

Darwin Initiative – Final Report

(To be completed with reference to the Reporting Guidance Notes for Project Leaders
(<http://darwin.defra.gov.uk/resources/reporting/>) -

it is expected that this report will be a **maximum** of 20 pages in length, excluding annexes)

Darwin project information

Project Reference	14-030
Project Title	Going for Gold – Cordyceps conservation in Bhutan
Host country(ies)	Bhutan
UK Contract Holder Institution	CABI
UK Partner Institution(s)	
Host Country Partner Institution(s)	Council for Renewable Natural Resource Research of Bhutan (CoRRB)
Darwin Grant Value	£204936
Start/End dates of Project	1 April 2005 – 30 September 2008
Project Leader Name	Paul Cannon
Project Website	http://194.203.77.76/Cordyceps
Report Author(s) and date	Paul Cannon and Lungten Norbu, November 2008

1 Project Background

Ophiocordyceps sinensis, parasitic on Himalayan ghost moth caterpillars, is the most valuable fungus in the world, with retail prices reaching over US\$30000/kg, and is valued as a remedy in traditional Oriental medicine. However, its biology is poorly understood, levels of sustainable harvest are unknown, and livelihoods of the yak herders who gather the crop are uncertain. The *Going for Gold* project is based in Bhutan. It has carried out research into the fungus and its ghost moth hosts, established a long-term programme to monitor population levels, improved the regulatory system for harvest and sale, and promoted community-based natural resource management.

2 Project support to the Convention on Biological Diversity (CBD)

The project directly supports Bhutan's commitment to the CBD. Its primary focus is sustainable harvest of a valuable native species that occurs in fragile montane ecosystems, and protecting the livelihoods of the indigenous populations. In addition to the sustainable use component (Article 10) of the CBD, the project has contributed to Bhutan's constructive response to many of the other Articles, especially:

Article 6: developing national strategies [through development of the regulatory system]

Article 7: identification and monitoring [by study of the fungus and its host moths and establishing population monitoring schemes]

Article 8: in-situ conservation [through protection of habitats via regulation of collection, protection of traditional lifestyles via support for indigenous yak-herders' livelihoods]

Article 12: research and training [through education at various levels in mycology and entomology, survey and monitoring, sustainability etc.]

Article 13: public education and awareness [through publicity of the importance of sustainable harvest, best-practice for harvesters etc.]

Capacity building occurred primarily through training of staff (scientists, foresters, National Parks staff etc.) in a range of disciplines including fungal and insect biology, identification, laboratory methods (including DNA analysis), survey methods, and socioeconomic issues. The nature of the problem addressed by the project does not require substantial investment in capital equipment etc.

The CBD focal point in Bhutan resides within the National Environment Commission, which is focused primarily on macroeconomic issues including environmental sustainability and pollution control. The implementing agency for the CBD is the Ministry of Agriculture, primarily via the Nature Conservation Division, the Forestry Department and CoRRB. CoRRB is of course one of the primary project partners. We worked closely at various levels with all of the other relevant agencies, on a strategic level via regular stakeholder workshops and on a practical level through day-to-day contact with National Parks staff etc. There are regular high-level meetings between staff of the NEC and the Ministry of Agriculture that ensure appropriate implementation of the CBD.

The project was not designed to provide explicit support to other biodiversity conventions, although its outputs are relevant in part to CITES as *Ophiocordyceps sinensis* was listed by the CITES Management Authority of China as an endangered species for protection. Its harvest is regulated by other Himalayan nations including India, Nepal and of course Bhutan.

3 Project Partnerships

Demand for the project was formalized in Bhutan's Biodiversity Action Plan, and developed from consultancies carried out in-country by Dr Hywel-Jones (BIOTEC). Prior to initial development of the project, the primary partners had no contact, demand for the project being expressed via BIOTEC. There were a few glitches in the early days as the primary partners got to know each other, but all have approached the project in a constructive and business-like manner. CABI is now recognized as a valued project partner at very senior levels of the Royal Government of Bhutan (RGoB) with interest expressed in Bhutan becoming a member country, and further collaborations (especially focused on invasive species) are being developed.

Project planning and decision-making was a collaborative process throughout the project, with formal annual project meetings and activities for the coming months mapped out together during project visits to Bhutan. Several activities in support of the project were initiated and implemented almost entirely by the Bhutanese partner.

