesis\repdarwin2.doc
Indicadores de la calidad del suelo en tres cronosecuencias de bosque mesófilo de montaña: Sierra Norte, Oaxaca.	BAUTISTA CRUZ, M.A. *	Concluded	thesis\tesisangelica.pdf
Análisis sucesional en el bosque mesófilo de montaña en el Rincón, Sierra Norte de Oaxaca	BLANCO MACÍAS, A. *	Concluded	thesis\alex.pdf
Influencia del suelo en el crecimiento de cuatro especies arbóreas a lo largo de un gradiente sucesional de un bosque mesófilo de montaña, Sierra Norte, Oaxaca.	HERNÁNDEZ PÉREZ, V. *	Concluded	thesis\tesisvero.pdf
Mineralización del nitrógeno en suelos de bosque mesófilo en la región de El Rincón, Sierra Norte, Oaxaca	VELÁZQUEZ ARAGÓN, ALBERTO*	Concluded	thesis\tssalber.pdf
Modelos de crecimiento para Pinus chiapensis (Mart.) Andresen de El Rincón, Oaxaca, México	SÁNCHEZ VARGAS, N.	Concluded	thesis\nahum.jpg
Ecología de comunidades de Pequeños Mamíferos en tres estados Sucesionales de bosque mesófilo De Montaña En Oaxaca, México	HERNÁNDEZ AYALA YURI	In progress	thesis\mamiferos.doc

* The thesis exam certificate is attached as a file and a hard copy of thesis is enclosed.

Short term training

Elaine Marshall, a M.Sc. from UK (Institute of Ecology and Resource Management, University of Edinburgh) conducted preliminary studies of forest resource use patterns during 1 month at the study area. She worked together with Janete Cordova. Elaine and Janete undertook interviews in the communities to assess the use non timber products in the forest and conducted workshops to assess the perception of the forest in separate groups of man and women.(reports\forestresource.doc). She later undertook a separate project on non-timber products in the same region.

Janete Cordova, a former student from CIIDIR, received short training from Elaine Marshall.

Ana Rito, a former M.Sc. student from the University of Edinburgh, produced a digital cartographic basis of the project by setting up a Geographic Information System at the study area. She also visited Oaxaca and provided training to Raul Rivera in the use of the GIS software ArcView®

Raul Rivera, a Mexican coworker at CIIDIR, was trained by Ana Rito during her visit to our research center in Oaxaca, Mexico. After such training, he continued learning the use ArcView and was responsible of the completion of all the GIS in the study area in this study.

Simoneta Negrete, a Ph. D. at the University of Edinburgh, received financial support from the project for traveling from Mexico to Edinburgh back and forth, during her Ph.D. training, which also has supported her thesis project (see above).

Rafael F. del Castillo, a senior researcher at CIIDIR, Instituto Politécnico Nacional, visited the Institute of Ecology and Resource Management, University of Edinburg, Scotland (August 14-28th, 2000). During this visit, he discussed and analyzed with Adrian Newton, the results and the planning for the second and third stages of the project. Dr. del Castillo also participated in a workshop describing research on forest conservation and management in Mexico, and in an additional workshop focusing on the preparation of a grant proposal which was submitted to the European Community for continuing the investigation on forest ecology and conservation in forests as part of an international team

Philip Bubb from the Environmental Program of the United Nations visit CIIDIR Oaxaca during May 2002. He helped the personnel of CIIDIR to establish links with other institutions involved in conservation, namely Grupo Mesófilo, an non governmental organization, and SEMARNAT, a federal institution, involved in planning and legislation of Mexican Natural Resources.

