Rediscovering the neglected insects of Mauritius: Building in-country capacity

Final report

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Darwin Initiative for the Survival of Species

Final Report

1. Darwin Project Information

Project Reference No.	*162/12/005*
Project title	*Rediscovering the neglected insects of Mauritius*
Country	*Mauritius*
UK Contractor	*University of Plymouth (UoP)*
Partner Organisation (s)	*Mauritius: Mauritian Wildlife Foundation (MWF), MSIRI, Mauritius Institute, University of Mauritius, NPCS, Forestry, Vector Biology Division, Ministry of Health, and Entomology Division, Ministry of Agriculture.* *UK: The Natural History Museum (NHM).*
Darwin Grant Value	*£51,491*
Start/End date	*1 October 2003 to 30 September 2006*
Project website	*See http://www.mauritian-wildlife.org/*
Author(s), date	*Sarah Donovan, Saoud Motala, 30th January 2007*

2. Project Background/Rationale

Much of the biodiversity in Mauritius is endemic but the population statuses of some taxa are virtually unknown. Knowledge relating to native insects is extremely limited, as few studies have been conducted since the 1960s. Management of key ecosystems and strategies to preserve native endemic insects is hindered by the lack of entomological expertise within Mauritian conservation organisations.
The aim of this project was to build essential in-country capacity in entomology and included the following components: (i) training to build institutional capacity; (ii) research to improve the information base on a neglected group of species; (iii) development of awareness of insect conservation into decision making for habitat management.

This project was developed by Dr John Mauremootoo (MWF) and Dr Linton Winder (UoP). The Mauritian Wildlife Foundation is the only Non-Governmental Organisation in Mauritius to be exclusively concerned with the conservation and preservation of the Mauritian nation's endangered plants and animals. Insects are a key component of the fauna, but had not previously featured heavily in MWF's work. This project aimed to fill that gap.

3. Project Summary

This project:
(i) Provided training to develop institutional capacity. This was initially achieved by a member of MWF, Mr Saoud Motala, attending the Advanced Methods in Taxonomy and Biodiversity MSc based at Imperial College London and the NHM. The three month research project focused on an endemic dung beetle genus (*Nesosisyphus* sp.)

collected in Mauritius and addressed taxonomy (using morphology and molecular techniques), field ecology and conservation.

(ii) Included a baseline study to create an inventory of extant invertebrates. Firstly, a review of historic literature was undertaken to determine the current knowledge-base. Secondly, a sampling programme was devised and carried out in areas largely cleared of introduced predators (rats, mongooses, cats and tenrecs) and mainland locations on Mauritius and Rodrigues. Specimens collected have been sorted and identified as far as was possible within the timeframe of this project.

(iii) Includes two workshops on insect sampling and ecosystem function. To expand awareness and expertise within MWF partner organisations, workshops were held in September 2006 incorporating sampling methods, basic identification of key groups and the importance of insects in ecosystems.

(iv) Prepare an exit-strategy document. Feedback from the partner organisations, and a review of specimens collected during the study went towards the preparation of a strategy document to develop insect conservation expertise and integrate knowledge into the wider conservation remit of MWF (see Appendix 1). The project has left a legacy by embedding expertise within the NGO and thus facilitating the development of long-term biodiversity conservation.

We have not modified the proposed operational plan. Please see Appendix 2 for logical framework.

The main focus of the project was on the sampling and identification of Mauritian beetles, to ascertain their current status on the island (article 7, identification and monitoring). Also covered were articles: 6 (general measures for conservation & sustainable use); 8 (*in situ* conservation); 12 (research and training); 13 (public education and awareness) and 17 (exchange of information) (Appendix 3).

The project was largely successful in meeting its objectives, as detailed in the project outputs of the original application. Unfortunately, the application to the Mauritius Research Council for funding Saoud Motala's staff costs was not funded, and so MWF covered his salary costs. There were some problems with the identification, as much of the material collected was not represented in local or international collections (see report from the Natural History Museum in annual report number 3). This hindered the identification of our specimens to a level much beyond that of family, therefore limiting the value of the CD ROM database distributed to local stakeholders.

However, a duplicate set of all the beetle morphospecies (or 'recognisable taxonomic units, RTUs) arising directly from the project has been deposited with the NHM. Over time, this material will be identified, and so the original collection held by MWF will become a valuable resource. Additional material collected over two trips by Clive Turner (see his report in annual report number 3, and Appendix 4) is also in the process of being identified by taxonomic experts worldwide, and specimens of all named material will be lodged at MWF. Surplus, named material will also be sent to the Mauritius Institute and the University of Mauritius. Clive Turner's initial visit was funded solely through the University of Plymouth.

In addition to the specimens themselves, the project has amassed taxonomic literature (see refs in Motala et al., in press). Further publications have been donated to MWF to facilitate future work:

Cooter, J. & Barclay, M.V.L. 2006. Coleopterist's Handbook. 4th ed. The Amateur Entomologist Vol 11. Orpington, Kent, UK. 439pp.

Dippenaar-Schoeman, A.S. & Jocqué, R. 1997. African spiders. An identification manual. Agricultural Research Council, South Africa. Pretoria. 392pp.

Jocqué, R. & Dippenaar-Schoeman, A.S. 2006. Spider families of the world. Royal Museum for Central Africa, Belgium. 336pp.

Murphy, F. & Murphy, J. 2000. An introduction to the spiders of South East Asia. Malaysian Nature Society, Kuala Lumpur, Malaysia. 625pp.

Tilling, S.M. 1987. A key to the major groups of British terrestrial invertebrates. Field Studies. 6. 695-766.

This project has significantly raised the profile of insects in the country. For the first time in Mauritian conservation, a restoration plan was changed due to the threat it could pose to endemic insects (Le Pouce restoration plan modified to ensure survival of endemic ants and dung beetles). Without sufficient interest generated, it is unlikely that there would have been a real consideration for invertebrates. MWF has also successfully advised on lowered frequency of weeding in the Black River Gorges National Parks to diminish adverse impacts of desiccation and loss of habitat for invertebrates.
Extra equipment, as well as the microscope and digital camera, was donated to MWF for further sampling work, e.g. water net, for aquatic beetles; generator and UV lights, for night trapping.

4. Scientific, Training, and Technical Assessment

The sampling and identification research program was carried out by Mr Saoud Motala, and Mr Zayd Jhumka. Local and expatriate staff were also included in the sampling (see below). The sampling was done according to the sampling program derived during the course of the project. In brief, seven sites were surveyed, covering lowland and upland wooded sites on both Mauritius and Rodrigues, and also two islets. Collecting methods were focussed mainly on litter-dwelling species (Winkler bags and pitfall), but flight-intercept traps, light and bait trapping and hand collecting were also used. Full details can be found in the appendix of annual report 2.

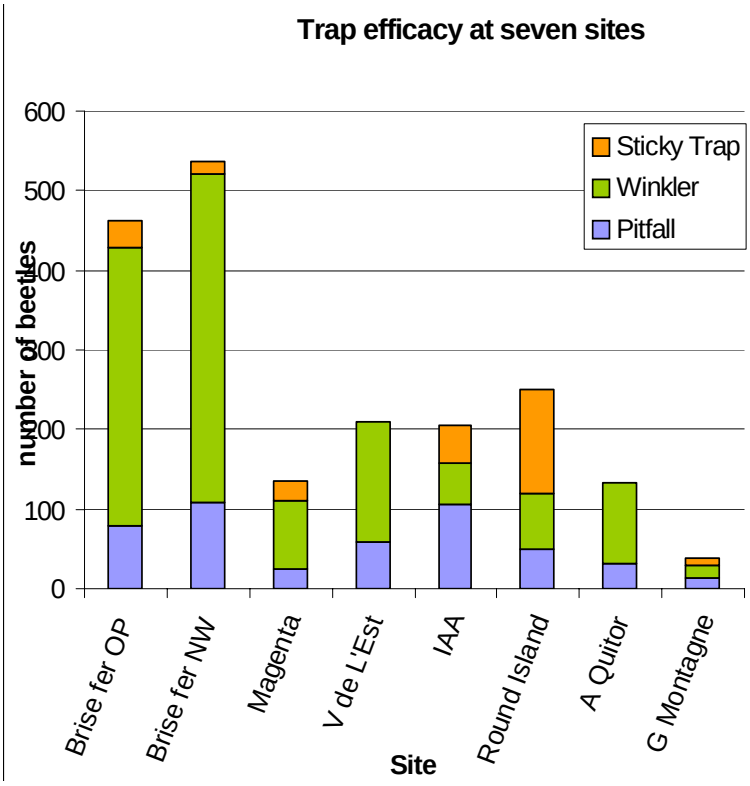
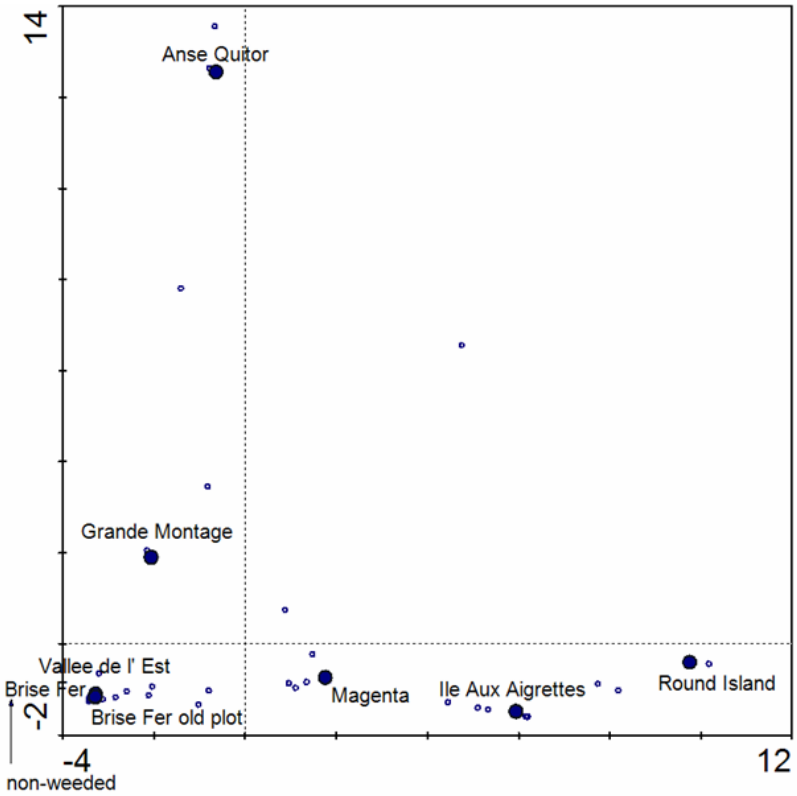


