

# **Darwin Initiative for the Survival of Species**

## **Final Report**

### **Terrestrial invertebrate biodiversity in Galapagos: training and collection rehabilitation.**

**Project Reference No. 162/9/010**



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# Darwin Initiative for the Survival of Species

## Final Report

### 4 Darwin Project Information

|                          |   |
|--------------------------|---|
| Project title            | Terrestrial invertebrate biodiversity in Galapagos: training and collection rehabilitation. |
| Country                  | Ecuador   |
| Contractor               | National Museums & Galleries of Wales   |
| Project Reference No.    | 162/9/010   |
| Grant Value              | £160,652  |
| Starting/Finishing dates | April 2000 to March 2003  |

### 2 Project Background/Rationale

#### Location and circumstances of the project

The Galapagos archipelago, Ecuador is the largest, most complex tropical oceanic island ecosystem that still remains in pristine condition. It is a World Heritage Site of exceptional value for its flora and fauna. The principal threat to the unique biological diversity is the introduction and dispersal of alien organisms.

The WWF funded ecosystem regional planning workshop in the Galapagos in 1999, attended by over 60 scientists from around the world, and endorsed by the Minister for Environment Dr Yolanda Kakabadse, identified the urgent need to obtain baseline invertebrate data for the Galapagos. Invertebrates are the least studied, yet the largest group of organisms in the archipelago. This is one of the most urgent priority areas for research and is essential to the preservation of Galapagos. Prior to identifying species and communities in danger of extinction, it is necessary to know what species are found in the archipelago, and which are entirely restricted to the Galapagos Islands. At the same time, an inventory of introduced species is required to identify species that are a threat to the conservation of flora and fauna of Galapagos. This information is now urgently required with the need to implement the Special Law for Galapagos with a planned quarantine and inspection system for the islands (SICGAL). This work is recognized within the management plan of the Galapagos National Park Service (GNPS), the responsible Government body, although within-country funding is not available for it. The Government relies on the Charles Darwin Research Station (CDRS) to carry out this research in the islands.

#### Identification of the need for this project

The Charles Darwin Foundation (CDF), founded with the auspices of the UNESCO in 1959, operates the Charles Darwin Research Station in Puerto Ayora, Galapagos. The Charles Darwin Foundation is the only organization in the Galapagos that conducts research to protect the unique biodiversity. The Galapagos National Park Services is CDF's primary partner in the conservation efforts as described in the memorandum of understanding between the Ecuadorian government and the CDF.

The plans for this project were derived from this workshop and discussions with staff of CDRS, including its Director, Head of Department of Plant and Invertebrate Sciences (Dr Alan Tye) and then Head of the Invertebrates Programme (Dr Charlotte Causton).

In 2000, the Terrestrial Invertebrate Department was created with several full-time entomologists and the Invertebrate Reference Collection to support the project's efforts.

### **3 Project Summary**

#### Purpose and objectives of the project?

This project aimed to provide training in sampling and identification of the major invertebrate groups in order to provide baseline data for, a) a self-sustaining monitoring programme and, b) identifying future conservation actions. The overall objectives were:

- 5 To train CDRS personnel in invertebrate taxonomy.
- 6 To establish training sessions for local scientists and National Park staff in simple pest identification techniques and sampling protocols.
- 7 To evaluate current museum infrastructure, identify what was needed to be able to provide a reference collection of common invertebrates and an electronic database, and buy equipment. The rehabilitation of the small existing collection and expansion under this programme will provide the basis for future improvements to the facilities.
- 8 To strengthen knowledge of potentially invasive organisms that may threaten survival of the unique fauna.
- 9 To recommend further conservation actions to CDRS and GNPS.
- 10 Acquire funding for continuation of the project (species monitoring) and for conservation actions identified by the project.

#### Modifications of original objectives or operational plans

The original objectives of the project were not modified during the reporting period and no significant changes made except in one objective. The original plans of holding a workshop at the end of the project did not come to fruition. Dr Charlotte Causton, the original co-ordinator of the project left Galapagos in June 2002 and was not replaced until October 2002, only 6 months from the end of the project. By then it was both too late to arrange a workshop but also it was considered to be too expensive in relation to the perceived benefits at this stage. The international airfares alone would have been £10,000 to gather participants. In hindsight it might not have been an appropriate aim in relation to Galapagos invertebrates where the taxonomic expertise is so scattered. While this was reported to DI Secretariat it was not discussed at an early enough stage to make alternative plans.

