

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

## ***Final Report***

### **1. Darwin Project Information**

Project Reference No.	13-003
Project title	Taxonomic Capacity Building in Support of Biodiversity Conservation in Thailand
Country	Thailand
UK Contractor	The Natural History Museum (NHM)
Partner Organisation (s)	Queen Sirikit Botanic Garden (QSBG), Chiang Mai
Darwin Grant Value	£208,722
Start/End date	1 June 2004 / 31 May 2007
Project website	<a href="http://rx-staging.nhm.ac.uk/researchcuration/projects/biodiversity-conservation-thailand/index.html">http://rx-staging.nhm.ac.uk/researchcuration/projects/biodiversity-conservation-thailand/index.html</a>
Author(s), date	Ralph Harbach & Tony Shelley, 25 July 2007

### **2. Project Background/Rationale**

- Thailand's biodiversity is at risk because of human population pressures, and there is an urgent need to assess and monitor endangered insects. A recent assessment by the national GTI focal point, the Office of Natural Resources and Environmental Policy Planning (ONEP) of the Ministry of Natural Resources and the Environment (MNRE) of Thailand, emphasised the absence of a national biosystematic centre and the dearth of taxonomists in the country. During a short visit by Ralph Harbach and Tony Shelley (Natural History Museum, London [NHM]) to Thailand in February 2003, with the objective of setting up collaborative research programmes on insects, two senior Thai scientists elaborated on the problem and made two important observations. Thailand was making efforts to protect endangered insect species under their obligations to the CBD and that this was considerably complicated by the lack of a national reference collection of insects in the country. Consequently, Thai scientists had to rely on foreign assistance for much of their taxonomic work.
- The recent construction of the Queen Sirikit Botanic Garden (QSBG) in Chiangmai and the National Science Museum that was being built in Bangkok at the time of our visit, demonstrated the Thai government's interest in biodiversity and conservation. A depository for insects in one or both of these institutions was regarded as a national priority. Initially, they wished to set up collections of well-known insect families on which research was being carried out and which were already well known taxonomically either in Thailand or the region, rather than make a general insect collection. The Culicidae (mosquitoes) and Simuliidae (blackflies) were selected because of the comparatively small size of both families and the comprehensive taxonomic studies (morphological, enzymatic, cytological and molecular) that had already been completed. Groups of researchers and curators would concentrate on these families with Thai funding, but NHM participation was initially needed as a pump primer for setting up the collections and training Thai staff in curation and research techniques. Once established the collections would be expanded to include other insect orders. The Darwin Initiative was regarded by all concerned to be the perfect vehicle for providing this essential entomological infrastructure in Thailand. Professor Visut Baimai, Mahidol University (Director,

Biodiversity Research and Training [BRT] Program, MNRE), Bangkok, was then responsible for initiating the political procedures necessary for the integration of a Darwin project in the national plan for biodiversity and conservation studies by the Thai authorities.

- A major constraint to developing Thai expertise on insects was the total absence of in-country reference collections essential for their identification. The project filled this gap by building the capacity of key institutions needed to conserve insect biodiversity. It met GTI and CBD aims by strengthening relevant Thai institutions, provided a link between these institutions and the NHM, and sought means to enable effective use of taxonomic information, as laid out in the Thai National Report on the Implementation of Convention on Biological Diversity (2002). A Protected Area System had been set up in which the principles of the CBD were being implemented in three distinct ecological settings: (1) watersheds, (2) unique natural ecosystems that are sensitive and vulnerable to destruction from human impact, and (3) areas with aesthetic value. The project was based at the QSBG at Chiangmai in northern Thailand, with field work centred in Doi Inthanon National Park (DINP) and within the extensive grounds (1000 hectares) of the QSBG, both of which have these three ecological settings. The project became the cornerstone for Thai biodiversity and conservation research on insects by providing a state-of-the-art entomological depository in the QSBG. Prof. Baimai became the country co-ordinator for the Darwin project. Dr Chaweewan Hutacharen, Director of Research in the Department of National Parks (DNP) in the MNRE and SBSTTA representative for Thailand, was appointed by the Director of QSBG as an entomology adviser and later by us as local project coordinator.

### **3. Project Summary**

See Appendix V

- The project was set up to provide a national depository and identification facility for insects, a prerequisite for generating the biological information needed for effective biodiversity conservation in Thailand. UK expertise was used to establish a focus to help build and maintain the human resources, systems and infrastructure needed to obtain, collate and curate the biological specimens that are the basis for taxonomic knowledge. A principal aim was to link this entomological infrastructure to current and future entomological expertise in Thai universities and other institutions and the NHM. Insects were initially collected in DINP and processed and curated in QSBG. In the third year, once training of local staff had been accomplished, collections of insects in the grounds of QSBG were initiated with an emphasis on the orders Coleoptera and Lepidoptera that contain all the protected species registered by the DNP for Thailand.
- No alterations to proposed outputs or operational plan were made.

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

- See Appendix I. A recent assessment by ONEP, the national focus of the GTI in Thailand, identified two major taxonomic impediments to endangered insect conservation in Thailand. These are the lack of a national reference collection and a dearth of research taxonomists. The Darwin project has now provided a national reference collection and trained entomologists in taxonomic disciplines, thus facilitating research on endangered species in Thailand with a view to their conservation.

*Project objectives*

- All the objectives of the project were fully met within budget. The legacy of this project is the installation of the first state-of-the-art entomological facility for Thailand staffed by competent Thai biologists and technicians.