An MoU between CABI and CoRRB was formulated and signed within two months of the project inception.

From CABI's perspective, project implementation has in general been good. The most challenging aspect of the partnership has been restricted manpower in CoRRB which caused frustrations, especially early in the project. Bhutan is a small nation (only around 600000 people) with a small Civil Service, and sometimes there were too few staff available to carry out tasks in the most effective manner. These difficulties were exacerbated by somewhat inflexible Government policies (e.g. not allowing temporary staff to replace those abroad for long-term training), and CoRRB experienced cash-flow problems on occasions through delays in processing project payments by the Finance Ministry.

The project has also suffered to some extent from an inflexible approach by the relevant authority to authorising temporary export of biological material for study by the project partners. The issue is that legal mechanisms are in place to regulate such exports, but they require agreement by an expert committee that has not yet been formulated. We managed to circumvent the problem to some degree by exporting material under personal and direct control of CoRRB staff, but several activities were delayed substantially and work on fungal population genetics and insect systematics is not yet complete.

4 Project Achievements

4.1 Impact: achievement of positive impact on biodiversity, sustainable use or equitable sharing of biodiversity benefits

The RGoB has sustainable use high on its agenda, so our task at the political level was largely to reinforce the message rather than establish its legitimacy in the first place. The most difficult challenge is of course to translate political will to sustainability on the ground: in common with natural resource harvest in many other countries, those directly benefiting are tempted to maximise short-term income rather than focus on the long-term.

The project was primarily designed to lay the foundations for sustainable harvest of *Ophiocordyceps* rather than directly achieving this goal, so the final impact overlaps with the outcomes described below. The future impact of sustainability will be preservation of the species-rich high-montane ecosystems of Bhutan, while maintaining and improving traditional livelihoods of their human inhabitants. Bhutan has a large proportion of the remaining pristine habitats of these ecosystems, so their preservation is of particular significance.

It is too soon to be able to measure the social impact of the project on communities. Local incomes have improved over the life of the project, but the market value of the harvest is strongly affected by external factors so it is not possible to link the financial outcomes directly to project activities. Early indications are that the harvest is not having a seriously deleterious effect on natural populations, and that the regulatory system in place at the end of the project is fit for purpose. The long-term monitoring activities initiated during the project should ensure that the harvest is secured.

Interviews with harvesters make it clear that sale of *Ophiocordyceps* represents a major and often overwhelming proportion of their annual income, and that without it many would consider giving up their traditional livelihoods. The increasing income from *Ophiocordyceps* harvest has had some unpredictable impacts: for example harvest of medicinal plants has declined as more money can be made from *Ophiocordyceps*. The supply of horses for trekking expeditions has also reduced during the *Ophiocordyceps* harvest and auction season, and those that are available are significantly more expensive to hire. There have been claims that Tibetan *Ophiocordyceps* harvesters are spending their money on snow leopard pelts, but our Bhutanese partners consider that these stories are likely to be apocryphal.

4.2 Outcomes: achievement of the project purpose and outcomes

Broadly speaking, the Going for Gold project has achieved its purpose. It has provided a scientific framework within which the RGoB can make informed decisions on *Ophiocordyceps* harvest which will preserve and enhance local livelihoods in the long term. Its inputs led directly to changes in the regulatory system which should benefit harvesters while preserving the resource, and placed the need for sustainability firmly on the public agenda. The project has however been battling against the economic tensions caused by increasing prices, and consolidation activity will be needed to ensure that the message is maintained. The RGoB is committed to this and will also build on the project outputs by continuing the survey and monitoring activities established during the project.

4.3 Outputs (and activities)

Almost all of the outputs were achieved as specified in the logical framework, and two additional outputs occurred. Outputs with satisfactory outcomes included survey, monitoring and seasonality studies of *Ophiocordyceps*; biology of the host moth; yak grazing impacts; monitoring of auctions; liaison with collectors; takeup of recommended changes to the regulatory system; public outreach; training in fungal and insect biology; surveys for other entomogenous fungi; plant survey work.