### Articles under the Convention on Biological Diversity (CBD)

The following Articles under the Convention on Biological Diversity best describe the project:

| <b>Article No./Title</b>                                  | <b>Article Description</b>   |
|---|--|
| 7. Identification and Monitoring                          | Identify and monitor components of biological diversity, particularly those requiring urgent conservation; identify processes and activities which have adverse effects; maintain and organise relevant data.  |
| 8. Prevent introduction                                   | Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.  |
| 10. Sustainable Use of Components of Biological Diversity | Integrate conservation and sustainable use in national decisions; protect sustainable customary uses; support local populations to implement remedial actions; encourage co-operation between governments and the private sector.  |
| 12. Research and Training                                 | Establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components; promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries (in accordance with SBSTTA recommendations). |
| 13. Public Education and Awareness                        | Promote understanding of the importance of measures to conserve biological diversity and propagate these measures through the media; cooperate with other states and organisations in developing awareness programmes.   |
| 16. Access to and Transfer of Technology                  | Countries shall ensure access to technologies relevant to conservation and sustainable use of biodiversity under fair and most favourable terms to the source countries (subject to patents and intellectual property rights) and ensure the private sector facilitates such assess and joint development of technologies.   |
| 17. Exchange of Information                               | Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge  |

### Objectives

The project's objectives were successfully met:

1. Facilitate identification work through developing a well stored, accessible reference collection

At the beginning of the DI project, the Reference Collection included 12,000 specimens under poor conditions. At the end of the project, more than 26,000 specimens were maintained in the Collection following international standards.

2. Establish collection protocols

A Reference Collection Protocol was established to standardize the Museum's procedures, exchange of material, cataloguing of specimens, and maintenance of the specimens and use of the Museum.

3. Enact inter-institutional agreements for exchange of material

Following international standards, a protocol was written to define the procedures of exchanging material between institutions, independent scientists and the CDRS.

4. Train CDRS personnel in taxonomy

Several CDRS personnel received training in taxonomy including the Museum's curator and the assistant. As a result of the training sessions, a pictorial key for the Galapagos spiders was developed by the Museum's Assistant Curator.

5. Establish training sessions for national scientists and GNPS staff

Various national scientists and GNPS staff received training in arthropod taxonomy, museum procedures and collecting methodologies including a postgraduate training and MSc course in the UK.

6. Design ecological methodologies

Significant advances were made in the research of biological and ecological data on invertebrates including research on important quarantine and invasive pests and their control such as cottony cushion scale (or Australian mealybug, *Icerya purchasi*), the little fire ant, *Wasmannia auropunctata*, the black fly, *Simulium ochraceum*.

## 4 Scientific, Training, and Technical Assessment

### Research, training, and/or technical work.

The emphasis of the project was not so much on research but building capacity and increasing confidence in the ability to identify invertebrates. This has now allowed some preliminary ecological work to be carried out, especially into pollination ecology and insect plant interactions.

Some taxonomic work has been carried out on Hemiptera by MRW and also identification of potentially new introductions and new records in this group. A first paper on 11 new Heteroptera records for Galapagos has been accepted for publication (Henry, T.J & Wilson, M.R. Journal of the New York Entomological Society in press 2004)

The project significantly increased the local capacity in arthropod collecting and taxonomy for CDRS and GNPS staff. At the end of the project, 7 trained entomologists were employed by the Invertebrate Department to collect, identify the Galapagos invertebrates and manage the Reference Collection.

Several CDRS staff received taxonomy and museum management training at the NMGW. Lazaro Roque was enrolled as MSc student at Cardiff University. In 2002, he was accepted as Ph.D. student (and will complete his PhD thesis in 2004)

As a result of the DI project, more than 15 papers were published and 10 more are presently in preparation.

### Taxonomic Training courses.

An initial training course in Galapagos focussed on methodology for the preservation of specimens in the collection and on the curation and collection management of the existing collection. Great emphasis was placed on what data should be included on the labelling of specimens for future use.

The taxonomic training courses were intended for CDRS entomology staff and student volunteers and undergraduates undertaking project work in Galapagos. No training manuals were written especially for the training courses in Galapagos. They largely utilised some existing material as well as the draft keys and checklists to the insects of Galapagos prepared by Prof. Stewart Peck (Carleton University, Canada).

Taxonomic training courses were carried out by direct examination of specimens and use of keys and by close supervision and discussions. Initially specimens were collected during short field trips in various localities close to the Charles Darwin Station in Santa Cruz. Additional specimens for study were available from the permanent collection. Specimens that were identified during the training courses were added to the collection.

Field excursions allowed discussion and demonstrations of various trapping and sampling techniques for invertebrates.

During the training sessions techniques in slide making were demonstrated as well as preparing specimens for morphological examination of internal structures, and for preserving these samples after examination and identification. The importance of keeping voucher specimens was also emphasised.