## 4. Scientific, Training and Technical Assessment

### *Facilities*

Sixteen insect cabinets and drawers funded by QSBG using the NHM steel cabinets as a model are now in use. A further 40 cabinets are included in the October 2007 Thai budget for QSBG to allow for expansion of the collection. The National Reference Collection of Insects is housed in these cabinets in a climate controlled room in QSBG. A fully equipped laboratory for insect curation, an insectary, two firefly rearing rooms, a meetings room and five staff offices were developed by the Darwin project. A digital imaging system provided by Darwin is housed in a separate room with access limited to two specially trained staff members of QSBG.

### *Techniques for research and curation*

Extensive collections of Culicidae and Simuliidae were made from diverse habitats in the DINP during the first two years of the project to serve as a foundation for training and the development of the insect reference collection. Two separate routine monthly collections (one for each family) ended in November 2005, followed by targeted collections as required using a GPS to record the coordinates for each locality. Culicidae were collected from all types of larval habitats (temporary and permanent bodies of ground water and artificial and natural containers, such as leaf axils, tree-holes, rock-holes, crab-holes, bamboo internodes, fruit shells, fallen leaves and flower bracts), and reared to adults in the QSBG. Simuliidae were collected only from running water by prospecting submerged vegetation and rocks for immature stages. Larvae were collected into Carnoy's solution for later morphological and cytological studies. Pupae were placed in plastic bags and stored in a cooler with a bag of ice for later rearing to adults in the laboratory. Qualitative human-landing collections were made at each locality into glass tubes containing 70% ethanol to establish which species are anthropophilic. Each collection of Culicidae and Simuliidae was individually recorded in a field notebook with comprehensive data for each locality, which were later entered into the collections database.

In the laboratory, culicid larvae were kept in plastic bowls to the fourth instar and allowed to molt to pupae. Both laboratory-reared and field-collected pupae were then separated individually into plastic tubes and reared to the adult stage. Some mature larvae from each collection were killed and preserved in 80% ethanol. Larval and pupal exuviae, and mature larvae, were thus associated with individual adults. Larval and pupal exuviae were mounted on microscope slides and adults were pinned. The genitalia of some pinned males were dissected to aid species identification. Computer generated images of selected species were then made for the image archive. In the case of Simuliidae, field-collected pupae were placed individually in glass, plastic stoppered tubes with damp filter paper until adults emerged. A portion of adults was individually pinned with their pupal exuviae in a plastic tube filled with glycerin. Others were stored in 70% ethanol for later dissection and slide mounting. Where small numbers of a species were collected, preference was given to pinned adults ([heads and genitalia of pinned specimens could be subsequently removed and dissected for identification). Images of the diagnostic morphological features of each species were made.

Procedures for data collection for both Culicidae and Simuliidae were established. Data sheets were filled in as dissection and identification of each specimen from each locality progressed (data sheets available on request). These were then provided to the IT specialist at QSBG who transferred them to the computer database.

Having established a functional entomological infrastructure during the first two years of the project, the third year was dedicated to fine tuning and expanding the collection to include all insect orders, with emphasis on the Coleoptera and Lepidoptera. These orders were selected because of their large species diversity, and all protected species in Thailand belong to these two orders. Martin Brendell, Collections Manager in the NHM, and specialists from Chiangmai University, provided training for this work. General collecting by chance encounter and targeted collecting of certain micro-habitats was undertaken.

A regular schedule of collecting new material in the QSBG grounds was set up (see Appendix VI). The following collecting methods were demonstrated to the Darwin project members at QSBG, and these then became part of the regular collecting programme.

1. Sieving material collected from specialised habitats such as leaf litter, fungi, dead animals, nests and rotting fruit, etc. in both the morning and afternoon. Samples were labelled in pencil and the label inserted into the relevant tube. 'Beetle sieves', aspirators (pooters), etc. were made.
2. Malaise and Flight Interception Traps (FITs). Both traps were supplied and demonstrated. Malaise traps catch rising insects into 75/80% ethanol and are emptied once a week. FITs catch by 'drop down' into water-filled trays each laced with half a teaspoonful of chloral hydrate (as a bactericide) and a dash of washing up liquid to break the surface tension. A trap run of one to two days only was recommended before servicing. The liquid in the FIT pans should be changed once it is contaminated by mud or debris, or after two weeks. A discussion document on the working of FITs was left at QSBG. Both types of equipment were built to NHM standards.
3. Carrion Pit-fall Traps. Transects or random placing of dry-baited carrion pit-fall traps were demonstrated using plastic buckets and bait (usually chopped liver in a state of decomposition) filled baby food jars with perforated screw-top lids. The buckets are protected from rain by using simple squares of plywood tilted on sticks as umbrellas. Sets of 10 or more buckets were employed at any one time. They were emptied each day of the run. The pitfall run of ten buckets was set up for one week in each month, unless catches were very high or particularly interesting, when they were used for longer periods.
4. Winkler Funnels. This method of drying extraction was demonstrated for collecting insects from woodland litter. A discussion document was supplied.
5. Berlese Funnels. This other method of drying extraction was dedicated to collecting Protura for an MSc thesis study.
6. Light Traps. A standard MV light bulb and vertical settling sheet was demonstrated, with power provided by a portable generator. Trapping periods began just before dusk and ended before dawn the next day. It was shown that these traps were effective for simultaneously collecting insects of several orders. Specimens were killed by using ethyl acetate; larger specimens by injecting a saturated solution of oxalic acid. Beetles were injected between the anterior sternal plates of the abdomen pushing the needle towards the mesothorax of the insect. Smaller specimens were collected with an aspirator or small tube and placed in a jar primed with ethyl acetate.
7. Water netting was demonstrated, especially gravel kicking in well-oxygenated rapids whilst holding the net downstream on the riverbed.
8. Ethanol and sugar trap bottles were also set up for making general collections of insects.