Figure 1. Numbers of beetle specimens recovered from seven sampling sites by three different methods.

Provisional analyses have shown that different sampling methods result in site specific beetle catches (Figure 1). Each of the forests sampled had significantly different beetle faunas (Figure 2), but certain types showed more similar faunal compositions, such that mainland upland sites showed a high similarity (Brise Fer, Vallee de l'Est and Grande Montagne), as did the two islets (Ile aux Aigrettes and Round Island). Lowland sites were also similar to each other (Magenta, Ile aux Aigrettes and Round Island) with the exception of Anse Quitor (which was geographically distinct, being on Rodrigues). This dataset is still being collated and analysed, but we expect to submit the results for publication in a peer reviewed journal in the summer of 2007.

Figure 2. Principal Components Analysis of beetle fauna composition (by family) of seven sampled sites in Mauritius and Rodrigues.



The main recipient of training in this project was Mr Saoud Motala, who completed an MSc in *Advanced methods in taxonomy and biodiversity* based at Imperial College London in conjunction with the NHM. Using the skills he gained on this course, he was responsible for training another member of staff at MWF, Mr Zayd Jhumka, who assisted in the sampling programme and subsequent identification work. Zayd also spent six weeks based at MSIRI, the main stakeholder partner, using their insect collections and facilities.

Saoud Motala and Zayd Jhumka provided training on the techniques involved in insect sampling and monitoring to local and expatriate staff from MWF, including Ms Poonam Gangaram, Mr Steeves Buckland and Ms Nabiiha Romaldawoo. Other members of staff were associated with the sampling programmes: Ms Zareen Futloo, Mr Ashok Khadun, Mr Jean Claude Sevathian, Mr Richard Payendee, Mr Alfred Begue and Mr Harel Begue. This leaves MWF with a pool of staff trained in insect sampling techniques who can carry out subsequent insect survey work in Mauritius.

There were two workshops held at the end of the project in September 2006, both hosted by the University of Mauritius. Proceedings started with an official opening ceremony with introductions from Mrs Ginny Silva (First Secretary, British High Commission), Prof. Li Kam Wah (Dean, Faculty of Science, University of Mauritius) and Mr Jacques Jullienne (Executive Director, MWF). This was well reported in the media, and appeared on national television.

The first workshop (15th – 18th Sept 2006) trained biology undergraduates from University of Mauritius in practical techniques for sampling and identifying forest insects. Thirty students attended, and spent one day in the field, collecting material from within and outside of Brise Fer Conservation Management Area (CMA). They then spent one day in the

lab identifying their material and collating their results. Even in this short time period, and at a low taxonomic resolution, they found significant differences between the two sites, and were able to see endemic Mauritian insects. Suitable keys for invertebrate identification were left with the University. Training was carried out by Sarah Donovan and MWF staff members Saoud Motala and Zayd Jhumka.

The second workshop (18th – 20th Sept 2006) was for stakeholder partners, and had 15 attendees. They were trained in taxonomy of a number of groups of Mauritian insects: aquatic beetles (Clive Turner, UoP), spiders (Peter Smithers, UoP) and termites (Sarah Donovan, UoP). Unfortunately, a fourth taxonomic expert (Darren Mann, Hope Museum, Oxford) was unable to attend due to an accident a couple of days before he was due to leave. It was clear that not only was there an enthusiasm to learn these taxonomic skills, but the participants were also keen to take these skills and train others in their own departments; to that end, they were all supplied with a copy of all of the keys and presentations arising from the workshop. A significant period of time was allocated towards group discussion of the future of insect conservation in Mauritius, and forms the basis of the 'insect conservation strategy' document (Appendix 1).

5. Project Impacts

MWF are very keen to build on these foundations built by the project:

a) A legacy from the project remains at MWF in trained personnel, who have gained skills and knowledge;
b) There is a reference collection available locally;
c) MWF stakeholders are keen to participate further in the development of insect work in Mauritius, with a strong interest evident in the formation of a network.
d) There is an exit strategy document that MWF and other interested parties can refer to.

There are a number of unexpected impacts arising from the project:

a) Through the workshop, stakeholders previously identified as secondary, such as the vector biology department, are keen to have a more active role and consider the importance of water insects in their work;
b) Modification of weeding strategy and consideration of invertebrates in habitat restoration projects;
c) MWF have submitted a proposal for funding towards workshops in: Mauritius Ant course and Invertebrate Monitoring and Census Techniques;
d) Invertebrate sampling on islets carried out as part of reptile translocation works;
e) Assessing insect abundance on islets and mainland in view to translocate Mauritius Fodies (passerine birds) to Round Island in late 2007 to early 2008.
f) Starting to think of restoring insect communities on islets.

Perhaps one of the most significant unexpected result arising from the project was the employment by MWF of Zayd Jhumka. He has proved to be an exceptional entomologist and bought a high level of enthusiasm, dedication and ability to the project. His work, under the tutelage of Saoud Motala, greatly enhanced the output, and it is encouraging to see that he remains committed to the field of Mauritian insect conservation.

Insect conservation had not been included in earlier national biodiversity strategic action plans. However, due to the profile-raising by the DI project, insects now feature as a conservation priority area in the NBSAP 2006-2016 (Appendix 5).

A number of the personnel involved with the project still retain ties to Mauritian invertebrate work:

- Saoud Motala is currently working at the Entomology department of the NHM;
- Zayd Jhumka is a warden on Round Island and is continuing surveys and insect identification despite end of DI project. He is applying to universities for a PhD studentship on Mauritian insect conservation.
- MWF staff: Poonam Gangaram (plant-insect work), Ashok Khadun (island restoration and insect work), Jean-Claude Sevathian (rare plants and insect conservation).

A good partnership now exists between MWF and UoP, and discussions are ongoing regarding a follow-up project, with Paignton Zoo as a possible funder. There are also improved links between UoP and MI and NPCS; Sarah Donovan is currently working in collaboration with both organisations to produce new displays highlighting the importance of Mauritian endemic beetles. Within country, the project has certainly strengthened collaborative links between MWF and NPCS, Forestry, their traditional government partners. It has also reinforced links with private parastatal MSIRI, Ministry of Agriculture Entomology Division, Ministry of Health Vector Control Division and, although to a lesser degree, MI. The project proposal did not include community participation. This project did not cover social impact

6. Project Outputs

Project outputs have been quantified in Appendix 6. Due to the UK staff change, fewer weeks were spent in Mauritius by the project leader (Sarah Donovan) than had originally been planned, due to prior commitments. The effects of this were mitigated to some degree through increased communication. Publicly accessible material has been listed in Appendix 7, and a copy of the publication has been attached as a pdf file.

Information on insect conservation will continue to be posted on the MWF website (*http://www.mauritian-wildlife.org/*), as many of their on-going projects now have a significant entomological component, particularly with regards to invertebrates in the diet of endemic birds and reptiles.

7. Project Expenditure

This covers the final stage of the project; the funding allocated for 2005/2006 covers the period from April 2005 to September 2006 (ie, 17 months). Therefore, this final project expenditure covers the period of May 2006 to September 2006. There have been no changes to the original budget.