As a result of the taxonomic training there was immediately an increased confidence in being able to recognise species

Most taxonomic training took place in Galapagos but one important group the Hymenoptera (bees and wasps) was not dealt with in Galapagos. This was covered by sending one person (Ruth Boada) to an internationally recognised training course held annually in Imperial College, London, where a small team of world specialists train groups of, mostly overseas, students. However, this does not address the need for more people to be trained in Galapagos in this very important group of insects.

The following training courses and activities were held.

- 11 After an initial visit by MR Wilson in July 2000, two training courses were held in November 2000: In the invertebrate collecting techniques, collection management and the application of the Red list for threatened species.
- 12 May 2001: Hemiptera: 3 components: Auchenorrhyncha (leafhoppers & planthoppers), Coccoidea (scale insects) and Heteroptera (true bugs).
- 13 Visit to National Museums & Galleries of Wales by Germania Estevez to study museum curation and database techniques.
- 14 Lazaro Roque to Cardiff, registers for MSc, supervised by Dr Hefin Jones, Cardiff University.
- 15 October/November 2001: Coleoptera & Diptera courses held in Galapagos.
- 16 April 2002: International training course on Hymenoptera, Imperial College, London attended by Ruth Boada
- 17 September – November 2002. Lazaro Roque to Cardiff. Report on MSc thesis reviewed and recommendation made that transfer to PhD would be approved.

## **5 Project Impacts**

### Project achievements

Before the DI project started the invertebrate collection was housed in rather poor quality storage that was inadequate for a permanent collection. It was not databased and it was difficult to access and use. The invertebrate collection has also doubled in size.

The Collection now comprises more than 26,000 specimens stored in insect boxes and alcohol, and has a comprehensive data base soon accessible through the WWW. With funds of the project, basic equipment and material for the Reference Collection were purchased. Presently three full-



time curators maintain the collection and permanently add new specimens. Up to 4 Ecuadorian thesis students and 6 volunteers are assisting in processing newly collected specimens.

An important achievement is that the Galapagos Invertebrate Reference Collection is now officially recognized as the CDRS Invertebrates Collection in the Bishop Museum, Hawaii. Checklists of the following groups were finalized as a result of the DI project:

Acarina  
Araneae  
Isopoda  
Scorpiones  
Solifugae  
Schizomida  
Amblypygi  
Opinionones  
Pseudoscorpiones  
Symphyla  
Chilopoda  
Diplopoda  
Orthoptera  
Hymenoptera: Formicidae  
Lepidoptera,  
Coleoptera  
Diptera

All specimens are labeled and registered in the Reference Collection database with ecological and biological information where available.

#### Meeting obligations under the Biodiversity Convention (CBD)

The Galapagos Archipelago is the largest, most complex tropical oceanic island ecosystem that still remains in near pristine condition: it is estimated that 95 percent the original, pre-human diversity of species is still recoverable (Snell et al., 2002). Galapagos is a UNESCO World Heritage Site of exceptional value due to its high rate of flora and faunal endemism and is considered one of Earth's most biologically outstanding terrestrial, freshwater and marine habitats as defined by World Wildlife Fund (WWF) in its Global 2002 analysis (CDF & WWF, 2002; Margules et al., 2000).

Galapagos is the world's last nearly intact invertebrate ecosystem where evolutionary and ecological processes existing prior to homogenization by invasive species can be identified. Although scientists have intensively studied and collected in the Galapagos Islands, terrestrial arthropods, the largest faunal group, have been largely ignored and are poorly understood (Peck, 2001; Snell et al., 2002). The WWF funded ecosystem regional planning workshop held in Galapagos in 1999, attended by over 60 international scientists, and endorsed by the Ecuadorian

Minister of Environment, identified the urgent need to obtain baseline arthropod data for the Galapagos (CDF & WWF, 2002). With the help of the DI project, local capacity was built to initiate the important process of an invertebrate baseline study and to improve the museum management.

In 2000, the CDRS officially formed the Terrestrial Invertebrate Department as response to the need of base line information on the Galapagos invertebrate fauna. The department improved its small invertebrate collection to accommodate new specimens and comply with international standards. In 2004, the Invertebrate Museum will receive a new building to host the growing reference collection.

Measures for biodiversity conservation defined in the CBD Articles.

See Appendix 1 to show the contribution made by different components of the project to the measures of biodiversity conservation defined in the Articles of the CBD

The project worked directly with the two organisations charged with implementing Ecuador's commitments under the Biodiversity Convention in Galapagos (CDRS and GNPS). It directly addressed several articles of the Biodiversity Convention as given above; 7 (identification, monitoring), 8 (possible introduction), 10 (Sustainable use of components of biological diversity) 12 (research, training), 13 (public education), 16 (technology transfer), 17 (information exchange).