Staff were informed of other collecting methods that are described in '*Biodiversity Assessment, A Guide to Good Practice*' (Field manual 2 London: HMSO), which was supplied to QSBG.

Once collected, specimens were processed in the laboratory as follows. Conventional methods of pinning and carding beetles and setting Lepidoptera were demonstrated and implemented. Other orders of insects, such as Diptera, Hemiptera and Odonata, were also collected, but only the more common species were identified. Unsorted and partially sorted samples in spirit were numbered and some stored in stackable, plastic boxes in a freezer. Cupboards in the laboratory were also used for storage and ethanol levels checked regularly. Identified specimens were then recorded in the database. Label data followed the format shown in Appendix VII. Slight changes in the juxtaposition of the component parts of labels were allowed to produce a label of balanced, minimal size. GPS coordinates, collection dates and collector, country of origin, province or district, town, village and other relevant collecting data are mandatory. The QSBG registration number was always included in the label data. Pest management in collections was also implemented. All specimens, and returned loans, were passed through a freezer (-30°C) before being incorporated into drawers in the cabinets. A monthly pest check involving manual inspection of each drawer was established. Drawers suspected of being infested with pests were placed in plastic bags and frozen for three days. It was suggested that trays of naphthalene should be placed on the floor of

each cabinet as a deterrent to pests. The health and safety aspects of such action should be fully examined before action.

#### *Keystone insect reference collections and literature*

The dipteran families Culicidae and Simuliidae collected from DINP during the first two years on which the entomological infrastructure was based were identified, labelled, and representative species imaged and data based. Some 2,800 specimens of Culicidae among 366 collections from all the geological and vegetation areas in the DINP were pinned and 3,600 slide mounts made of larvae and larval and/or pupal exuviae representing 126 species of mosquitoes. At least one species of each major subgenus was digitally imaged for the database. Similarly, a total of 236 collections of Simuliidae were made and from these all pinned and alcohol-preserved adults representing 40 species were identified. A total of 245 microscope slides of these species were mounted and digital images of the scutal patterns of all species captured and archived. Images of morphological characters (apart from scutal patterns) were captured from selected species.

Data on the distribution of Culicidae and Simuliidae in DINP were geo-referenced and are currently being integrated with geological and vegetation data layers within a GIS constructed within ArcGIS.

During the third year, collections of insects in QSBG were made with emphasis on the Coleoptera and Lepidoptera. These are all being processed and those specimens that were identified have been placed in the collection.

The National Reference Collection of Insects now contains 25,000 specimens represented by 8,000 entries in the database. Collection development occurs in two principal ways: the collection of fresh specimens and the acquisition of extant collections. As the National Reference Collection of Insects at QSBG becomes better known, more specimens will be acquired through entomologists sending insects for identification and through loans of unidentified specimens to relevant specialists. The collection is expected to grow exponentially over the next three years as reference collections from the 30 national parks being sampled by the Thailand Insect Group for Entomological Research (TIGER) project are incorporated.

A system for loaning specimens to specialists was developed (see Loan Regulations set out in Appendix VIII). Loan forms consist of an Office Copy, a Dispatch Note and a Receipt, each of a different colour and bearing a unique loan number. Examples of suitable self-adhesive parcel labels and customs declarations labels were provided. A programme for an automated loan system was set up electronically. Loans of specimens may include identified and/or unidentified material. The method for packing specimens for shipment was demonstrated.

Funds from the Darwin project were also used to purchase relevant books and reprints that are now housed in a section of the QSBG library, and will expand as research progresses.

#### *Database, web pages, GIS*

The provisional format for the database was set up by **Mr Thanawat Lertprasert** for the Simuliidae and Culicidae, and this was refined and now includes data for all insects collected (Appendix IX). This expandable taxonomic database can be accessed through the QSBG and the Darwin pages on the NHM web site. The database can also be directly accessed at <http://www.qsbginsects.org/databases.php>. The database correlates field collection data with curatorial data, thus facilitating location of a species in the collection, image archive and information on specific collection sites.

Web pages describing the Darwin Initiative project with links to the specimen database and the NHM, QSBG and Darwin Initiative web sites may be accessed through <http://rx-staging.nhm.ac.uk/research-curation/projects/biodiversity-conservation-thailand/index.html>; <http://www.qsbginsects.org/index.html>.

GIS and image processing research was based on a photo montage of seven IKONOS images that represent the land cover of DINP. Each image was geo-referenced and imported into Erdas Imagine 8. Training sites were selected within representative vegetation groups and the first ground truthing data were incorporated. An unsupervised isodata classification was run to provide input into a supervised max-likelihood classification of the IKONOS 5-metre multispectral image. Data on the distribution of Culicidae and Simuliidae were geo-referenced and are being integrated with geological and vegetation data layers in a GIS constructed within ArcGIS for purpose of publication. Mr Lertprasert was trained in GIS management and the appropriate software was donated to the QSBG.