Sonia Trujillo Argueta a junior researcher from CIIDIR received training on molecular biology techniques at the at the Institute of Ecology and Resource Management, University of Edinburg, Scotland (August 14-28th, 2000)

Papers and manuscripts

We have already six manuscripts finished derived, totally or partially, from Darwin Initiative Funding. Three of them are already published. The rest were submitted, and two are currently accepted for publication with modifications (**Table 2**). Although not part of the research program, an additional published scientific paper by Vargas and del Castillo on theoretical population genetics was included in the list of publications because this study was performed with aid of the computer equipment purchased with the Darwin Initiative funding. As developments in population genetics are necessary for conservation issues, we considered this paper as an additional output of the present project. The Darwin Initiative support was acknowledged in the article.

In addition to that list, at least four scientific manuscripts are going to be derived from the project, for which we have already a significant advance:

(a) Demography of *Pinus chiapensis*. (b) Changes in soil properties during secondary succession of a cloud forest. (c) Successional studies during the secondary succession of a montane cloud forest, and, (d) Multivariate relationships between diversity of soil macrofauna community and changing environmental conditions along a chronosequence of cloud forest. Also, Darwin Initiative was important to start a series of studies for which an additional funding will be needed to complete. For example, our study of nitrogen mineralization *in vitro* was a good starting for a further study of the same process in the field. A study of plant- animal interactions related to seed and seedling dispersal and predation is part of a future project funded by the European Community. This study will complete the plant and fauna studies of the present project.

Dissemination

Our results have been disseminated to three kinds of people: scientists, general non-scientist, and indigenous people from the communities in which the fieldwork was conducted.

In addition to the papers described in the previous section, our results were presented in both national and international symposia, congresses and meetings (Table 3).

Our writing dissemination work included one newspaper article and one magazine article (dissemination\newspaper.jpg, dissemination\NUBES.pdf). Our results were presented to the community of Juquila Vijanos and San Miguel Yotao in different ways: (a) a copy of our results was provided (community\juquila.tif; community\yotaodoc.jpg; community\delicias.jpg); (b) a video was presented to the indigenous communities (community\video_meso.WMV); and (c) formal and informal talks with the members of the communities and authorities involved in conservation, permissions for logging and forest management.

We are also working in a web page. Unfortunately our server is broken down, for the moment. But we will continue to work with this page as soon as our equipment is repaired.

Reports

We are currently including the following individual reports: (a) *Pinus chiapensis* demography, (b) forest resource use patterns, (c) Potential timber species in the study area, (d) Biodiversity of El Gavilan Area, (e) Properties of the ecosystem derived from our studies that can be used as bioindicators for monitoring the cloud forest, and (f) a proposal for a natural protected area (**Table 4**).

Biodiversity assessments

The project made a significant contribution to biodiversity assessment of the cloud forest of the study area. In particular, the project contributed to the knowledge of soil microfauna through Simoneta Negrete´s thesis, for which virtually nothing was known before in this kind of forests. The thesis of Blanco (2001) made a significant contribution to the flora of vascular plants in the area. The thesis by Yuri Ayala contains a list of small mammals. Finally, the article of Cordova and del Castillo (2001) provides a list of vascular plants and major groups of epiphytes. These studies not only contribute to the knowledge of the biodiversity of the area, but also studied how biodiversity change through secondary succession. In this way, this studies have an assess of the impact of forest changes on biodiversity of different grups of organisms from small mammals, soil macrofauna, vascular epiphytes and terrestrial vascular plants. Except for the work of Ayala, all of these studies included true replicates of seral states, something unusual in studies of succession. The study of Ayala could not include true replicates as sampling of small mammals require a continuous sampling throughout all year in all the elected sites. This precludes sampling in more than one chronosequence. Finally, the study of the flora of El Gavilán area contributed to a list of 218 species of vascular plants. In addition to those studies, an electrophoretic survey of *Pinus chiapensis* contributed to the biodiversity knowledge at gene level of this timber species (**Table 5**).

Soil studies

Darwin Initiative funding was instrumental in developing soil studies in the cloud forest . Virtually, no soil information was available before on this kind of forest in Mexico. A brief summary of the studies funded by the present project follows.