The project fed results into Ecuador's CBD focal point, the Ministry of the Environment, and its local representative, the GNPS, in order to aid their conservation planning.

| Article No./Title   | Article Description   |
|---|---|
| 7. Identification and Monitoring                          | The CDRS implemented a long-term ecological monitoring and surveillance system for native species to detect potential adverse impacts on eco-systems. As part of the quarantine system, the Invertebrate Department set up a specific surveillance system to detect invasive species. An important tool is the Reference Collection to be able to quickly identify new species and to implement an emergency response plan. |
| 8. Prevent introduction                                   | Personnel trained by the DI project assist in the quarantine efforts by identifying intercepted species. The database of the Reference Collection is essential to respond to the challenges of new introductions.   |
| 10. Sustainable Use of Components of Biological Diversity | The results of the DI project provided data that is important for the GNPS to justify their decisions on conservation efforts in order to protect the Galapagos biodiversity. The base line information of the invertebrate fauna is essential to coordinate national decisions on the protection of the Galapagos.   |
| 12. Research and Training                                 | The DI project allowed the Invertebrate Department of the CDF to prioritize its research program in native insect conservation. Several   |

|  |  |
|--|--|
|  | <p>projects resulted directly in conservation efforts to protect the indigenous insect fauna, such as the implementation of the Galapagos quarantine system and research on the insect fauna in volcano Alcedo.</p> <p>Data on indigenous insect species collected during the DI project helped define management decisions for specific conservation priority sites.</p>                            |
| 13. Public Education and Awareness       | <p>Through the Communication Department of the CDF, the DI results were disseminated to the broad public and to the political decision makers in Galapagos and on national and international level. Several talks, radiobroadcast and TV interviews transmitted the importance of insect conservation for Galapagos.</p>   |
| 16. Access to and Transfer of Technology | <p>Key issue of the DI project was the access and transfer of science related to conservation, taxonomy and museum management from the University of Cardiff to the Department of Invertebrates. Capacity building is considered essential in the effort to protect the unique Galapagos biodiversity.</p>   |
| 17. Exchange of Information              | <p>Training by National Museums &amp; Galleries of Wales staff allowed developing a comprehensive data base for the Invertebrate Department's museum. During the DI project, several Ecuadorian professionals were trained at Cardiff and one student will defend his Ph.D. thesis in 2004. Another Ecuadorian professional recently started a 6-month Darwin Fellowship at Bristol University .</p> |

### Training or capacity building

Training in museum management and taxonomy by NMGW has helped the CDRS to establish research strategies for endangered endemic invertebrate species, built the capacity to increase the knowledge of Galapagos invertebrates. In the 3 years of the DI project more than 40 species new to science were described and more than 100 new records for Galapagos were recorded.

Lazaro Roque, the museum curator, is finishing up his Ph.D. research and will defend his thesis in 2004. His research has helped to significantly increase our knowledge on Lepidoptera in Galapagos.

Germania Estevez, the assistant curator, increased the number of invertebrates in the museum from 12000 to more than 26000 specimens. Several check lists are available for Diptera, Orthoptera, Hymenoptera and spiders. Most of the museum data are in electronic form and will be soon available on the web.

Ruth Boada intensively researched the ecological relationship between endemic plants and insects in order to define conservation actions. She also received training at Cardiff University. In April 2004, Ruth Boada is starting a 6-month internship at Bristol University as a Darwin Fellow, possibly leading to a Ph.D at Bristol.

Some other students that received some training have returned to mainland Ecuador and several

have obtained positions that involve their training.

Presently 3 full-time staff are employed to manage the Invertebrate Reference Collection.

#### Collaboration between UK and local partner.

The DI project strengthened the relationship between research institutions and museums in the UK and the CDRS. Many research collaborations have resulted from the initial project, including working relationships with the National History Museum in London. The project has strengthened the personal links and research projects between the UK Co-ordinator and Galapagos but also created links in mainland Ecuador as well. After the project conclusion, several follow-up visits took place by the UK and CDRS staff and many project proposals were presented to various donors as direct results of the DI project data.

The increased knowledge on Galapagos invertebrates helped determine conservation efforts that CDRS recommends to its partner, the Galapagos National Park Services (GNPS). The most direct influence the DI project had on local institutions is the implementation of the Galapagos Inspection and Quarantine System (SICGAL). CDRS, GNPS and many scientists agree that the biggest threat to the Galapagos diversity comes from the introduction of invasive invertebrate species. Without a comprehensive baseline information on indigenous invertebrate fauna, it is difficult to assess the impact of invasive species. Intensive taxonomy training and efficient collection management are key points in conservation management decisions.