Initially, there was an overall under-estimate of the time needed for, and physical hardships involved in, the field survey work. The main research area (chosen primarily because it was known to be a rich *Cordyceps* site from previous years) is about 4900m altitude, three days walk from the road over two separate 5000m passes. Other sites visited were even more remote, taking up to seven days to reach from our main base. It has to be admitted here that the overall level of fitness of the UK/Thai researchers did not quite match that of their Bhutanese counterparts... The seasonality studies involved continuous monitoring over 3-month periods, so the field surveyors spent long periods camping in harsh conditions. The extra time needed for travelling resulted in the UK/Thai scientists spending significantly greater time in-country than was originally anticipated.

We also found that research on the moth biology was more intractable than anticipated, partly because we expected that flight times would be broadly similar to those reported from Nepal, the only source of specimens with collection dates that we found early on in the project. Flight times in Bhutan turned out to be rather later in the year, one of the main reasons why the entomological component of the project fell behind schedule. This had a knock-on effect on the potential for developing pilot-scale farming. In hindsight this was an over-ambitious component of the project and with support from the project reviewer, work on this was curtailed. Much of the work on fungus and insect biology would inform further developments in this area. We were able to carry out surveys for other insect fungi in Bhutan that were not part of the original project plan, and we also have large numbers of plant images that will provide support for further biodiversity studies in Bhutan.

4.4 Project standard measures and publications

See responses in Annexes 4 and 5.

4.5 Technical and Scientific achievements and co-operation

Here we provide a short summary of the technical and scientific achievements of the Going for Gold project. These are supplemented by several supporting documents which provide some more detail and place the achievements in perspective. In the text below, they are referred to within square brackets.

1. Knowledge of the fungus *Ophiocordyceps sinensis*

- a. Surveys of incidence and seasonality in six localities throughout northern Bhutan, with the establishment of one long-term monitoring site and the groundwork for two satellite sites, and correlation of phenology with environmental factors [A3].
- b. Morphological and molecular analysis of populations (the latter continues) to analyse possible geographical variants, potentially with differing properties and phenologies. A

distinct ecotype of *O. sinensis* found in forest margins, that may represent a different species, and a further “giant” type identified from samples presented at auction [A3, A9].

c. Studies of the timing of and environmental factors relating to spore release, of potential value in future farming activities [A3].

d. Establishing the likely infection process and dormant period for the fungus within its host [A3].

e. Study of the impact of grazing by yaks (partially funded through matching sources) [A6]

2. Knowledge of the host moth *Thitarodes* sp.

a. Study of the hepialid caterpillar populations at the main study site, including analysis of size classes and observations of pupae [A3, A4]

b. Studies of feeding preferences using in-situ pot-based methods [A5]

c. Establishing phenology of adult moths using light-trapping, taxonomic studies leading to recognition and description of one new species with a further one being analyzed [A3, A4].

d. Observation of egg-laying by adult females, of potential value in future farming activities [A3, A4].

e. Analysis of existing literature-based information on *Thitarodes* species of the Himalayan plateau by translation of Chinese sources, and study of specimens in European collections [A12]

3. Socioeconomic impacts

a. Indirect surveys of population size and year-on-year variation via analysis of *Ophiocordyceps* presented at 13 auction sites within Bhutan [A3].

b. Analysis of socioeconomic impact of income from *Ophiocordyceps* and threats to sustainability, through questionnaires and interviews with harvesters [A3]

c. Pilot project on establishment of community-based natural resource management for *Ophiocordyceps* (to be continued with matching funding) [A7]

4. Public awareness

a. Colour leaflet widely circulated on best practice for *Ophiocordyceps* harvest and the need for sustainability, backed up by discussions with village leaders etc. [A2]

b. Stakeholder workshops held to promote sustainability and consult on regulation, focused on village leaders, businesses, Government staff and politicians.

c. Project activities and aims promulgated through television broadcasts in Bhutan, news articles in Bhutan (Kuensel) and the UK (*Observer*, *New Scientist*), scientific meetings (e.g. Mycological Society of America, 2008) and information placed on websites [e.g. A11]

5. Training and capacity building

a. Two workshops held for Government staff on fungus and insect biology, with special reference to *Ophiocordyceps* and its host moths; matching funding achieved [A7].

b. Study visits for project staff to Thailand and Hong Kong to analyze end-user markets

c. Workshop and training programme for project staff in Thailand on insect fungi and molecular methods

d. Project management meetings in Thailand and the UK, including liaison with other scientists at CABI, RBG Kew and RBG Edinburgh.