#### *Training of Thai museum staff and partners*

On-site training was carried out twice per year by **Ralph Harbach** and **Tony Shelley**. Visits to Thailand were also made by **Luis Hernandez** (research entomologist, NHM) for training on simuliid curation and digital imaging, and by **Malcolm Penn** (GIS specialist, NHM) for GIS training. **Howard Mendell** (Head of insect curation, NHM) visited QSBG during an independent field trip and provided advice on ways to fine tune the entomological infrastructure. **Martin Brendall** (Head of Coleoptera curation, NHM) made two visits in the third year of the project to advise on general insect collecting and curation, with emphasis on the Coleoptera. Visits to the NHM were made by **Dr Weerachai Nanakorn** (Director, QSBG), **Dr Chaweewan Hutacharen**, **Dr Rampa Rattanarithkul**, **Dr Jumnonjitt Phasuk**, **Mr Mark Isenstadt**, **Mr Wirat Sommit** and **Mr Paisan Thongsorn** to observe insect curation in a major museum. The last four biologists also received training in curation and collections management.

Our local coordinator, **Dr Rattanarithkul** (Darwin), having launched the project from her private museum and successfully transferring it to QSBG, stepped down as local coordinator and was replaced on 1 August 2005 by **Dr Phasuk** (Darwin), a freshwater biologist working on the Simuliidae. She subsequently received training in the QSBG and NHM in collection and curation techniques both for Simuliidae, insects in general and imaging techniques, and was made responsible for the imaging equipment. She was head hunted for a permanent position as a lecturer in freshwater insect biology by Kasetsart University, Bangkok, and took up the appointment in February 2007.

Coordination of the project was then transferred to **Dr Hutacharern** (Darwin). This was highly appropriate because Dr Hutacharern is active politically in biodiversity and conservation of insects in Thailand. She is also the Thai coordinator for the TIGER project, a three-year National Science Foundation (USA) project that is using the Darwin infrastructure for housing reference collections of insects from 30 national parks. She is also the author of a recently published book on the insects and mites of Thailand, with a list and photographs of protected and regulated species. Dr Hutacharern effectively linked the Darwin and TIGER projects and thereby ensured the smooth incorporation of TIGER into the QSBG entomological infrastructure when the Darwin project ended.

**Mr Mark Isenstadt**, Darwin field biologist, also in charge of sourcing and purchasing equipment and reagents during the third year, left the project in February 2007 to take up an appointment in an NGO working with hill tribes and Burmese refugees in northern Thailand. **Mr Wichai Srisuka** concluded his MSc at Chiangmai University, with Mr Luis Hernandez of the NHM as external adviser. Wichai was supported by the Darwin project to conduct fieldwork at DINP for studies on the morphology and biology of Simuliidae at three adjacent locations. He was then funded by Darwin to carry out general insect collections, curation and digital imaging at QSBG. Since the Darwin project has now ended he has been successful in obtaining a permanent position as curator of the National Reference Collection of Insects at the QSBG. **Mr Wirat Sommit** (MSc), a QSBG entomologist, was trained in collection, curation and imaging of insects. He is carrying out research on culicid species in collaboration with Dr Rattanarithkul and is conducting work on fireflies at QSBG. He has found four species of firefly, one of which is new to science. **Mr Thanawat Lertprasert**, an IT specialist at QSBG, assisted in setting up the insect database and was also trained by Dr Malcolm Penn of the NHM on GIS analyses of the collection data for Culicidae and Simuliidae. **Mr Raewat Sawkord**, a QSBG botanical technician, was loaned to

Darwin for training in insect collection and curation. He produced large numbers of high quality microscope slides of immature stages of Culicidae in collaboration with Dr Rattanarithikul and worked on other insect groups during the third year of the project. His skills were recognised by QSBG management and he has been transferred to a permanent position as assistant curator in the Entomology Section of the Research Department. **Mr Apilat Aksornporn** was employed by Darwin for the final year of the project to input data into the insect database. He also participated in insect collections. He is now registering for an MSc in entomology at Chiangmai University.

During the final year of the project, the Darwin project provided funding to assist MSc students of the Entomology Department of Chiangmai University in their field studies at QSBG and elsewhere in Chiangmai Province (see **5. Project Impacts** for details).

## 5. Project Impacts

- There is now a fully equipped entomological facility in a Thai national institution with trained staff and the National Reference Collection of Insects. A fully functional database is available on the internet and through the Darwin web pages on the QSBG and NHM web sites. The facility is now accessible to the international scientific community. This legacy has been recognised by the DNP and is currently being used by the TIGER project in their evaluation of insect biodiversity in the National Park System of Thailand.

Loans of Simuliidae have been made to the NHM, Mahidol University in Bangkok, Clemson University in the USA, and a loan of Culicidae has been made to the NHM.

The objective of the project was fully achieved. It resolved the two major stumbling blocks to insect conservation: the lack of a national depository for insects and the lack of insect taxonomists. It now enables the ONEP to begin its programme of conservation of insects, thus satisfying its obligations to the GTI.