Item	*Budget*	*Expenditure*	*Balance*

8. Project Operation and Partnerships

There were seven local partners (Mauritian Wildlife Foundation, Mauritius Sugar Industry Research Institute, Mauritius Institute, National Parks and Conservation Service, University of Mauritius, Ministry of Health and Quality of Life, Entomology Division, Ministry of Agriculture). This hasn't changed from the initial plans. The main partner was MWF, with valuable assistance in the beetle identification from MSIRI. All partners had the opportunity to comment on the sampling plans, but these were not significantly modified.

We were fortunate in that Saoud Motala was involved in a previous Darwin Initiative project between MWF and University of Reading, and was able to apply his databasing skills to this project. Concurrently, a National Science Foundation (US) -funded project on Mauritian ants was run, headed by Dr Lori Lach. This enabled two Mauritian BSc holder to be fully trained in ant survey techniques and identification; both are still working with MWF at the end of the project. There are also links to the reptile DI funded project, whereby the effect on endemic insects of translocation of reptiles to islets can be studied (Dr Nicholas Cole, University of Bristol).

The main international partner was the Natural History Museum, London. A number of staff in the entomology department were involved in the project, particularly within the soil biodiversity group (head, Dr Paul Eggleton).

MWF has already built on this project with the reptile and passerine translocation works and is continuing to do so. It is hoping to hold an ant workshop and invertebrate sampling training workshop, and is supporting staff for higher degrees (e.g. considering supporting Zayd Jhumka for a PhD studentship).

Community participation is not relevant in insect conservation as they are in remote managed areas and islets and do not impact directly on livelihoods. However, there is a role for the private sector as owners or leasers of large tracts of land that holds forest could be harbouring rare endemic species. In March 2007, UNDP is supporting the creation of a protected areas network, which will involve private land owners in an association. MWF will carry out conservation assessments of these lands and also design the protected area network. It is based on plant and large animal diversity, but it is probably that once set up these areas can be surveyed specifically for invertebrates and their conservation.

9. Monitoring and Evaluation, Lesson learning

Progress of the project was monitored by the UK (Linton Winder, then Sarah Donovan) and Mauritius (John Mauremootoo, then Yacoob Mungroo, then Vikash Tatayah) based project leaders. This was through email, phone and meetings when the UK leader was in Mauritius. The project was successful at delivering all of its indicators:

1. MWF staff member, Saoud Motala, trained in UK-based MSc. Training by Saoud to other MWF staff members.
2. Review of historic data published (Motala *et al*. in press).
3. Sampling protocol developed - with reference to stakeholder partners - and conducted.
4. Inventory of specimens. The beetles collected during the sampling program were identified to as fine a taxonomic resolution as possible. Duplicates were lodged with the NHM for further identification. Additional material collected by Clive Turner is being identified and collections will be lodged with MWF, the Mauritius Institute and the University of Mauritius. A CD ROM of the beetle database, together with photographs, was created and distributed to all stakeholder partners.
5. A conservation strategy document was created, with input from MWF and all stakeholder partners (Appendix 1)

The main problems were due to the high turnover of staff associated with the project, both in the UK and Mauritius, and logistical problems with sampling and identifying material. Frequent communication between the UK and Mauritius, both by email and telephone, helped to minimise the impact of changing staff, particularly between Saoud Motala and Sarah Donovan. The flexibility displayed during the sampling program by Saoud Motala and Zayd Jhumka resulted in comprehensive coverage of all sites. They made the fullest use of the taxonomic resources and contacts available to them, both within Mauritius (e.g. collections and expertise at MSIRI), and abroad (e.g. having material from the NHM sent over).

As one of Darwin Initiative's closed projects, this work has been evaluated by Anna Karp.

The scope of this project was perhaps too wide-ranging, with respect to the identification work possible. Future invertebrate projects might benefit from a tighter focus, which would enable greater evaluation of maybe a smaller number of sites to be done. More targeted conservation recommendations might then be made with regard to particular endemic species. Alternatively, a greater pool of taxonomic expertise should be recruited.

10. Actions taken in response to annual report reviews (if applicable)

Every response to our annual reviews was discussed between Sarah Donovan and Saoud Motala. Unfortunately, we didn't receive the comments from the final annual report until September 2006. However, in response to specific points:

ii (b) The modified flight intercept trap was successful in trapping beetles, and was particularly successful at certain sites (Figure 1). In particular, it was useful in trapping a section of the beetle fauna not collected by Winklers and pitfalls (data not shown).
ii (c) The sampling detailed in the NHM report refers to preliminary sampling carried out by Saoud Motala and Mike Sharpe, an undergraduate from the University of Plymouth. This initial work helped to inform the sampling strategy employed for the Darwin Initiative project. The report was compiled for the purposes of the annual report, and refers mainly

to the identification work. It is expected to be submitted to a peer reviewed journal with authorship including MWF staff.
ii (f) During the course of the project it became apparent that it would not be feasible to create the web-based catalogue of the Mauritian beetles housed at the NHM. However, we (Frank Krell, NHM; Saoud Motala, MWF; Sarah Donovan, UoP) approached the Darwin Initiative for a fellowship for Saoud Motala to do this as a stand-alone project, separate from this DI project. We were successful and Saoud is now three months into his fellowship.
ii (g) The reference collections are a 'work in progress' (see section 3, and reports by Clive Turner and Peter Smithers – Appendix 4). However, a beetle reference collection, identified as far as has been possible, is now housed at MWF, with replicates lodged at the NHM pending further identification to species level.

11. Darwin Identity

The Darwin Initiative was acknowledged in all media publicity in Mauritius (website (*www.mauritina-wildlife.org*), radio, newspaper and television). Where appropriate, the DI logo was also displayed, for example, during the stakeholder partner and undergraduate workshops; the former was also covered in national Mauritian television.

Within the host country, all of the stakeholders are familiar with the Darwin Initiative, both from this and previous DI projects (e.g. fern conservation, reptile translocation, reef monitoring, seed bank etc). In addition, the workshops from the insect project appeared on prime time national TV in French and Creole and at other hours in, English and Hindi; the media coverage was very encouraging.

However, in a country where the lay man does not even know the Pink Pigeon is truly Mauritian or that fruit bats are beneficial, the Darwin Initiative would admittedly be quite foreign to them. If they do not even know 'Darwin Initiative', they would less likely know the aims of Darwin Initiative. As hard as it is to admit, it is the sad truth. But as MWF has more projects, the DI will become more widely known. It is linked to environmental consciousness, which at the moment is fairly low. Hence the reason to increase the number of Darwin initiatives!

The project was recognised as an innovative piece of work with a clear identity, and fell within the remit of the conservation work carried out by MWF, which has a strong presence on Mauritius. However, it also generated its own publicity, both through the media and via interactions with the stakeholder partners and University of Mauritius undergraduates. MWF has moved on from species to habitat conservation, to ecological restoration and is now addressing education and awareness. Every action is part of a wider puzzle, although it may seem unconnected to the rest at first glance. In fact, we see insect conservation key to reptiles, birds and plants, and whilst MWF did not have any choice but to concentrate on most threatened species, the long term vision has always been whole ecosystems restoration, not neglecting invertebrates.

12. Leverage

An additional £2,000 was invested in the project by the University of Plymouth, for a collecting trip by aquatic beetle expert, Clive Turner.

Meetings with MWF executive management have discussed the project scope, so that they are in a position to seek out funding opportunities that fit into the overall direction of conservation work of the organisation. These staff include: Mrs Lone Raffray, fundraising co-ordinator at MWF, Dr Carl Jones, scientific Director, Mr Vikash Tatayah, Conservation Manager and Mrs Debby de Chazal, Treasuruer.

13. Sustainability and Legacy

The fact that insects are now part of the thinking when restoring habitats is in itself a very significant change in the right direction. Entomological expertise is now embedded at MWF; this is through personnel (Zayd Jhumka), and through the provision of taxonomic resources (collecting equipment, beetle reference collection and taxonomic literature).

MWF has always had good communication with the stakeholder partners, and is hoping to develop a further project through UoP. In addition, one of the key results of the stakeholder partner workshop in September 2006 was the will to form an entomological network for Mauritius (see Appendix 1 – insect conservation strategy document). This would provide sound means for communication between partners and would further entomological conservation in Mauritius. Insects are also being considered in the wider remit of other conservation projects, in particular as a food resource for endemic birds and reptiles.

Currently, funds are being sought for Zayd Jhumka in order for him to study for a PhD in conservation of Mauritian insects. The possibility exists for Zayd to register at University of Mauritius, which would bring down the costs considerably. One possible funder for such a project is Paignton Zoo.

Improvement to the project's legacy would have been to (a) train more personnel during the course of the project, including MWF staff based in Rodrigues and (b) have immediately moved into a follow-up project.

14. Value for money

All of the outputs were achieved, and no extra costs were incurred. Additionally, a further £2,000 was added to the project (source: UoP) which greatly enhanced the work. All results have been disseminated to the stakeholder partners, through updates, the stakeholder workshop, the insect conservation strategy document and the provision of a CD ROM. All publications arising from this project will also be circulated to partners. These, together with the probable formation of an entomological network, will enhance insect conservation in Mauritius.