No study of soil classification was performed in the area and very few were performed in other cloud forest in the world. The study of Bautista *et al*. (*in revision*) was the first to classify the soils of a Mexican cloud forest.

The thesis of Bautista (2001) shows how soil properties change during secondary succession of the cloud forest using three chronosequences. This study is unique, as we are not aware of any other study performed in tropical montane cloud forest in the world that documented changes in soil properties during secondary succession with three independent replicates (chronosequences). This study provides evidence that soil properties may change dramatically during secondary succession and, therefore, they may potentially influence the species composition and structure of plants.

The thesis of Hernández Pérez, shows that plants typical of different seral stages have different responses to growth and resource allocation to soils from different seral stages. Thus, it is possible that changes in soil properties affect the course of secondary succession in cloud forest.

The study of Velázquez shows that potential nitrogen mineralization change during secondary succession; and that ammonia is the dominant form of nitrogen in old seral stages, whereas nitrate is dominant in early succession states. These results are important in the design of restoration plans, as forest plants can be very selective to the form of nitrogen in soil.

The thesis of Negrete not only provides evidence of the variation in composition of structure of soil macrofauna during secondary succession of the cloud forest, but also reveals how spatial patterns of these organisms change.

Analysis of ecological impact of extraction of forest product

A major contribution of the present project is showing that pine forests are secondary and depend almost exclusively on human intervention. . Because of the relevance of this result a new ongoing project, financed by the European Community, will continue to address this issue and will develop models on population dynamics of this pine.

This part of the project was focused manly on the demography of *Pinus chiapensis* for the following reasons: (a) this pine is the dominant species of young secondary forest surrounding the towns of El Rincón. (b) Because of (a) and the quality of its wood, this pine is the most important forest resource available in the area. (c) This species is considered threatened. (d) We are not aware of any serious intent to preserve this species. We have collected demographic information for several years using permanent plots and conduct a series of simulations to explore the impact of population structure of forest extraction, which is included in the final report.

The study by Elaine Marshall and Janete Cordova deals on the impact of fuel wood extraction

We did not pay much attention to *Magnolia dealbata* that was considered as a secondary important species for the following reasons:

(a) Our studies revealed that this species is not common in the woods and (b) this species is already protected by the people of the communities. In particular, when a site is cleared for agriculture or for other reasons (e.g. trails, right-of-ways of electricity lines, roads, etc.) people do not cut down this plant. Commercially is not very important and it is used only seasonally, during the spring when the plants are blooming.

Developing of a management plan

Our contributions in this area are the following: (a) a survey of biodiversity of the area is already available. (b) we have developed a series of bioindicators which can be used to monitor the forest. Indeed, our first publication deals with the use of epiphytes for this

purpose. Our results show that small mammals, plants, and soil properties can be used as bioindicators for cloud forest monitoring. (c) We provide a survey of the forest resource use patterns in the community of Juquila Vijanos. (d) a list of the major uses of *Pinus chiapensis* trough all its range is provided. (e) The thesis of Nahum Sánchez Vargas developed groth models and site indices for Pinus chaipensis at the study site. Finally, we enclosed a report proposing a conservation area in El Gavilan as a core zone and a management plan in the secondary forest of Juquila, most of them surrounding the core zone. We are in touch with the communities regarding the use and conservation of forest ecosystem.

Table 2. Papers and manuscripts published or submitted derived from research totally or partially funded by the Darwin Initiative for the Survival of Species through the project Biodiversity, conservation and sustentable use in a Mexican cloud forest.