- See Appendix I for biodiversity conservation defined in the CBD Articles.
- The Darwin project not only provided an entomological infrastructure and trained staff, but also provided taxonomic training essential for the career development of several Thai biologists. Dr Jumnonngjit Phasuk received training in all aspects of museum taxonomy and research on the family Simuliidae, and as a consequence she was recruited for a lectureship in freshwater biology at Kasetsart University in Bangkok. Four students from Chiangmai University were funded by the Darwin project in their MSc thesis research. One of these individuals, **Mr Wichai Srisuka**, successfully completed his MSc on the biology of Simuliidae in DINP under the supervision of Luis Hernandez (NHM). Following the completion of the Darwin project, he was appointed curator of the National Reference Collection of Insects at QSBG. Three other students, **Mr Arthit Rukasikon**, **Mr Natdanai Likitrakorn** and **Miss Ninat Buawangpong** were supported in their field work and are currently writing up their MSc dissertations based on research data. Their research dissertations are as follow: Mr Rukasikon – Diversity of Saturniidae in northern Thailand; Mr Likitrakorn – Taxonomy of Protura in QSBG; Miss Buawangpong – Taxonomy of Collembola in QSBG.
- The objective of the project was not to set up collaboration between government and civil society groups, but to provide an entomological infrastructure that could be used by other researchers and institutions in Thailand. A number of collaborative research projects were developed during the course of the Darwin project. These now consist of:
  - Chiangmai University, Chiangmai – Dr Hans Banziger and Mr Prachawan Sukumolanaen, Lepidoptera research; Dr Roger A. Beaver, Coleoptera research.
  - Mahidol University, Bangkok – Dr Chaliow Kuvangkadilok, “Cytogenetics of Simuliidae from Doi Inthanon National Park”.

- Department of National Parks, Bangkok – Dr Chaweewan Hutacharern, “Insect species distribution in National Parks of Thailand –TIGER project”.
- Kasetsart University, Bangkok – Dr Jumnongjit Phasuk, “The taxonomy of Simuliidae of Doi Inthanon National Park” with Mr Luis Hernandez (NHM, London).
- Armed Forces Institute of Medical Research, Bangkok – Dr Rampa Rattarithikul, “Illustrated keys to the Mosquitoes of Thailand”.
- University of Kentucky, USA – Prof. Michael Sharkey, “Insect Species Distribution in the National Parks of Thailand” (TIGER project).
- Clemson University, USA – Prof. Peter Adler, "Cytogenetics of Simuliidae from Doi Inthanon National Park”.
- Natural History Museum, London – Dr Yvonne Linton, “Mosquito DNA Barcoding”.

The infrastructure has provided the TIGER project with a base for its operations, and this resulted in a very strong link between the entomology section of the QSBG and the DNP. All insect species from the 30 National Parks involved in the TIGER project will be deposited in the National Reference Collection of Insects at QSBG.

A workshop on aquatic insect ecology (May 2007) based at Chiangmai University carried out fieldwork at QSBG using the Darwin infrastructure (Dr Chaweewan Hutacharern, Darwin/TIGER, Dr Peter Cranston, University of California at Davis, USA, and Dr Greg Courtney, Iowa State University, USA).

- The project has not had any impact on local communities because conservation was not an objective, its remit being to set up a working infrastructure for research on insects with a view to their future conservation.

## 6. Project Outputs

See Appendices II and III.

The entomological infrastructure has a relatively restricted audience: scientists and government biodiversity and conservation planners. Initially research entomologists in Thailand were made aware of the facility and collection and collaboration started on insect biodiversity research in northern Thailand. Two projects are now underway on medically important groups involving the NHM and Thai researchers. Dissemination of the facility will increase as the USA-led TIGER project progresses and the collection becomes of increasing necessity to biodiversity, economic and medical studies. The QSBG-based project on fireflies will develop and be related to conservation studies of one protected species in southern Thailand. Current insect biodiversity and conservation research in Thailand will develop since the first phase of providing an insect depository and fully trained staff to ensure its efficient functioning is now complete. Political planners see the QSBG structure as serving northern Thailand and the NHM in Bangkok as covering southern Thailand and the South-east Asian region.

## 7. Project Expenditure

Expenditure over the three years of the project.


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The original total Darwin budget was £208,722. This is incorrect and should have been £208,422. The table shows the actual expenditures during the three-year period of the grant. There were no changes to the budget. Based on no audit costs to date, there was an under spend of £2,328.

## 8. Project Operation and Partnerships

- Since the aim of the project was to set up an entomological infrastructure at QSBG, only the NHM and QSBG were involved from the outset. These partners were equally active. There were no significant changes to the project as originally planned, but Drs Harbach and Shelley were asked to provide a short review of the future development of Entomology in QSBG for justification of their 2007/2008 budget request (Appendix X). The QSBG is now a national reference centre for plants and insects.
- No collaboration took place with other Darwin projects in Thailand because none involved insects or the setting up of an infrastructure. There was full consultation with the host country and the CBD concerning the integration of the project into the national biodiversity and conservation strategy. Dr Chaweewan Hutacharern, our local coordinator, represents Thailand on the SBSSTA committee of the CBD, liaises with staff of the GTI national focus at ONEP and is in constant contact with DNP where she was Director of Research. Professor Visut Baimai, our country coordinator, is Head of the national Biodiversity Research and Training Program (BRT), MNRE, and has formulated future research and conservation on Thai insects based on the results of the Darwin project.
- The TIGER project ran in tandem with the Darwin project during the last six months using the entomological infrastructure for the deposition of reference collections of insects from biodiversity research in 30 national parks in Thailand.
- The project only ended in May 2007. However, the prognosis for entomology in the QSBG is excellent. The Thai government has approved a budget of 64 million Thai baht for the coming financial year for a fully equipped insect museum and expansion of the Darwin infrastructure. The QSBG has appointed a curator and a technician for the National Reference Collection of Insects for its continued development. This will be considerable over the next two and a half years as identified specimens collected as part of the TIGER project are deposited in the collection. Firefly research in the grounds of the QSBG is continuing with a grant from the Royal Family of Thailand. Collaboration between QSBG staff of the Entomology Section and Chiangmai University researchers continues with work on Coleoptera, Diptera and Lepidoptera. At this stage there is no role for the private sector. This will only be feasible once studies on insect biology indicate what species need conserving and what measures are necessary for conservation.