Exit Strategy Document: Insect conservation in Mauritius

The objective of this document is to provide guidelines for future insect conservation in Mauritius as a requirement of the Darwin Initiative project "Rediscovering the neglected insects of the Mascarene (162/12/005)". Many of the suggestions in this document have arisen from the Stakeholder Workshop held in Mauritius, September 2006.

1. Background

The richness of Mauritian insects and their ecological importance have long been recognized but no integration of the group into local conservation activities has yet been attempted (see Motala et al., in press, for a more detailed review). The potential for initiating such activities in Mauritius is high given that there is already a substantial skills base in the form of local research groups which are active separately in conservation and entomology (Appendix 1). The Darwin Initiative funded project 'Rediscovering the neglected insects of Mauritius: building in-country capacity' has already succeeded in establishing the foundation for future insect conservation work by increasing awareness of the importance of the work, providing baseline information, developing the expertise and building a closer interaction between the relevant stakeholders through meetings and workshops. As a final step, this exit strategy document is intended to address the three issues, detailed below. When translated into practice, these guidelines will lead to the integration of insects into practical conservation work in Mauritius.

2. Future monitoring of conservation sites

A detailed sampling protocol was developed as part of the Darwin Initiative project (Appendix 2). These methods are widely used and have been shown to be highly effective at recovering a significant proportion of the beetles present.

The sampling carried out in the current DI project showed some interesting patterns in beetle distribution. Each of the forests sampled had significantly different beetle faunas, but the certain types showed more similar faunal compositions, such that mainland upland sites showed a high similarity (Brise Fer, Vallee de l'Est and Grande Montagne), as did the two islets (Ile aux Aigrettes and Round Island). Lowland sites were also similar (Magenta, Ile aux Aigrettes and Round Island) with the exception of Anse Quitor, which was geographically distinct, being on Rodrigues). A low percentage of specimens were identified to species level (Table 1). The value of the Conservation Management Areas (CMA), such as Brise Fer and Mont Cocotte, is evident, and it can be clearly seen that each CMA supports a distinct beetle fauna. It must be stressed that this is provisional data, and that there are likely to be many more endemic species in the material collected that will be uncovered as the material is identified. This baseline data can inform management decisions on the inherent conservation value of a site in terms of its insect fauna (i.e. *in-situ* insect conservation).

Locality	Family	Species	Collected	
			How	When
Anse Quitor	Nitidulidae	*Cybocephallus mollis*	Pitfall	DI project, main
Brise Fer	Anthribidae	*Talpella mauritiana*	Winkler	NHM, pre project
Brise Fer	Curculionidae	*Cratopus vulgaris*	Light Trap	DI project, main
Brise Fer	Curculionidae	*Syzygops similis*	Winkler	NHM, pre project
Brise Fer	Hydrophilidae	*Cercyon crenatostriatus*	Winkler	NHM, pre project
Brise Fer	Melolonthidae	*Hyposerica abdominalis*	Light Trap	DI project, main
Brise Fer	Melolonthidae	*Hyposerica vinsoni*	Light Trap	DI project, main
Brise Fer	Nitidulidae	*Stelidota didyma*	Winkler	NHM, pre project
Brise Fer	Scarabaeidae	*Nesosisyphus pygmaeus*	Pitfall	DI project, main
Brise Fer	Scarabaeidae	*Nesosisyphus pygmaeus*	Winkler	NHM, pre project
Iles aux Aigrettes	Anthribidae	*Talpella atra*	Winkler	NHM, pre project
Iles aux Aigrettes	Carabidae	*Aephnidius hypolithoides*	Winkler	NHM, pre project
Iles aux Aigrettes	Tenebrionidae	*Enicmosoma testacea*	Winkler	NHM, pre project
Mount Cocotte	Anobiidae	*Anakania subvelutina*	Winkler	NHM, pre project
Mount Cocotte	Anthribidae	*Prototropis pulicarius*	Winkler	NHM, pre project
Mount Cocotte	Anthribidae	*Scirtetinus gomyi*	Winkler	NHM, pre project
Mount Cocotte	Anthribidae	*Talpella mauritiana*	Winkler	NHM, pre project
Mount Cocotte	Carabidae	*Cyptomicrus pollicis*	Winkler	NHM, pre project
Mount Cocotte	Curculionidae	*Ochronanus vinsoni*	Winkler	NHM, pre project
Mount Cocotte	Curculionidae	*Syzygops obscurus*	Winkler	NHM, pre project
Mount Cocotte	Nitidulidae	*Stelidota didyma*	Winkler	NHM, pre project
Pigeon Wood	Cerambycidae	*Megopis mutica*	Hand collection	DI project, main
Plaine Champagne	Cerambycidae	*Megopis mutica*	Hand collection	DI project, main
R Island	Curculionidae	*Cratopus punctum*	Sticky Trap	DI project, main
Reduit	Curculionidae	*Cratopus melanocephalus*	Hand collection	DI project, main
Vallee de L'Est	Curculionidae	*Cratopus psittacus*	Hand collection	DI project, main

Table 1. Endemic Mascarene beetle species collected and identified as part of the Darwin Initiative project (162/12/005).

Any specimens collected in future work, using the sampling protocol detailed in Appendix 2, can be identified using a number of resources.

(a) Insect collections: A number of reference insect collections are available on Mauritius, but they include mostly insect of agricultural (MSIRI, Entomology Division of the Ministry of Agriculture) and medical importance (Entomology Division of the Ministry of Health). A national collection is also available at the Mauritius Institute. A reference collection of the beetles collected during the course of the DI project was deposited at the NHM and a duplicate copy is also held at MWF.

(b) CD-ROM: A reference collection of forest beetles collected through the project now exists as a CD-ROM (Appendix 3) available at the MWF. Copies are also held by all stakeholder partner organisations.

(c) Taxonomic literature: As with the collections, keys and other taxonomic works are held at various of the stakeholder partners, including MWF. It was agreed that these collections and associated literature form a valuable resource and should be made available to stakeholders through an entomology network (see below).

(d) International institutions: Many taxonomists are prepared to identify collected material from such an ecologically interesting area as Mauritius, in return for voucher specimens. Taking a long-term view, this is one way to build a reference collection for future work.

3. Conservation of endangered insects

There are a number of practical conservation measures that can be undertaken as and when funding becomes available. These cover a number of areas:

- *Translocation/introduction/re-introductions*. Many of the endemic Mauritian invertebrates show limited dispersal abilities, and so will be unable to re-colonise suitable areas. These could be moved, wholesale, to these sites. Habitats could be matched on the basis of their ecological characteristics (plant composition, altitude, microclimate *etc*.) and on the baseline data on the beetle fauna composition arising from the Darwin Initiative project. For example, this information can serve to identify pairs of sites which have relatively similar beetle faunas, indicating similar ecological niches in both. The site with a higher proportion of endemic beetles can then be used as 'donor' for future invertebrate translocation work. The longer term viability of such translocated populations can be evaluated through the use of the same sampling protocol.
- *Habitat management*. Habitats can be managed with a view to increasing endemic invertebrate populations. MWF is currently working in a number of mainland Conservation Management Areas (CMAs) in collaboration with the Government of Mauritius. These CMAs are sites on the mainland and islets, which have been weeded of exotic plant species and are being managed for the endemic birds, reptiles and plants. Many of the management practices (e.g. weeding, predator control, endemic plant introduction) are likely to also be beneficial to insect populations. It should be possible to refine some of these practices so that they have an improved impact on the insects present. An example of this increased awareness of insects is the alterations made to weeding of exotic plants on Le Pouce (MWF, pers. comm.) following the consideration of rare insects such as an endemic dung beetle and the recent discover of rare endemic ants there (Fisher, 2005).
- *Continued monitoring*. It is only possible to determine the increase or decrease of endemic insect populations through repeated sampling at intervals, using the same protocols. The collections held at various institutions in Mauritius (MWF, MSIRI, MI) will improve over time, as more identified material is added, e.g. from the NHM. This will facilitate future identification work.
- *Breeding programmes*. With continuing monitoring, it should be possible to identify species that are particularly at risk, and might benefit from a captive breeding programme. Initiatives might be set up in conjunction with other institutions abroad, e.g. London Zoo, Bristol Zoo, which have had success in this area.

4. Entomology network

The Darwin Initiative stakeholder workshop (18 - 20 September 2006) was a step towards bringing interested people together (Appendix 1) and a large part of the information in this document has come from the discussion held during the workshop. In this meeting it was highlighted that improved communication between local entomologists could bring both ecological and economic benefits.

In general terms, it was agreed that the main aim of such a network would be to increase awareness and share knowledge of Mauritian insects and other invertebrates, covering both applied entomology and conservation. This would be facilitated via a number of routes:

- Regular meetings;
- Creation of openly available reference collection(s);
- A dedicated society website and newsletter;
- Improved access to relevant literature.