Paper title	Author(s)	Type	Status	File attached
En el país de las nubes	Del Castillo, R.F.	Magazine dissemination	Published	papers\NUBES.pdf
Changes in epiphyte cover in three chronosequences in a tropical montane cloud forest in Mexico.	Cordova J, and R.F. del Castillo	Scientific	Published	papers\life forms.pdf
Ethnobotanical Notes on *Pinus strobus* var.*chiapensis*	del Castillo, R.F. and S. Acosta.	Scientific	Accepted with minor changes	papers\ETHNO.DOC
Clasificación del Suelo de Bosques mesófilos Secundarios de diferentes edades, El Rincón, Sierra Norte-Oaxaca	A. Bautista Cruz, M. C. Gutiérrez Castorena, R. del Castillo and J. Etchevers Barra	Scientific	Submitted and accepted with modifications	papers\articulo.doc
High population differentiation and low genetic diversity in *Pinus chiapensis*, a threatened Mexican pine, detected by RAPD and mitochondrial DNA markers	Newton, A. C., T. R. Allnutt, W. S. Dvorak, R. F. del Castillo, and R. A. Ennos.	Scientific	Submitted	papers\pinemolecular.doc
Genetic associations under mixed mating systems: The Bennett-Binet effect	Vargas, J. A. and R. F. del Castillo	Scientific (see comment in text)	Published	papers\ima.pdf

Table 3. **Proceedings and conferences derived from the Darwin Project (C:\proceedings)**

Hernández, Yuri, M. Briones-Salas, R. F. del Castillo, S. Lozano- Trejo 2002.Analisis de la comunidad de mamíferos pequeños en diferentes etapas serales de un bosque mesófilo de montaña en la sierra norte de Oaxaca. VI congreso Nacional de Mastozoología, Oaxaca de Juárez, México 21-25 de octubre del 2002. proceedings\COMUNIDAD DE MAMÍFEROS PEQUEÑOS.doc

Bautista, C. M.A. Gutierrez Castorena, M.C., del Castillo, R:F: 2002. Changes in soil properties in three montane cloud forest chronosequences in Mexico. To be presented at the 2002 Annual Meeting of the Ecological Society of America, in Tucson, Arizona, August 4-9, 2002. proceedings\bautista.doc

Trujillo, A.S., del Castillo, R.F. Rivera G.R. 2002. Pine invasions in cloud forests: factors determining seedling regeneration in a secondary tropical pine. To be presented at the 2002 Annual Meeting of the Ecological Society of America, in Tucson, Arizona, August 4-9, 2002. proceedings\Trujillo.doc

Negrete. S.Y. 2002. ¿Se cumplen las hipótesis del seguro biológico para la biodiversidad? El caso de los microinvertebrados del suelo en un bosque mesófilo de Oaxaca. Instituto de Ecología Xalapa Veracruz, México. 22 de mayo del 2002 proceedings\negrete.jpg.

Negrete. S.Y., Fragoso, C., William, H.O., Newton, A. 2001. Do sucessional changes in aboveground environmental conditions lead toa parallel succession in soil macrofaunal communities? Abstracts of 86 Annual Meeting of the Ecological Society of America, Monona Terrace, Madison, Wisconsin, p. 323 dissemination\negretabs.pdf.

Bubb, P. 2001. Componentes del desarrollo sustentable una visión holísitica. conference May 24th , CIIDIR Oaxaca, Méxicoproceedings\philipconf.jpg

Del Castillo, R. F., A, Bautista Cruz, A. Blanco Macías, M.A. Briones Salas, J. Cordova,.Veláquez y R. Rivera. 2001. Bases ecológicas para un manejo sustentable del bosque mesófilo de montaña : bioindicadores y dinámica sucesional ante el disturbio I. VI Foro Estatal de Investigación Científica y Tecnológica. SIBEJ CONACyT. 10 – 11 Diciembre 2001. Instituto Tecnológico de Oaxaca Memoria pp. 77-78. proceedings\foro2001.pdf

Del Castillo, R.F. A. Bautista Cruz, A Blanco Macías, M.A: Briones Salas, J. Córdova Velázquez y R. Rivera. 2000, Bases ecológicas para un manejo sustentable del bosque mesófilo de montaña, bioindicadores y dinámica sucesional ante el disturbio. V Foro Estatal de Investigación Científica y Tecnológica, Memoria, 11-12 de diciembre 2000, Oaxaca.proceedings\foro2000.pdf