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

- We were in constant email and telephone contact with the country and local coordinators of the project. Scientific and financial reports were received monthly from the local coordinator, and decisions were made accordingly. Drs Harbach and Shelley made biannual visits to the QSBG to assess development of the entomological infrastructure. This was also accomplished through the expertise of visiting specialists. The integration of the project into the national strategy for biodiversity and conservation was discussed with officials from the DNP and MNRE. Relevant officials at the British Embassy were kept informed of the progress of the project through visits and annual reports. The value of the project is clearly apparent in the smooth functioning of the entomological infrastructure at QSBG, which is the cornerstone for development of biodiversity and conservation research in Thailand to satisfy the country's obligations to the CBD.
- Many problems were encountered during the development of the project, but none were insurmountable. The most important was the asynchrony of the Thai and British financial years that could have seriously delayed the purchase of the imaging system. This was obviated by the provision of a loan by the NHM. Another problem was the importation of some reagents and consumables due to local bureaucracy. This was resolved by their purchase by Dr Hutacharern and Mr Isenstadt, who then received re-imburement from Darwin. Importing essential items will be a problem for QSBG in the future. The third problem was the faulty manufacture of some of the collection drawers, but these were returned for rectification.

The original project intended to include the Natural History Museum (THNMF), Bangkok, in the third year. Delays in the construction and equipping of this museum precluded this. Efforts were therefore concentrated on development of the facility at the QSBG. The future development of the Entomology Department in the THNMF is envisioned, with emphasis on research on the biology and conservation of endangered insect species.

- Mr Elliot Morley, Minister for Defra visited the QSBG shortly after the inauguration of the Darwin project and a short aide memoire was prepared for him (Appendix XV). The project was reviewed by external referees at the end of years one and two.
- It is essential to have a senior Thai involved in such a project, with links to government because setting up an infrastructure depends heavily on policy makers to provide funds. The success of our project and its lasting legacy were due to the appointment of two senior government figures as country and local coordinators.

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

We addressed three points made by the referee in response to our first-year annual report. 1. We provided more technical details to facilitate its scientific and technical assessment. 2. The discrepancy in grant value was resolved. 3. Comments were made on the dissemination of the results of the project, and we were reticent at that stage to advertise its success prematurely. The nature of the project in providing an infrastructure restricts its audience to research entomologists and political planners. Requisite steps were taken to make this audience fully aware of the new facility that resulted from the Darwin project.

## **11. Darwin Identity**

- The Darwin name and logo appears on all publications, reports, NHM and Thai museum web sites, the laboratory and equipment, insect trapping sites and the vehicle that was used for field work (Appendix XI). The British Embassy in Bangkok was kept informed of developments. At the end of the project a report was published in the Chiangmai Mail (Appendix XII) and the closing ceremony was filmed for Thai national television (Channel 11, Education), including an interview with the

Director of QSBG. Dr Harbach made a press release through the NHM press office concerning the project (Appendix XIII). Reference was made to the Darwin project in the MSc thesis of Wichai Srisuka.

- The Darwin Initiative is clearly associated with biodiversity and conservation and is regarded by various elements of Thai society as a promoter of and key contributor to projects associated with these two areas of biology. Entomologists and politicians are familiar with the project through the Darwin web pages and our national coordinators. The general public in Thailand is now aware of Darwin's support of biodiversity and conservation studies in the country through the above local press article and Thai national television coverage.
- The infrastructure created by the project is a keystone to future conservation of insects and provides a platform for the development of GTI initiatives in Thailand. The political significance of the project has been managed by our local and country coordinators, who are responsible for representing Thailand in CBD meetings and in providing funding for biodiversity projects in the country. The success of the Darwin project has now lead to a request from the Director of the THNHM and the Director of BRT, MNRE, to the NHM participants to manage the next phase of the national plan for insect conservation. This will involve development of a regional hub for teaching insect taxonomy and conservation and implementation of research in these two fields, which will focus on endangered insect species. The Thai government regards the Darwin Initiative as a catalyst for bringing together foreign and local expertise to form the first insect conservation framework for the country.

## **12. Leverage**

- As a result of the successful installation of an entomological infrastructure at the QSBG, the Thai government has now provided funding in the amount of 64 million baht (approximately a million pounds sterling) for further development of this infrastructure to include an insect museum (new building) for public education and awareness of insect biodiversity.
- Drs Harbach and Shelley provided a report for QSBG to obtain Thai government funding for the year following the end of the Darwin project (see Appendix X).

## **13. Sustainability and Legacy**

- The infrastructure developed at the QSBG for insect taxonomic research will undoubtedly continue now that the project has finished, as evidenced by the recruitment of Thais to run the facility and the approval of Thai government funding for the next financial year (See Appendix XVI).
- The state-of-the-art entomological facility established at QSBG has already gained national and international recognition and it is not seen how this legacy can be improved. Development of the facility in the future lies with the Thai government's degree of commitment to insect conservation within CBD guidelines.
- Our country coordinator, as head of the Biodiversity Research and Training Program, MNRE, has agreed to provide funding for Thai students interested in working on insect biodiversity and conservation.