5. Funding

Appendix 1. Insect conservation in Mauritius

For insect conservation to continue in Mauritius, it is important to find funding opportunities. Two government ministries were highlighted as possible funders for future insect conservation work as follows: Ministry of Agro-Industry and Fisheries and Ministry of Environment. Private local companies should also be approached, with a particular emphasis on letting them publicise their involvement. International conservation bodies are also a likely source, particularly with international partners e.g. the present Darwin Initiative).

Appendix 1. Insect conservation in Mauritius

Key stakeholders and partners of the Darwin Initiative project

Mauritius Sugar Industry Research Institute
Réduit
Mauritius

Forestry Service
Ministry of Agro-Industry and Fisheries
Botanical Gardens Road
Curepipe
Mauritius

National Parks and Conservation Service
Entomology division
Ministry of Agro-Industry and Fisheries
Réduit
Mauritius

Mauritius Institute
La Chaussée
Port-Louis
Mauritius

University of Mauritius
Réduit
Mauritius

Ministry of Health & Quality of Life
Entomology Division
National Laboratories Complex
Réduit
Mauritius

Ministry of Agro-Industries and Fisheries
Entomology Division
Réduit
Mauritius

Darwin Initiative project: 'Rediscovering the neglected insects of Mauritius: building in-country capacity'

Sarah Donovan[1]; Saoud Motala[2]

[1] Plymouth University, Devon, UK; [2] Mauritian Wildlife Foundation, Vacoas, Mauritius

Sampling protocol; Jan – Aug 2004

The aims of this sampling regime are firstly to produce as comprehensive a species list as possible of forest Coleoptera, to be compared against earlier sampling and historic data in order to establish their probable conservation status. Secondly, we can evaluate the potential of the Conservation Management Areas (CMAs) and islands in providing a refuge for native and endemic species, with a long term view towards possible relocation of vulnerable species to these refuges.

Sampling: techniques are essentially quantitative, with additional methods providing qualitative data on invertebrate populations. A range of techniques are used to collect the widest ecological range of taxa.

- Pitfall traps (quantitative). These are set out along a 100 m transect at 10 m intervals. This method is good for collecting actively moving, ground-dwelling invertebrates.
- Litter (quantitative). Ten lots of $1m^2$ of leaf litter + top 1cm soil are collected along the same 100 m transect as the pitfall traps. Invertebrates are extracted using Winkler bags (see Appendix A). This method is effective at recovering slow-moving, small, cryptic species. Winkler bs are preferred over Tollgren funnels as they are highly portable, can be used in the field, and do not require any light (heat) source.
- Light trapping (qualitative). This technique is effective at targeting certain invertebrate families, e.g., long-horn beetles, jewel beetles and some scarab beetles. However, it is dependent on the availability of a portable generator.
- Aquatic habitats (qualitative). A wide taxonomic range of beetles can be found in a variety of aquatic habitats. Sampling of aquatic areas is qualitative and focuses mainly on: ponds, rivers and streams (netting vegetation, rocks, gravel, sand, coarse organic detritus, trapping), water margins (hand searching, stamping and splashing, digging, sieving), madicolous habitats (hand searching, rock turning, wood turning).
- Flight intercept/Malaise traps (qualitative) (see Appendix B). NB, Malaise traps are highly influenced by local conditions (within a few metres), so limited sampling cannot be regarded as quantitative for a particular site.

Selected taxa: all material collected will be sorted to Order. Coleoptera (beetles) will be sorted to as fine a taxonomic resolution as possible with reference to taxonomic keys, and collections (held at MWF). It is important to sort to this level as many arthropod groups show a greater response to habitat differences than those observed at coarser taxonomic levels (Nakamura *et al*. 2003).

There are many reasons for focusing attention on Coleoptera. This Order has been shown to most closely resemble the response of arthropods in general to restoration processes (Neumann, 1979; Moeed & Meads, 1985; Longcore, 2003). They are one of the most diverse groups of organisms and comprise about 20% of total arthropod diversity (Stork, 1988; 1993). They show a wide range of trophic functions (Watts & Gibbs, 2002), and so are indicative of ecosystem functions as well as species diversity. Coleoptera may be an alternative indicator assemblage to arthropods in general and provide a finer resolution of response to habitat changes. In particular, beetles - at the species level - are recommended for use in comparative biodiversity surveys of forest litter faunas (Carlton & Robinson, 1998) as they are indicative of subtle habitat changes. Preliminary studies in Mauritius indicate that beetles will provide valuable information on habitat differences (Motala, 2004; Sharp, 2004; Jhumka, 2002; Budullah, 2001)

In addition, the beetles are the one group of invertebrates that have been comprehensively surveyed within the Mascarenes (e.g. Vinson 1967), enabling a comparison to be made with the historical distribution of beetles with regard to (a) which species have decreased in numbers or disappeared, (b) what species have invaded and (c) whether any species have increased their range/numbers. Many keys

exist for their identification (e.g. Williams & Cox, 2004), and the original collections are accessible, having been lodged in the Natural History Museums at London and Paris. Saoud Motala has taxonomic knowledge of this group, and there is taxonomic expertise available through contacts with MSIRI, the NHM, London and, for aquatic beetles, Clive Turner (a UK based coleopterist). This gives us the best chance of being able to obtain the essential species-level identifications.

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Appendix A. Use of Winkler bags

Samples are taken at 10 m intervals along a 100m transect (totalling 10 samples) laid out in as homogeneous piece of forest as possible. Leaf litter and any loose soil is collected from $1m^2$ quadrats. This litter is then sifted through a wire sieve of 1 cm^2 mesh to exclude larger elements of the litter; all material that passes through the mesh (fine debris and invertebrates) is collected into a sealable plastic bag. All material is decanted into mesh bags and hung within the Winkler bags; samples from different quadrat samples are never put together in the same Winkler bag. These samples are then hung for three days in a constant temperature (Fig 1). Ideally, this is done indoors, but may be done outside, so long as the site is dry and extremely sheltered: any movement to the Winkler bags results in debris falling into the collecting pot and makes subsequent work on the samples much more time consuming. As the litter dries, the invertebrates within it move around to find damper conditions and eventually fall out of the mesh bags into the pot at the bottom, which contains alcohol. All samples at one site should be taken within on the same day, and sampling should not be done in the rain as smaller specimens tend to stick to the litter, and also is likely to reduce the amount of specimens recovered as the litter takes longer to dry.

Fig 1. Winkler bags hanging in roof space.

Appendix B. Use of Flight Intercept Traps (FIT): setting and servicing for beetle (Coleoptera) sampling in woods and forests.

Introduction: many beetles in tree covered terrain search for specific habitats, food and for mates by flying about the area in which they live, often within 3 or 4 feet of the general ground surface. The Flight Interception Trap (FIT) breaks this flight by surprise and collects the specimens into a killing/preserving solution set in open trays positioned beneath the flight break (the interceptor). These can then be transferred to a permanent preserving fluid for removal. This particular type of large area 'window' trap was developed in 1985 (by Peter M Hammond of the Natural History Museum) and has been used for quantitative sampling of insects in both temperate and tropical forests.

The trap components:

- *The interceptor*. Black, synthetic net 1 x 1.25 m. There are loops at the corners and along the top and bottom for guy strings and anchorage pegs.
- *The roof*. Green, woven polythene 1.3 x 3.3 m. There are 8 perimeter and 2 internal eyes. Essential to prevent wash-out in rain or contamination of the trays by leaves, twigs and falling debris.
- *The ground-sheet*. Green, woven polythene 0.9 x 2.4 m. There are 4 perimeter eyes, at the corners, and 3 internal eyes. Essential to prevent contamination of the trays from mud-splash should it rain.
- *The catchment trays*. A set of 22 trays, 20 x 11 cm, is supplied with each trap.
- *The ridge rope*. Approx. 10 metres of 10mm synthetic rope.
- *The guy lines*. A ball of synthetic string is supplied.
- *The staking-out pegs*. If tent pegs are not supplied, pegs can be cut from the forest.
- *Servicing equipment*. You will need the following
    - ✓ *A 2 gallon water carrier*
    - ✓ *A 1 litre plastic beaker with spout*
    - ✓ *2 x ¼ litre screw-cap plastic bottles*
    - ✓ *A 140 micron strainer*
    - ✓ *A 10 cm plastic funnel with most of the spout removed*
    - ✓ *Wash bottle*
    - ✓ *At least 2 litres of 80% ethyl alcohol*
    - ✓ *500g of chloral hydrate crystals ($CCl_3CH(OH)$ 2=165.40)*
    - ✓ *Old teaspoon for dispensing above* **KEEP THIS AWAY FROM FOOD**
    - ✓ *1 bottle washing up liquid*
    - ✓ *A small pair of pointed forceps*
    - ✓ *Small paint brush*
    - ✓ *Plastic pipette*
    - ✓ *A supply of vials for specimens*
    - ✓ *Paper for labels*
    - ✓ *Sharp knife for cutting pegs and clearing site*
    - ✓ *Graphite pencils*
    - ✓ *A small pair of scissors.*
    - ✓ *Notebook*
    - ✓ *Plastic carrier bags are ideal for carrying all this*

Choice of site. The aim is to cut across a busy insect flight path such as a man-made path through the forest or any similar natural corridor that flying insects might select; perhaps a strip of sparser herbage among the trees. There will be many options in a forest, remember the aim is to cut ACROSS the natural passage of the insects. Note, a good flight path may not look busy in day-light. It is essential to choose flat ground or level off a strip with a spade. These traps are not effective in open spaces such as the centres of clearings or the middle of deserts, or in high winds.