#### Social impacts

The CDRS generally presents research results to the local community through its communication department. In workshops, seminars, open day and media presentations, results of the DI project were presented to Galapagos stakeholders, such as farmers, park wardens, guides, etc.

All park wardens and tourist guides are obliged to report observations of new invertebrate species or new records to the GNPS and the CDRS.

A massive public campaign of the potential and actual impact of invasive species helped to “buy in” the community and gain confidence and support for the SICGAL quarantine system.

## **6 Project Outputs**

#### Project outputs

See Appendix II for list of project outputs

#### Publications

See Appendix III for list of publications

#### Dissemination of project outputs and outcomes

The CDRS generally presents research results to the local community through its communication department. In workshops, seminars, open day and media presentations, results of the DI project were presented to Galapagos stakeholders, such as farmers, park wardens, guides, etc.

## 7 Project Expenditure

**Total Darwin Grant: £160,652**

Annual Darwin Grant:

2000/2001 £44,684

2001/2002 £69,624

2002/2003 £46,344

| <b>Expenditure details</b>                | <b>2000/2001</b> | <b>2001/2002</b> | <b>2002/2003</b> | <b>Total</b> |
|---|------------------|------------------|------------------|--------------|
| Rents, rates, heating. lighting. cleaning |                  |                  |                  |              |
| Postage stationary                        |                  |                  |                  |              |
| Travel & subsistence                      |                  |                  |                  |              |
| Printing                                  |                  |                  |                  |              |
| Conferences, seminars                     |                  |                  |                  |              |
| Capital items; storage, cabinets          |                  |                  |                  |              |
| Other                                     |                  |                  |                  |              |
| Salaries                                  |                  |                  |                  |              |

Variance from expected

## 8 Project Operation and Partnerships

### Local partners

Throughout the project the only local partner was the Charles Darwin Research Station in Galapagos.

Joint-institutional strategy planning meetings between CDRS and GNPS were held throughout 2003 to prioritize research needs and conservation actions.

I am not aware of any similar projects elsewhere in Ecuador. The Catholic University in Quito has a large insect collection and also trains students in basic collection and taxonomic work as part of their undergraduate course. Some of these graduates have gone on to work in Galapagos as part of this project.

### International partners

The DI project was complemented by projects related to invasive species financed by GEF (Global Environment Facilities) and UNF (United Nation Foundations).

## **9 Monitoring and Evaluation, Lesson learning**

### Monitoring and Evaluation (M&E)

Evaluation centred around two basic measures of progress that contribute towards the purpose of the project. One is the number of people that have been trained during the reporting period. The second is that as a result of training has the collection been enhanced? Measures of achievement in the latter are both qualitative and quantitative. Additional specimens collected and added to the permanent collection were counted and also those that have been added to the database. The enhanced capability and confidence in sampling and being able to deal with the identification and preparation of different invertebrate groups is a direct measure of progress made during the project.

A direct measure of success is the number of specimens stored in the Invertebrate reference collection before and after the DI project. Before the start of the project, only 12000 specimens were stored in the collection without an efficient labelling system, data base entries and proper management protocols. The number increased to almost 26000 specimens, properly classified, labelled, and maintained. Seventeen checklists were finalized, with all specimen data are in a data base.

Evaluation of training progress was a continuous process throughout the DI project. The CDRS applies an internal evaluation system to monitor the efficiency of its staff. At the end of each year, all personnel present a detailed workplan with objectives and goals. The head of each department evaluates department's staff according to the workplan.

### Internal or external evaluation

The CDRS is subject to periodic external and internal auditing to assure the correct use of funds according to the annual PlanOps. Several independent external audits are performed each year to assess and analyse the CDRS bookkeeping.

Scientific work progress is permanently evaluated by the Heads of the each Department and subsequently by the Director of Sciences of the CDRS. Annual reports are presented to the CDF Board and the General Assembly for approval.

### Key lessons.

The DI project proved essential for building local capacity in invertebrate research and museum management. With the help of the DI project financing and the Cardiff scientific and technical training support, the CDRS Invertebrate Department could finally be established and important work on the Galapagos invertebrate fauna initiated. Although, entomological work was done prior, the DI project sparked the beginning of an intensive research on Galapagos invertebrates

and initiated the Invertebrate Reference Collection.

Budgeting. Some of the original budget headings did not fully reflect the expenditure or had not been allowed for- especially the fees for external MSc. These amounts needed to be transferred from salaries of from T & S.