6. Regulatory and political issues

a. Following recommendations from the project, legal collection period moved initially to mid May – mid June, and establishing a cut-off date of mid June (but no start date) after further liaison with stakeholders [A1, A3]

b. Strong support at senior Government levels to maintain sustainable harvest policies, and to regionalize the project through workshops with other nations that harvest *Ophiocordyceps* [A1].

7. Surveys for other species of insect fungi

a. Four surveys (partially funded through matching sources) for entomogenous fungi; one new species of *Ophiocordyceps* definitely identified and several other species likely to be undescribed [A9]

8. Image library of plant species

a. A large collection of plant images (of potential host plants and others inhabiting montane grasslands, upper forest levels etc., potentially to be used as the basis for a field guide [A10].

Supporting documents include:

A1. Paper detailing final recommendations of the project partners to RGoB, largely endorsed already by senior members of the Government.

A2. Leaflet documenting best practice and sustainability

A3. Paper submitted to *Biodiversity and Conservation* providing background to *Ophiocordyceps* harvest in the Himalayas and describing project activities

A4. Draft paper (soon to be submitted) describing the new species of *Thitarodes*

A5. Document summarizing results of caterpillar feeding preference trials

A6. Report on grazing studies (as submitted to the Stapledon Memorial Trust)

A7. Presentations for workshops on fungus and insect biology

A8. Photo album of project activities

A9. Summary of surveys for other species of insect fungi

A10. Sample images from plant image library

A11. Poster presented at Darwin workshop, February 2006

A12. Chinese literature survey for information on *Thitarodes* spp. (hosts of *Ophiocordyceps*)

4.6 Capacity building

CoRRB had generally good capacity for project implementation and management at the project initiation, although small and fluctuating staff numbers led to some continuity difficulties.

The high priority for CoRRB was capacity building in specialist areas, where little or no expertise existed in-country. Capacity has improved in a number of ways for the host country partner, from basic knowledge, identification, collection and curation to survey methods for fungi and insects. Several staff have gained experience in lab-based activities such as DNA extraction and analysis. The project has also led to further collaboration between CoRRB and other Bhutanese institutions, and the final project workshop provided a potent example of the benefits of liaison with the newly established political system.

4.7 Sustainability and Legacy

Sustainable harvest of *Ophiocordyceps* will remain high on the RGoB's agenda for the foreseeable future, due to the extraordinary economic impact of the crop on montane communities. The most valuable contribution of the Going for Gold project has been to cement the concept of sustainability into policy and regulatory systems. The RGoB has also been adamant that decision-making will be based to the maximum degree possible on scientific principles. We are therefore confident that the long-term survey and monitoring programme initiated by the project will continue, with the results continuing to feed into reviews of the regulatory system. Bhutan-based project staff are all permanent Government employees so it can be expected that the knowledge gained will continue to be used for the benefit of society.

The RGoB has agreed to continue the long-term *Ophiocordyceps* survey subject to adequate funds, and will continue to monitor the auction process. We are also aware of the likely establishment of a private charitable foundation in Bhutan that will have a remit to support environmental sustainability through scientific research, and it is probable that *Ophiocordyceps* will be part of its initial work programme.

CABI and the Bhutanese Ministry of Agriculture (of which CoRRB is an agency) are likely to continue their partnership into the future; there have already been positive discussions on invasive species management. The RGoB strongly supports an application (to be made imminently) for a post-project grant to be funded by the Darwin Initiative, and has expressed interest in Bhutan becoming CABI's 46th member country.

5 Lessons learned, dissemination and communication

Perhaps better described as a lesson reinforced rather than a lesson learned, the key message from the Going for Gold project is the importance of basing sustainability policy on objective scientific principles. Prices for *Ophiocordyceps* started going through the roof around the time of project inception, providing much increased public pressure to abandon the precautionary principle and completely deregulate collecting. The RGoB was therefore able to use the project as evidence that it was taking action to build the scientific basis to sustainable harvest. The impact of this cannot be easily measured, but without the project it would have been substantially more difficult to maintain a cautious approach to regulation of collecting.

Review of the project by the partners and also by high-level Bhutanese stakeholders has identified a number of areas where further investment would have been beneficial. The most important of these is to extend the project to encompass a regional approach, with opportunities to share best practice and coordinate regulation of *Ophiocordyceps* harvest across the Himalayan plateau. This and several other additional activities will be the subject of a post-project grant application.