Trap erection. Establish the ridge-rope first, trying-off between two trees or posts across the chosen flight path. Tie-off on selected trees at one end and pass ridge-rope into the roof via an internal eye, pass it through the 4 loops along the upper length of the black interceptor and out of the roof via the other internal eye, and tie-off at the other tree. The ridge rope should be taut and at such a height as to allow the interceptor to be stretched out tight, flat and exactly vertical and with its bottom edge running

lightly along the tops of the trays when they are placed on the ground sheet; this is done by trial and error and it must be right. The top corner loops of the intercept should be pulled out through the internal holes of the rood and tied off separately to the same trees that anchor the ridge-rope. The ridge-rope passes through these loops but by typing them separately you can more easily adjust the tension of the interceptor (refer to diagram). Tie off the corners and edges of the roof to saplings, trees, bushes or sticks to form a four-slope roof like that of a simple, rectangular, detached building.

Before pegging out the bottom edge of the intercept put down the ground sheet. This is a little longer than the intercept and should be centred under it. If a wooden plank can be acquired place this under the ground sheet as a firm, level base for the trays. Peg out the bottom of the intercept, the internal eyes in the ground sheet allow the passage of pegs securing the middle loops along the bottom of the intercept. The intercept should be tight as a drum with NO wrinkles. Remember that the bottom edge of the intercept should lightly brush the tops of the foil trays once the trap is set up. Check that the roof is tight again; trial and error in moving the guys about in inevitable in order to achieve this to operational perfection. Arrange a line of 22 trays, long axis at right angles of the intercept; the trays should be shoulder to shoulder and can be formed around the intercept pegs that pass through the ground-sheet.

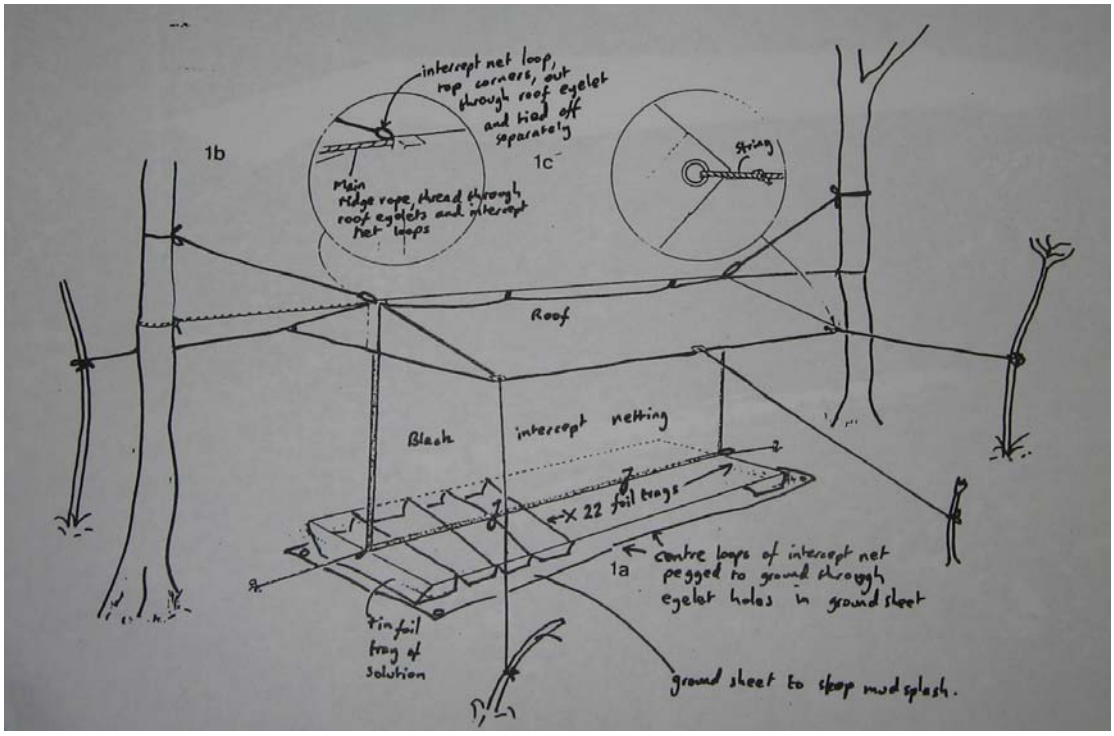
Trap operation. Once the trap is up and the foil trays in place, about an inch depth of water is poured into each tray. Next add about half a teaspoon of chloral hydrate crystals to each tray – THIS IS A TOXIC CHEMICAL AND SHOULD BE HANDLED WITH RESPECT – its function is to inhibit bacterial breakdown of the insects that fall into the trays. Lastly add a few drops of washing-up liquid to each tray; this reduces surface tension and allows the specimens to sink as soon as they fall in. The trap is now up and running and can be left for 24 hours. Remember where you left it!

At the end of 24 hours each tray should contain quite a number of beetles and other insects. Using pointed forceps remove and discard any leaves, butterflies, moths, grasshoppers, large flies and wasps. Next, using forceps, remove all large beetles to a ¼ litre plastic pot which is half-filled with 80% alcohol. Now position the plastic beaker near the trays and, one by one, empty the whole contents of each tray through the 140 micron strainer. A small spout can be made by pulling out the corner of each tray. As you fill the beaker return the strained solution to the trays as you work your way along. Nearby keep the ¼ litre plastic pot and empty the strainer into it as it becomes loaded with specimens. This is best done by picking out ‘bundles’ of insects with the forceps and finishing by knocking the strainer upside down against the sawn-off funnel placed in the mouth of the ¼ litre pot. Use the wash bottle containing alcohol to rinse round the funnel. Sometimes the plastic pipette is more useful. The small paintbrush is handy for fielding small, stray specimens. Thus all the specimens caught end up in the plastic pot and the solution is safely returned to the trays for the next 24 hour run.

Before leaving the site place a pencil written data label in the pot with the specimens giving locality, date, collector etc. Once back at the base camp/hotel remove the beetles from the plastic pot to glass vials, again use the strainer and sawn-off funnel to do this. Place a duplicate of the data label in each tube used and remember to use only graphite pencil for this. Use a new set of tubes for each days samples.

Notes. Use two traps running concurrently within one notional hectare of forest. Run them for at least 7 consecutive days at each site emptying the trays preferably once a day, or at least every other day. Keep all beetles from each session as the number of individuals for each species are some of the essential data that will be studied. Recharge trays that may have lost their solution. Tighten guys and pegs that may have slackened at each visit. If you lose the chloral hydrate, vinegar will do mixed 1 to 4 parts water. At the end of a trap dispose of toxic tray solution by pouring into a small hole in the ground and cover. Bring left-over chloral hydrate back to UK in its original canister. Return all major parts of the FITs to the Museum. Glass vials of insets should travel as hand baggage. Your expedition should check with the host country regarding removal of insect specimens of no commercial value through their customs. The glass vials should be packed very carefully for the return journey as they are not very strong. Photograph the traps *in situ* if you can. Also make an on-the-site description of each trap site in a note book. The foil trays, unused glass vials and alcohol can be carefully disposed of at the end of the expedition.

Figure 1. Flight intercept trap *in situ*.


intercept net loop, top corners, out through roof eyelet and tied off separately
1b
1c
String
Main ridge rope, thread through roof eyelets and intercept net loops
Roof
Bleach
intercept netting
x 22 foil trays
1a
centre loops of intercept net pegged to ground through eyelet holes in ground sheet
Tinfoil tray of solution
ground sheet to stop mud splash.