The original spreadsheet that was set up to manage the finances of the project was inflexible and could not be changed when DI wanted the finances presented in a different way. The original way of estimating expenditure in one quarter against actual expenditure in the quarter before worked well enough but was difficult to explain and was difficult to manage at the end of the financial year.

## **10 Darwin Identity**

### Publicity for DI

Wherever possible the Darwin Initiative was publicised; In all technical reports, CDRS annual reports and publications related to the DI project, DI was mentioned as financial contributor.

### Understanding of DI in Ecuador

DI is a well known and respected supporter of conservation programs throughout Galapagos and Ecuador.

### Contribution of Darwin funding

The annual budget of the CDRS is around 4 million dollars so an annual DI contribution of around 100,000\$ clearly formed a small part of the total budget. However, the DI project of the Invertebrate Department formed an important part of its funding over the three years of the project. DI was the most important donor for research of endemic and native species and the invertebrate museum.

## **11 Leverage**

### Additional funds

During the lifetime of the project, CDRS secured two major projects related to alien invasive species control financed by GEF and UNF. It is certainly the case that the DI grant assisted in being successful in these additional projects.

### Strengthening ability to secure funds

Whenever possible discussions were held on the possibilities of securing additional and further funds to continue invertebrate work in Galapagos. The Invertebrate Department presented projects to various donor organizations such as NSF to secure continuation of its work.



## **12 Sustainability and Legacy**

### What project achievements will endure?

The collection maintained at CDRS will be the enduring legacy of the project, and while staff remain in post the collection will continue to grow and be used. The project partners remain in constant weekly contact and discussions made on further research topics.

There are no final conclusions to a project of this nature. Further information is always required in order to monitor the distributions of the fauna and any potential changes and threats from invasive species. The legacy of the improved collection storage is a lasting one that can only be improved by further funding to allow trained personnel to remain in post.

### Additional funding

Additional funds are being sought to continue aspects of the project. CDRS applied (July 2003) for further funding from the US National Science Foundation to build on the inventory and database work started during the Darwin Initiative project. The proposal was rejected but has good chances for approval in the next re-submission in July 2004.

MRW was successful (September 2003) in an application to The Royal Society, to allow fieldwork (November 2003) in mainland Ecuador, in order to search for Hemiptera that may be related to the Galapagos fauna.

MRW applied for National Geographic funding to enable further visits to Galapagos in 2004/5 to continue research work on Hemiptera speciation and characterisation of species but this application failed in the second round.

## **13 Value for money**

We consider the project to have been good value for money for the following reasons.

1. The confidence gained by individuals in Galapagos in dealing with the invertebrate fauna, and the potential problems of invasive species.
2. This confidence has allowed other grant applications to be made to continue the work but also could allow personal development by individuals in gaining other employment in invertebrate biodiversity assessment.
3. One individual (Lazaro Roque) will complete a PhD thesis at Cardiff University (started as MPhil during project), and will publish further peer-reviewed papers on the Lepidoptera of Galapagos.
4. One individual (Ruth Boada) has gained a Darwin Fellowship to enable further study in the UK in 2004.

### **Author(s) / Date**

Dr M.R. Wilson with the assistance of Dr Helmuth Rogg  
December 2003

## Appendix I: Project Contribution to Articles under the Convention on Biological Diversity (CBD)

| <b>Project Contribution to Articles under the Convention on Biological Diversity</b> |           |   |
|--|-----------|---|
| Article No./Title  | Project % | Article Description   |
| 6. General Measures for Conservation & Sustainable Use                               | <b>30</b> | Develop national strategies which integrate conservation and sustainable use.   |
| 7. Identification and Monitoring   | <b>20</b> | Identify and monitor components of biological diversity, particularly those requiring urgent conservation; identify processes and activities which have adverse effects; maintain and organise relevant data.   |
| 8. In-situ Conservation  | <b>10</b> | Establish systems of protected areas with guidelines for selection and management; regulate biological resources, promote protection of habitats; manage areas adjacent to protected areas; restore degraded ecosystems and recovery of threatened species; control risks associated with organisms modified by biotechnology; control spread of alien species; ensure compatibility between sustainable use of resources and their conservation; protect traditional lifestyles and knowledge on biological resources. |
| 9. Ex-situ Conservation  |           | Adopt ex-situ measures to conserve and research components of biological diversity, preferably in country of origin; facilitate recovery of threatened species; regulate and manage collection of biological resources.   |
| 10. Sustainable Use of Components of Biological Diversity                            |           | Integrate conservation and sustainable use in national decisions; protect sustainable customary uses; support local populations to implement remedial actions; encourage co-operation between governments and the private sector.   |
| 11. Incentive Measures   |           | Establish economically and socially sound incentives to conserve and promote sustainable use of biological diversity.   |
| 12. Research and Training  | <b>20</b> | Establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components; promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries (in accordance with SBSTTA recommendations).  |
| 13. Public Education and Awareness   | <b>10</b> | Promote understanding of the importance of measures to conserve biological diversity and propagate these measures through the media; cooperate with other states and organisations in developing awareness programmes.  |
| 14. Impact Assessment and Minimizing Adverse Impacts                                 |           | Introduce EIAs of appropriate projects and allow public participation; take into account environmental consequences of policies; exchange information on impacts beyond State boundaries and work to reduce hazards; promote emergency responses to hazards; examine mechanisms for re-dress of international damage.   |
| 15. Access to Genetic Resources  |           | Whilst governments control access to their genetic resources they should also facilitate access of environmentally sound uses on mutually agreed terms; scientific research based on a country's  |