## **14. Value for money**

The Darwin project has been invaluable as the keystone for the ONEP/GTR initiative in Thailand for the future conservation of insects. The project itself has been very cost effective, producing a fully functional facility that is recognised both nationally and internationally.

## 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>		
<b>Article No./Title</b>	<b>Project %</b>	<b>Article Description</b>
<b>6. General Measures for Conservation &amp; Sustainable Use</b>	0	Develop national strategies that integrate conservation and sustainable use.
<b>7. Identification and Monitoring</b>	25	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.
<b>8. In-situ Conservation</b>	0	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.
<b>9. Ex-situ Conservation</b>	20	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.
<b>10. Sustainable Use of Components of Biological Diversity</b>	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.
<b>11. Incentive Measures</b>	0	Establish economically and socially sound incentives to conserve and promote sustainable use of biological diversity.
<b>12. Research and Training</b>	20	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).
<b>13. Public Education and Awareness</b>	0	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.
<b>14. Impact Assessment and Minimizing Adverse Impacts</b>	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.

<b>15. Access to Genetic Resources</b>	5	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.
<b>16. Access to and Transfer of Technology</b>	20	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.
<b>17. Exchange of Information</b>	10	Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge
<b>19. Bio-safety Protocol</b>	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.
<b>Total %</b>	<b>100%</b>	<b>Check % = total 100</b>

## Appendix II: Outputs

Code	Total to date	Detail
<b>Training Outputs</b>		
1a	0	Not applicable
1b	0	Not applicable
2	1	MSc in biology obtained from Chiangmai University on the biosystematics of Simuliidae in Doi Inthanon National Park (fieldwork funded by Darwin; supervision by L.M. Hernandez).
3	0	Not applicable
4a	0	Not applicable
4b	0	Not applicable
4c	7	All the staff and students detailed in Section 4 – <i>Training of Thai museum staff and partners</i> – received training in field collection and curation of insects.
4d	24	Regular visits by Drs Harbach and Shelley and sporadic visits by Dr Penn and Messrs. Hernandez and Brendall
5	0	Not applicable
6a	0	Not applicable
6b	0	Not applicable
7	1	Simuliid identification key produced from specimens collected in Doi Inthanon National Park as part of training in taxonomy of this family because of the lack of any reliable identification key in Thailand.
<b>Research Outputs</b>		
8	24	The visits detailed above involved training, collection and research.
9	1	Entomology development in QSBG (see Appendix X).
10	1	Documents include the following: collecting schedule, label style and layout, loan regulations, databases, future development of entomology in QSBG, simuliid identification key (see Appendices VI-X, XIV).
11a	4	Harbach <i>et al.</i> 2007 (see Appendix III).
11b	0	Not applicable
12a	1	Database for collections and associated information: <a href="http://www.qsbginsects.org/databases.php">http://www.qsbginsects.org/databases.php</a>
12b	0	Not applicable
13a	1	National Reference Collection of Insects.
13b	0	Not applicable

<b>Dissemination Outputs</b>		
14a	6	Two annual workshops (6) discussing the development of the infrastructure and future work.
14b	0	Not applicable
15a	0	Thai partner regarded local press release more appropriate (15b)
15b	1	Press release in the Chiangmai Mail covering the closing ceremony of the Darwin project (Appendix XII).
15c	0	Press release by Dr Harbach through the NHM Press Office (Appendix XIII).
15d	0	Not applicable
16a	0	Not applicable
16b	0	Not applicable
16c	0	Not applicable
17a	4	QSBG and NHM web pages ( <a href="http://www.qsbginsects.org/index.html">http://www.qsbginsects.org/index.html</a> )

		and <a href="http://rx-staging.nhm.ac.uk/research-curation/projects/biodiversity-conservation-thailand/index.html">http://rx-staging.nhm.ac.uk/research-curation/projects/biodiversity-conservation-thailand/index.html</a> , respectively); QSBG annual reports; annual reports of DNP and BRT.
17b	0	Not applicable
18a	1	Thai Channel 11 News Report (educational channel), an overview of the Darwin project by the Director of the QSBG.
18b	0	Currently being dealt with by NHM Press Office.
18c	0	Not applicable
18d	0	Not applicable
19a	0	Not applicable
19b	0	Currently being dealt with by NHM Press Office.
19c	0	Not applicable
19d	0	Not applicable
<b>Physical Outputs</b>		
20	£20,000	Image analysis system donated to the QSBG.
21	1	Entomological infrastructure established at QSBG.
22	1	Extra – grounds of QSBG firefly research and general insect collecting.
23	2	As a result of the Darwin project, the TIGER project (US\$650,000) was located at the QSBG using the entomological infrastructure that the Darwin project established. Continuity of the infrastructure resulting from the Darwin project is guaranteed by a Thai government award in the next financial year of 64 million Thai baht (about £1 million).