Appendix 1. Insect conservation in Mauritius

Appendix 2. Logical framework

Project summary	Measurable indicators	Means of verification	Important assumptions
Goal: To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but poor in resources to achieve • the conservation of biological diversity, • the sustainable use of its components, and • the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources			
Purpose			
To initiate an insect conservation programme within the Republic of Mauritius, led by in-country capacity based within the Mauritian Wildlife Foundation (MWF).	Entomological expertise provision within MWF.	Training of Insect Conservation Manager.	Training completed successfully.
	The rediscovery of endemic and native species unreported since historic studies. Discovery of new species.	Publication of historic review and inventory of extant species.	Programme sufficient to adequately sample extant species.
	The development of awareness of insect conservation within MWF and other conservation stakeholders.	Insect Conservation Workshop. Publication of MWF strategy document.	Conservation stakeholders incorporate new knowledge into their strategic thinking.
Outputs			
1. MWF with capacity to manage and develop insect conservation strategies.	MWF staff member trained using UK-based MSc. Training provided to other stakeholders.	Award of MSc and training of four MWF field workers. Twenty delegates trained via workshop.	Successful completion of MSc by MWF staff member.
2. Report on review of historic entomological information.	Collation of material. Draft report edited by Project Leader.	Publication of report. Distribution to stakeholders.	Availability of historic documents, particularly unpublished field notebooks.
3. Baseline sampling programme designed and conducted.	Protocol developed by partners. Sampling programme conducted.	Sample collection. Field notes and diaries.	Co-operation of stakeholders and MWF volunteers.
4. Inventory of specimens sampled.	Database construction including records of extant species with ecological function, endemism and native/alien status.	Production of CD-ROM containing database. Distribution to stakeholders & MWF press release.	Identification of specimens to appropriate taxonomic level achievable.
5. Insect conservation strategy document including future-funders.	Meeting of collaborators to formulate strategy. Preparation and review of document.	Publication and distribution of report to stakeholders. Submission of at least one future-funding application.	Success of future-funding application(s).
Activities	**Activity Milestones (Summary of Project Implementation Timetable)**		
Training	Prior to YR 1: Application for place for S. Motala on UK MSc (including English test). YR1: Attendance on NHM MSc Sep 03 to May 04; Study/completion of dissertation Jun-Aug 04.		
Research programme	YR 2: Visit by UK Project Leader to Mauritius to work with MWF staff on literature review, preparation and testing of sampling protocol; Training of participatory MWF staff; Publication of documentation (Sep-Nov 04). Field sampling and specimen sorting conducted (Dec 04 to Aug 05).		
Inventory of species	YR 3: ID specimens to appropriate taxonomic level supported by UK expertise (Sep 05 to Feb 06). Collation of information & database; Distribution of CD-ROM & press release (Mar-Apr 06).		
Strategic review & workshop	YR 3: Project planning of workshop, delegate invitation and document preparation; Authoring MWF Insect Conservation Strategy; Future-funders identified and application prepared (May-Sep 06). Insect Conservation Workshop conducted (Sep 06). Supported by UK Project Leader visit.		

15. Appendix 3: Project Contribution to Articles under the Convention on Biological Diversity (CBD)

Please complete the table below to show the extent of project contribution to the different measures for biodiversity conservation defined in the CBD Articles. This will enable us to tie Darwin projects more directly into CBD areas and to see if the underlying objective of the Darwin Initiative has been met. We have focused on CBD Articles that are most relevant to biodiversity conservation initiatives by small projects in developing countries. However, certain Articles have been omitted where they apply across the board. Where there is overlap between measures described by two different Articles, allocate the % to the most appropriate one.

Project Contribution to Articles under the Convention on Biological Diversity		
Article No./Title	**Project %**	**Article Description**
6. General Measures for Conservation & Sustainable Use	3	Develop national strategies that integrate conservation and sustainable use.
7. Identification and Monitoring	60	Identify and monitor components of biological diversity, particularly those requiring urgent conservation; identify processes and activities that have adverse effects; maintain and organise relevant data.
8. In-situ Conservation	8	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	0	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	0	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	0	Establish economically and socially sound incentives to conserve and promote sustainable use of biological diversity.

Appendix 3. Articles in CBD

12. Research and Training	15	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	2	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	0	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	0	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	0	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	20	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	0	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.
Total %	**100%**	**Check % = total 100**

Preliminary results from the aquatic Coleoptera sampling of Mauritius and Rodrigues

By Clive R. Turner

Research in conjunction with Saoud Motala and Zayd Jhumka (of the Mauritian Wildlife Foundation) was carried out during a two week trip in December 2005 and was supplemented by a brief visit in September 2006. Zayd Jhumka was trained on the specialist field techniques pertaining to water beetle sampling and monitoring with the purpose of building local capacity in this field on the island.

Analysis	
Field days	**20**
Training days	**15**
Mean samples per day	**5.5**
Mean sites per day	**3.5**

A total of 70 sites were visited during these two trips, producing 110 samples comprising an estimated several thousand invertebrate specimens.

Trap type	Trap days
carrion	173
carrion/fermented	41
faeces	15
fermented	152
fermented raised	15
malaise	25
pitfall	66
	487

A total of 20 field days yielded a mean of 3.5 site visits a day with mean samples a day at 5.5. Trapping supplemented the manual catches and comprised primarily of malaise traps and baited pitfall traps. The baits used were: decomposing chicken (carrion), fermenting fruit, decomposing faeces or a combination of carrion and fermented baits. These were often used in conjunction with malaise traps to optimise capture rates. The focus of these traps was on capturing the detritivorous Hydrophilidae (Coleoptera) and any other incidental invertebrates encountered during the 487 trap days.

The emphasis of the manual fieldwork was on the aquatic insects, notably the water beetles where taxonomic resolution to species could be generally assured. Beetles were encountered, with varying abundance, at all of the 61 aquatic sites investigated. These sites were composed of habitats both inside and outside the protected areas to facilitate assessment of the current conservation strategy in terms of aquatic species. I have produced a key to the water beetle genera of Mauritius and Rodrigues as a result of this research, and have already begun extension to species level resulting in an important local resource for future researchers. Reference collections are currently being created for the Mauritian Wildlife Foundation and the University of Mauritius in addition to supplementing the material held at the Natural History Museum, London. In some instances identified material has increased the number of known examples in collections, some by a multiple of three or more.

Manual samples	Sites	Samples
Aquatic	61	74
Terrestrial	9	36
	70	**110**

Examples of rediscoveries for the aquatic beetles are emerging alongside the taxonomy. Although the analysis by species is in the early stages it is clear that the endemic and endangered *Rhantus vinsoni* has been encountered at two new sites and is the first encounter probably since the 1960's (Jean Vinson's material not dated, this period being the latest he generally collect material). *Rhantus socialis* has been found at a new locality in Rodrigues, where it is endemic and endangered, and considered the first record since 1930. Specimens of both of these are currently undergoing phylogenetic analysis from their DNA (Michael Balke, Unversity of Bavarian Natural History Collections, Bavarian State Ministry of Sciences). The endemic and endangered *Copelatus thiriouxi* and *Copelatus duodecimstriatus* were encountered in numbers and considered the first records since 1942. The Malagasy endemic *Copelatus distinguendus* was recorded for the first time from Rodrigues and was apparently absent from the Mauritian

samples despite a previous record to the contrary. The widespread *Methles cribratellus* was recorded as probably the second record for Mauritius, the first being in 1937. The Mascarene endangered endemic *Copelatus guerini* was found in numbers whilst previously only the type was known from Mauritius, other examples having been located on Reunion. Two species of *Heterocerus* were encountered where only one is previously known from the Mascarene Islands. Further phylogenetic analysis is hoped for the genus *Copelatus* from Mauritius and Rodrigues.

Novel ecological notes on the endemic and endangered species have been generated through habitat photography and behavioural notes. An example of this would be the first record of *C. thiriouxi* inhabiting running water where it was observed tenaciously clinging to the clayey sides of the fast flowing stream on Mt. Le Pouce; it was reticent with regard to swimming, an activity of which it was perfectly capable. Similarly, for the first time, *C. duodecimstriatus* and *Copelatus* sp. were recorded in flowing water over poached clayey ground where they occupied the soft substrate; it was previously only known from under stones in dried up stream beds.

Other taxa have begun to yield some interesting results with a new genus of Scelionid wasp anticipated (identified by the NHM, UK) and a new cockroach genus to the island awaiting final taxonomic resolution to species (Darren Mann, Hope Entomological Collections, Oxford University Museum of Natural History). It is clear that entomological research on the islands retains great potential for new discoveries and rediscoveries and that this project has generated an essential core skill and resource infrastructure.

The final species list is expected to be both comprehensive and exciting for the water beetles of Mauritius and Rodrigues. Coupled with locally accessible collections, supplemented museum material and taxonomic reference texts in progress the final result should be anticipated as a great boon to the study of insects in Mauritius and expected to stimulate further progress locally.

An estimated four thousand specimens were collected including approximately three thousand water beetles which will be identified to species by Clive Turner. It is expected that some species will be sent to the relevant international experts to confirm difficult identifications where only limited reference material is available. Other taxa have generally been passed to the relevant staff of the Entomology Department at the Natural History Museum, London. The water beetles were all identified to genus in the field and identification to species has begun in earnest this year with some preliminary results outlined above. Reference collections will be held by the Natural History Museum, London, Mauritian Wildlife Foundation, Mauritius University, Mauritius Sugar Industry Research Institute and Clive Turner.

The Spider Fauna of Mauritius

Peter Smithers, School of Biological Sciences, University of Plymouth.

Little work has been undertaken regarding the spider fauna of the Mascarene islands (Mauritius, Réunion and Rodrigues). Vinson (1863) published a list of spiders collected from the Madagascar sub region including Réunion and Mauritius that contained species from 19 families, while Saaristo (2003) has produced a list of species from the Seychelles which come from 40 families. Records of a species of theraphosidae new to science (*Mascaraneus remotus*) from Serpent Island have recently been published, Gallon (2005). Other than these studies the arachnid fauna of this group of islands appears to be under worked and little known with no recent records existing for the island of Mauritius itself.