|  |             |  |
|--|-------------|--|
|  |             | genetic resources should ensure sharing in a fair and equitable way of results and benefits.   |
| 16. Access to and Transfer of Technology |             | Countries shall ensure access to technologies relevant to conservation and sustainable use of biodiversity under fair and most favourable terms to the source countries (subject to patents and intellectual property rights) and ensure the private sector facilitates such assess and joint development of technologies.                 |
| 17. Exchange of Information              | <b>10</b>   | Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge  |
| 19. Bio-safety Protocol                  |             | Countries shall take legislative, administrative or policy measures to provide for the effective participation in biotechnological research activities and to ensure all practicable measures to promote and advance priority access on a fair and equitable basis, especially where they provide the genetic resources for such research. |
| <b>Total %</b>                           | <b>100%</b> |  |

## Appendix II Outputs

| Code                    | Total to date                 | Detail  |
|-------------------------|-------------------------------|---|
| <b>Training Outputs</b> |                               |   |
| 1a                      | 1                             | Number of people to submit PhD thesis   |
| 3                       | 1 Darwin Fellowship           | Number of other qualifications obtained   |
| 4a                      | 10                            | Number of undergraduate students receiving training   |
| 4b                      | 6                             | Number of training weeks provided to undergraduate students   |
| 7                       | 5 training manuals            | Number of types of training materials produced for use by host country(s)   |
| <b>Research Outputs</b> |                               |   |
| 8                       | Total of 12 weeks by 4 people | Number of weeks spent by UK project staff on project work in host country(s)  |
| 10                      | 3                             | Number of formal documents produced to assist work related to species identification, classification and recording.     |
| 11a                     | 6 (plus others in prep)       | Number of papers published or accepted for publication in peer reviewed journals  |
| 12a                     | 1                             | Number of computer-based databases established (containing species/generic information) and handed over to host country |
| 13a                     | 26,000 specimens              | Number of species reference collections established and handed over to host country(s)                                  |
| 13b                     | 1                             | Number of species reference collections enhanced and handed over to host country(s)                                     |

|                              |   |   |
|------------------------------|---|---|
| <b>Dissemination Outputs</b> |   |   |
| 14a                          | 3   | Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work                   |
| 14b                          | 3<br>see also below for additional outputs. | Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/disseminated. |
| 15a                          | 1   | Number of national press releases or publicity articles in host country(s)  |
| <b>Physical Outputs</b>      |   |   |
| 20                           | £35,000                                     | Estimated value (£s) of physical assets handed over to host country(s)  |

Notes:

14b: Additional outputs:

Posters by MRW at Entomological Society of America Annual meetings in Montreal, December 2000, Fort Lauderdale, 2002 and Cincinnati 2003.

16a: web- based newsletter was never instigated during the project but details of Invertebrate projects were included on the CDRS website.