Trujillo, A.S. del Castillo, R.F., Newton, A.C. and Allnutt, T.R. 2000. Genetic diversity in the endangered pine *Pinus chiapensis,* British Ecological Society. 2000 special symposium. Plants stand still but their genes don´t: integrating ecological and evolutionary process in a spatial context. Royal Holloway College, Egham, UK 21 – 31 August 2000. P. 26.proceedings\britishecol2000.pdf

del Castillo, R.F., S. Trujillo, N. Sánchez y R. Rivera. 1999. Comparing restricted *vs.* Widespread populations of the same species: studying the causes of extinction in *Pinus* . XVI International Botanical Congress Abstracts. St. Louis.U.S.A. 504.proceedings\MISSOURI.jpg

Bautista-Cruz, A., R.F. del Castillo, y R. Rivera. 1999. Changes in soil properties in three chronosequences in a montane cloud forest of Sierra Norte, Oaxaca, Mexico. XVI International Botanical Congress Abstracts. St. Louis.U.S.A. 523. proceedings\MISSOURI.jpg

Cordova, J., R.F. del Castillo. 1999. Epiphytes cover in diverse successional stages of a cloud forest in the Sierra Norte of Oaxaca. . XVI International Botanical Congress Abstracts. St. Louis.U.S.A. 550. proceedings\MISSOURI.jpg

Bautista Cruz, M.A. y R. F. del Castillo, R. Rivera 1999. Dinámica de los nutrimentos del suelo en las diferentes etapas sucesionales de un bosque mesófilo de montaña. 29° Congreso Nacional de la Ciencia del Suelo. La Investigación Edafológica en México. Tapachula de Córdova y Ordóñez, Chiapas. 27p. proceedings\QUIMSUELO.jpg

Table 4. Reports from research totally or partially funded by the Darwin Initiative for the Survival of Species through the project Biodiversity, conservation and sustentable use in a Mexican cloud forest.

Author(s)	Title	File
R.F. del Castillo S. Trujillo	Estudio demográfico de *Pinus chiapensis*	\reports\Estudio demográfico de Pinus chiapensis.doc
Rafael F. del Castillo Salvador Acosta Castellanos Alejandra Blanco Macías Raúl Rivera García	Inventario florístico de El Gavilán	\reports\Inventario florístico de la zona de El Gavilán.doc
R.F. del Castillo Raúl Rivera García	Propuesta De Area Natural Protegida El Gavilán, Sierra Norte, Oaxaca, México	plan de manejo\propuesta.doc
R.F. del Castillo	Usos Maderables Potenciales del Bosque Mesófilo de Montaña de El Rincón.	reports\timbersp.doc
Elaine Marshall and Janette Córdova	Field study of forest resource use patterns in the community of Juquila Vijanos, in el Rincon, in the sierra norte of Oaxaca, Mexico	reports\forestresource.doc

Table 5. Reports, papers, manuscripts or thesis derived from which have contributions to the biodiversity of the study area**.**

Report type	Title	**Organism**
thesis	The multivariate relationship between the diversity of soil macrofauna community and changing environmental conditions along a chronosequence of Cloud Forest in Oaxaca, Mexico	soil macrofauna
report	Ecología de comunidades de pequeños mamíferos terrestres en tres cronosecuencias de bosque mesófilo de montaña en Oaxaca, México.	Small mammals
report	Inventario florístico de El Gavilán	Vascular plants
thesis	Análisis sucesional en el bosque mesófilo de montaña en el Rincón, Sierra Norte de Oaxaca	Vascular plants
paper	Changes in epiphyte cover in three chronosequences in a tropical montane cloud forest in Mexico.	Vascular plants/cryptogams
report	Inventario florístico de El Gavilán	Vascular plants
thesis	Estudio de la variación genética de *Pinus chiapensis* (Mart.) Andresen a través de métodos electroforéticos	Genetic variation of *Pinus chiapensis*