The sampling regime utilized in the earlier part of this project to investigate the coleopteran fauna could have gathered useful information but unfortunately it failed to collect significant number of Araneae and those that were collected were in very early life stages which made identification uncertain.
In order to gather material and gain an overview of the islands spider fauna a quick survey was undertaken utilizing pitfall traps as outlined by Turner in a previous section of this report plus a mixture of beating sweeping and hand searching.

Spiders were collected from the following sites:

- Le Pouce plateau
- Black River view point
- Brise Fer
- Alexandra Falls
- Copse next to Hotel Maritim, Balaclava Bay
- Roadside nr. Petit Gamin
- Nr. Tombeau River
- Trou aux Cerfs
- River next to Grand Bassin

The spiders collected comprised 12 families (see appendix), including the apparent first record of a Mygalomorph from Mauritius (family Brachychelicidae). This initial survey has begun the process of recording and assessing the spider fauna but there is much to do. It is hoped that the formation of the Mauritian Entomological society plus the great interest in spiders that was generated during this visit, will generate the drive and energy required to continue this process and quantify the abundance and distribution of the islands araneid fauna.

References

Gallon R (2005) Bull Brit Arachnol Soc. 13 (5). 175-178

Saaristo M. (2003) List of spiders from the Seychelles.
http://www.sci.utu.fi/biologia/elainmuseo/seych_list.htm

Vinson A (1863) Araneides de iles Reunion, Maurice et Madagascar. Librairie Classique Eugine. Paris.

Appendix

List of the spider families recorded from the Seychelles
Compiled by Michael Saaristo (25.03.2003)

Appendix 4. Clive Turner and Peter Smithers' reports

Araneidae	Miturgidae	Segestriidae
Barychelidae	Mysmenidae	Selenopidae
Clubionidae	Nesticidae	Sicaridae
Corinnidae	Ochyroceratidae	Sparassidae
Cryptothelidae	Oecobiidae	Symphytognathidae
Ctenidae	Oonopidae	Telemidae
Ctenizidae	Oxyopidae	Tetrablemmidae
Deinopidae	Palpimanidae	Tetragnathidae
Filistatidae	Pholcidae	Theraphosidae
Gnaphosidae	Pisauridae	Theridiidae
Linyphiidae	Prodidomidae	Theridiosomatidae
Liocranidae	Salticidae	Thomisidae
Lycosidae	Scytodidae	Uloboridae
Mimetidae		

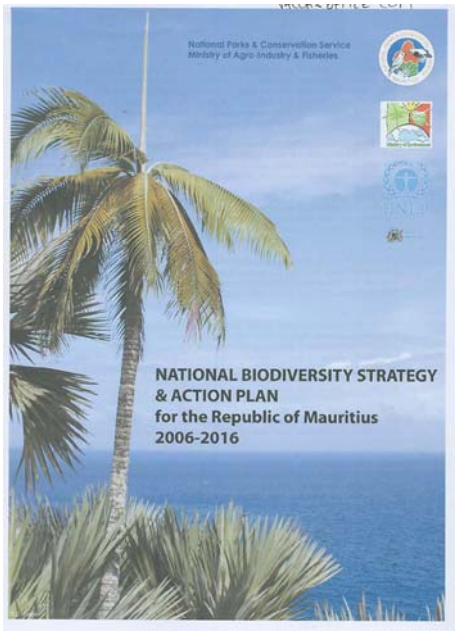
List of spider families recorded from Reunion, 1863 (Vinson)

Scytoidae	Selanopidae	Agelenidae
Lycosidae	Philodromidae	Araneidae
Pisauridae	Clubionidae	Tetragnathidae
Oxyopidae	Gnaphosidae	Ulaboridae
Atypidae	Pholcidae	Linyphiidae
Thomisidae	Theridiidae	

List of families recorded from Mauritius, September 2006 (Smithers)

Brachychelidae	Pisauridae	Salticidae
Araneidae	Pholcidae	Thomisidae
Clubionidae	Nephilidae	Tetragnathidae
Lycosidae	Theridiidae	Zorida

Appendix 5. NBSAP Mauritius 2006-2016



	Description	*OVIs*	*Partners*
Work Programme	***2f) Invertebrates***		
Objective	To develop and implement strategies for native insects and snails respectively.		
Results	Insect Strategy with targeted species action plans, as appropriate, developed and under implementation. Snail Strategy with targeted species action plans, as appropriate, developed and under implementation.	Strategy and Action Plan documents. Conservation status of species. Strategy and Action Plan documents. Conservation status of species.	
Activities	To carry out invertebrate surveys[1] building upon ongoing MWF activities. Develop and implement a native insect strategy. Carry out a survey of native snail species[1]. Develop and implement species recovery plans where necessary within the framework of an overall snail strategy.	Survey reports. Strategy document. Implementation reports. Survey reports. Strategy document. Implementation reports.	FS, MWF, University of Sussex. FS, MWF, Leguat Ltd.
Notes and Guidance	1: The stakeholder workshop identified lack of data as the key factor inhibiting effective action on invertebrates and targeted insects and snails of being of priority. If areas/habitats of key significance for invertebrate biodiversity are identified this information should be fed into WP 1a-c.		

16. Appendix 6. Outputs

Please quantify and briefly describe all project outputs using the coding and format of the Darwin Initiative Standard Output Measures.

Code	Total to date (reduce box)	Detail (←expand box)
Training Outputs		
2	Number of Masters qualifications obtained	Saoud Motala obtained a distinction in his MSc *Advanced Methods in Taxonomy and Biodiversity* based at Imperial College London in conjunction with the NHM
4a	Number of undergraduate students receiving training	30 undergraduates of UoM; attended a workshop on practical skills for sampling and identifying forest invertebrates. (NB. Saoud and Zayd were actively involved in this training, as well as Sarah Donovan.)
4b	Number of training weeks provided to undergraduate students	3 days
6a	Number of people receiving other forms of **short-term** education/training (i.e not categories 1-5 above)	1 at MWF: Zayd Jhumka (training by Sarah Donovan, Clive Turner, Peter Smithers). Additional training of MWF staff (detailed above) by Saoud Motala and Zayd Jhumka. 15 representatives from the stakeholder partners attended a three day workshop on advanced insect conservation and identification (trainers: Sarah Donovan, Clive Turner, Peter Smithers – UoP; Saoud Motala, Zayd Jhumka MWF)
6b	Number of training weeks not leading to formal qualification	2 (Zayd Jhumka) 3 days for 15 delegates at workshop. 3 days for several classes of primary schools (Zayd Jhumka taught them about insects and the use of microscopes; they proved to be a very appreciative audience!).
Research Outputs		
8	Number of weeks spent by UK project staff on project work in host country(s)	4 (two x two weeks)
10	Number of formal documents produced to assist work related to species identification, classification and recording.	Historical review of Mauritian insects published in Biodiversity and Conservation (Motala *et al*, in press). (Also research output 11a) Insect sampling protocol developed and distributed to stakeholder partners. Insect conservation strategy has been written (Appendix 1) and will be distributed to stakeholder partners.
11a	Number of papers published or accepted for publication in peer reviewed journals	See 10, above.
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	CD ROM of beetle specimens collected given to all stakeholder partners at the workshop in September 2006. (NB, some of these copies have been subsequently mislaid, and so a further copy is being sent officially from MWF.)

Appendix 6. Outputs

Code	Total to date (reduce box)	Detail (←expand box)
13b	Number of species reference collections enhanced and handed over to host country(s)	MWF has already got the beetle reference collection; duplicates from this, plus material collected by Clive Turner are being prepared for MSIRI, MI and UoM.
Dissemination Outputs		
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	1 workshop organised for stakeholder partners 18- 20 September 2006
15a	Number of national press releases or publicity articles in host country(s)	1 press release (to publicise stakeholder workshop in Sep 2006); 1 television interview; 2 radio interviews; 1 newspaper article.
Physical Outputs		
20	Estimated value (£s) of physical assets handed over to host country(s)	Microscope & digital camera (£3,073), generator, net, books (£250)
23	Value of additional resources raised for project	Equivalent to £29,472 plus £2,000 from UoP (Clive Turner's visit).

17. Appendix 7: Publications

Provide full details of all publications and material that can be publicly accessed, e.g. title, name of publisher, contact details, cost. Details will be recorded on the Darwin Monitoring Website Publications Database that is currently being compiled.

Mark (*) all publications and other material that you have included with this report

Type * (e.g. journals, manual, CDs)	**Detail** (title, author, year)	**Publishers** (name, city)	**Available from** (e.g. contact address, website)	**Cost £**
Journal	The terrestrial arthropods of Mauritius: a neglected conservation target Motala, Krell, Mungroo & Donovan 2007	Biodiversity & Conservation. Springer	Mr Saoud Motala	-

18. Appendix 8: Darwin Contacts

To assist us with future evaluation work and feedback on your report, please provide contact details below.

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Partner 1	
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