### Appendix III: Publications

<b>Type *</b> (e.g. journals, manual, CDs)	<b>Detail</b> (title, author, year)	<b>Publishers</b> (name, city)	<b>Available from</b> (e.g. contact address, website)	<b>Cost £</b>
Journal*	Systematics of a new genus and cavernicolous species of the mosquito tribe Aedini (Diptera: Culicidae) from Thailand. Harbach, R.E., Rattarithikul, R., Howard, T.M., Linton, Y.-M. & Kitching, I.J. 2007.	Proceedings of the Entomological Society of Washington, Washington, DC.	R.E. Harbach, Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD	None
Web pages	<a href="http://rx-staging.nhm.ac.uk/research-curation/projects/biodiversity-conservation-thailand/index.html">http://rx-staging.nhm.ac.uk/research-curation/projects/biodiversity-conservation-thailand/index.html</a>	NHM		None
Web pages	<a href="http://www.qsbginsec.ts.org/index.html">http://www.qsbginsec.ts.org/index.html</a>	QSBG		None
Database	<a href="http://www.qsbginsec.ts.org/databases.php">http://www.qsbginsec.ts.org/databases.php</a>	QSBG		None

## Appendix IV: Darwin Contacts

<b>Project Title</b>	Taxonomic Capacity Building in Support of Biodiversity Conservation in Thailand
<b>Ref. No.</b>	13-003
<b>UK Leader Details</b>	
Name	Dr Ralph Harbach
Role within Darwin Project	Project Leader
Address	Entomology Department, The Natural History Museum, Cromwell Road, London SW7 5BD
Phone	
Fax	
Email	
<b>Other UK Contact (if relevant)</b>	
Name	Dr Anthony Shelley
Role within Darwin Project	Project cocoordinator/researcher
Address	Department of Entomology, The Natural History Museum, Cromwell Road, London SW75BD.
Phone	
Fax	
Email	
<b>Partner 1</b>	
Name	Dr Nanakorn Weerachai, Director
Organisation	Queen Sirikit Botanic Garden
Role within Darwin Project	Project Leader, Thailand
Address	Ministry of Natural Resources and Environment, Mae Rim, Chiangmai 50180, Thailand.
Fax	
Email	
<b>Partner 2 (if relevant)</b>	
Name	Dr Chaweewan Hutacharern
Organisation	Retired, ex Department of National Parks, Thailand
Role within Darwin Project	Local Co-ordinator
Address	Queen Sirikit Botanic Garden, Ministry of Natural Resources and Environment, Mae Rim, Chiangmai 50180, Thailand.
Fax	
Email	

## Appendix V: Logical Framework

Project summary	Measurable indicators	Means of verification	Important assumptions
<p><b>Goal:</b></p> <p>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</p> <ul style="list-style-type: none"> <li>• the conservation of biological diversity,</li> <li>• the sustainable use of its components, and</li> <li>• the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources</li> </ul>			
<p><b>Purpose</b></p> <p>To establish capacity in Thailand for developing and maintaining national reference collections and identification facilities for insects in support of biodiversity conservation and research in Thailand.</p>	<p>Infrastructure and collections of model insect groups established at QSBG, and training for NSM staff.</p> <p>Thai capacity established for continued development and curation of insect reference collections to support biodiversity and conservation research.</p>	<p>Database and web-based system of information derived from state-of-the-art collections of Culicidae and Simuliidae.</p> <p>Collaborative research projects linking university researchers and Thai museum collections.</p> <p>Expansion/diversification of collections by Thai scientists; data added to database and website.</p>	<p>National and institutional agendas for biodiversity and conservation research do not change.</p> <p>Thai partners will maintain commitment and resources for continued development and use of collections for biodiversity and conservation research.</p> <p>Partners attract additional support and researchers to continue development and use of national collections.</p>
<p><b>Outputs</b></p> <p>Keystone insect reference collections.</p> <p>Expandable taxonomic database</p> <p>Expandable interactive website facility.</p> <p>Application of remote sensing and GIS techniques.</p> <p>Training of Thai museum staff and partners.</p>	<p>Culicid, simuliid and endangered species collections completed.</p> <p>Data collection and entry completed; database functional.</p> <p>Functional website of integrated data, images and identification keys.</p> <p>GIS data and maps linking collections, species and land cover ecology.</p> <p>At least 6 individuals trained in field methods, information and collection management practices, and/or GIS.</p>	<p>Accessible collections; inventories; Thai museum reports.</p> <p>Available on Thai museum websites; user notification; Thai museum reports.</p> <p>Available via internet; assessment by users; Thai museum reports.</p> <p>Database / website documented capability; image library in Thai museums.</p> <p>Annual appraisals and reports in Thai</p>	<p>No impediment for in-depth collection and curation; local contribution sufficient.</p> <p>First output successful and local IT support sufficient to complete development.</p> <p>First 2 outputs successful; local IT support sufficient; no technical limitations.</p> <p>GIS remains functional; contemporary satellite images available.</p>

<b>Activities</b>	<b>Activity Milestones (Summary of Project Implementation Timetable)</b>
Review and planning	Yr 1: planning workshop at start of project; Yr 2: coordination meeting; Yr 3: review and planning meeting at start of year, final workshop for participants and Thai officials.
Field work and training.	Yrs 1, 3: training in entomological techniques and GIS in Thailand, protocols for specimen and data acquisition; Yrs 1-3: field work in national park (9 days/month, 9 months/yr).
Collection management and training.	Yr 1: training visits to UK; Yrs 1-3: specimen preservation and identification, collection building and curation.
Information products.	Yrs 1-3: taxonomic database and website designed, implemented and populated in QSBG.
Collaborative links.	Yr 2-3 identify Thai scientists interested in biodiversity and conservation