### Appendix III: Publications

| Type    | Detail  | publishers   | Available from         | cost |
|---------|---|--|------------------------|------|
| Journal | Davis, D., Landry, B. and Roque, L. 2001. Two new Neotropical species of Bucculatrix leaf miners (Lepidoptera: Bucculatricidae) reared from Cordia (Boraginacea).   | Zoological Swiss Magazine, vol. 109, number 2 277-294        | Publishers & libraries | N/A  |
| Journal | Landry, B. and Roque-Albelo, L. 2001. Presence of Stenoma catenifer Walsingham (Lepidoptera, Stenomidae), the Avocado seed moth, in the Galápagos.  | Noticias de Galápagos. Vol 62                                | Publishers & libraries | N/a  |
| Journal | Roque-Albelo, L. 2001. The Butterflies (Papilionoidea, Hesperioidea) of the Galapagos Islands, Ecuador: Distribution, Host Plants and Biology..   | Rev. Zoological Society of Brazil                            | Publishers & libraries | N/a  |
| Journal | ROQUE- ALBELO L. & B. LANDRY (2001). The Sphingidae of the Galapagos Islands: their identification distribution, and host plants, with new records.   | Bull. de la Societe Entomologique Suisse 74, 217-226 .       | Publishers & libraries | N/a  |
| Journal | ROQUE-ALBELO, L, F. C. SCHROEDER, W. E. CONNER, A. BEZZERIDES, R. HOEBEKE, J MEINWALD, & T. EISNER (2002) Chemical Defense and Aposematism: the Case of Utetheisa galapagensis  | Journal of Chemoecology. 12: 153- 157.                       | Publishers & libraries | N/a  |
| Journal | ROQUE-ALBELO, L., B. LANDRY (in press) Presence of Stenoma catenifer Walsingham (Lepidoptera, Stenomidae), the Avocado seed moth, in the Galápagos  | Noticias de Galapagos.                                       | Publishers & libraries | N/a  |
| Journal | HENRY, T.J & WILSON, M.R. New Records for Eleven True Bugs (Hemiptera: Heteroptera) from the Galápagos Islands, with Miscellaneous Notes and Corrections to Published Reports   | (Submitted to Journal of the New York Entomological Society) | Publishers & libraries |      |
| Journal | ROQUE- ALBELO L (The butterflies (Papilionoidea, Hesperioidea) of the Galápagos Islands Ecuador: distribution, hostplants and biology.  | Submitted to Journal of the Lepidopterist Society, 2002)     | Publishers & libraries |      |
|         | ROQUE-ALBELO, L., B. LANDRY & C. PARENT Taygete sphecophila (Lepidoptera: Oecophoridae) in the Galapagos Islands, redescription, distribution, and importance for the control of introduced wasp Polistes versicolor (Oliver) (Hymenoptera : Vespidae). | In prep  |                        |      |
|         | ROQUE- ALBELO, L. Biology and taxonomy of Urbanus galapagensis (Williams, 1911) (Lepidoptera: Hesperidae-Pyrgyinae).  | In prep  |                        |      |

|  |   |         |  |  |
|--|---|---------|--|--|
|  | ROQUE- ALBELO, L, B. LANDRY & C. CAUSTON . Additions to the Noctuids moths (Lepidoptera: Noctuidae) of the Galapagos Islands, Ecuador   | In prep |  |  |
|  | ROQUE- ALBELO, L. Population decline of Galápagos endemic Lepidoptera from Volcan Alcedo, Galápagos Islands; is it an effect of the introduction of the cottony cushion scale?    | In prep |  |  |
|  | CASSOLA, F. & L. ROQUE ALBELO 2003 The larva of Cicalidia galapagoensis (W. Horn, 1920) Lambillionea  | In prep |  |  |
|  | ROQUE- ALBELO, L, C. V. COVELL & B. LANDRY . Additions to the Geometrid moths (Lepidoptera: Geometridae) of the Galapagos Islands, Ecuador with the description of a new species. | In prep |  |  |

## Appendix IV: Darwin Contacts

|                                       |  |
|---------------------------------------|--|
| <b>Project Title</b>                  | Terrestrial invertebrate biodiversity in Galapagos: training and collection rehabilitation.                                  |
| <b>Ref. No.</b>                       | 162/9/010  |
| <b>UK Leader Details</b>              |  |
| Name                                  | Dr M.R. Wilson   |
| Role within Darwin Project            | UK Coordinator   |
| Address                               | Department of Biodiversity & Systematic Biology,<br>National Museums & Galleries of Wales<br>Cathays Park, Cardiff, CF10 3NP |
| Phone                                 |  |
| Fax                                   |  |
| Email                                 |  |
| <b>Other UK Contact (if relevant)</b> |  |
| Name                                  |  |
| Role within Darwin Project            |  |
| Address                               |  |
| Phone                                 |  |
| Fax                                   |  |
| Email                                 |  |
|                                       |  |
| <b>Partner 1</b>                      |  |
| Name                                  | Helmuth Rogg, Charles Darwin Research Station  |
| Organisation                          | Charles Darwin Foundation  |
| Role within Darwin Project            | Local partner  |
| Address                               | Charles Darwin Avenida, Puerto Ayora, Galapagos, Ecuador   |
| Fax                                   |  |
| Email                                 |  |
| <b>Partner 2 (if relevant)</b>        |  |
| Name                                  |  |
| Organisation                          |  |
| Role within Darwin Project            |  |
| Address                               |  |
| Email                                 |  |