Dissemination has been an important component of the project, via a number of different popular and specialist media. Press releases at project inception led to articles in the UK press (*Observer* and *New Scientist*). We also had interest in the project from at least three separate television/film companies, though practical considerations relating to filming in the field meant that none led to broadcast products (filming the *Ophiocordyceps* harvest in Tibet is easier logistically). Project activities (especially stakeholder workshops) led to dissemination of results in various arenas, including seminars for civil service staff, informal events for harvesters and buyers at *Ophiocordyceps* auctions, community-based management and agricultural development shows. There have been regular newspaper articles on *Ophiocordyceps* in the Bhutanese newspapers, and television interviews with project staff have been broadcast.

Perhaps the most important dissemination event was the final project workshop, which was chaired by the Minister for Agriculture and attended by the Minister for Foreign Affairs and seven other MPs representing constituencies where *Ophiocordyceps* is harvested. A number of other senior Government staff also participated, including the Secretary for Agriculture [most senior civil servant], the Directors of Agriculture, Forestry [within which the Nature Conservation Division resides], and of the Bhutan Agriculture and Food Regulatory Authority. There was good consensus and strong support for the project outcomes, and active encouragement for a new phase of the *Ophiocordyceps* programme.

Dissemination will continue after project completion by all partners, with further publications planned and use of project findings in continuing policy development within Bhutan. The project will be showcased to CABI's Governing Board in December, which is comprised of representatives of member countries including China and India, the other major *Ophiocordyceps* producers.

5.1 Darwin identity

Funding from the Darwin Initiative has been indicated in all press releases etc., though despite specific requests it has not been easy to persuade the media to include this information in their articles. It is also clearly acknowledged in the submitted academic paper and will be when others are completed.

Within Bhutan, the Darwin logo featured on a leaflet that was widely promulgated as well as on conference banners, handouts etc. The logo was included in numerous Powerpoint presentation for workshops etc.

The Going for Gold project operated alongside other programmes within Bhutan, although it had a distinct identity and was always recognized as a separate, Darwin-funded entity.

Complementary activities included a large-scale project on medicinal plant production funded by the EU and a development programme on community-based management funded by IDRC.

The Darwin Initiative is widely recognized within the relevant communities in Bhutan as providing valuable support to conservation initiatives, including at Ministerial level. The DI is also valued as one of the few global organizations to provide support to wider biodiversity initiatives, which undoubtedly contribute towards conservation in the long term but do not necessarily have outputs that lead immediately to enhanced environmental protection.

6 Monitoring and evaluation

One substantial change to the logframe was made with the agreement of the project reviewer, to abandon work on a pilot project to farm *Ophiocordyceps* due to the difficulties encountered during the first part of the project in studying the insect hosts. An alternative, additional objective was agreed following a proposal by the project partners.

The logframe approach does have some benefits for project evaluation, but for relatively small-scale tightly focused projects such as Going for Gold, the hierarchy of objectives is unnecessarily complex. Activities frequently have outcomes which are relevant to more than one output, leading either to duplication of information or to arbitrary placement of results.

The external monitoring and evaluation is a valuable service provided by the DI, although we felt that the first-year reviewer did not have sufficient background understanding and some of that person's comments seemed irrelevant. For the following years the reviews were helpful and we were either already implementing their suggestions independently by the time the reviews arrived, or we were happy to take them on board.

There is one area where we feel there could be improvements in the monitoring and evaluation system. While financial matters are dealt with within the DI, it was not clear to us who has the final say on changes to science/ development objectives, and the extent to which such changes are partnerships rather than directives. Perhaps the external reviewers might act more actively as project mentors, making review a more two-way process through discussion/email exchange? We are aware that some projects are subject to more in-depth review.

6.1 Actions taken in response to annual report reviews

The reviews were discussed with all project partners during our internal review meetings, and work plans for the following period were modified accordingly. We do not believe that there are any substantive outstanding issues.

7 Finance and administration

7.1 Project expenditure

	2005/6	2006/7	2007/8	2008/9	Total
Staff					
Rent, rates etc.					
Postage, telephone etc.					
Travel and subsistence					
Printing					
Conferences, seminars etc.					
Capital items					
Others					
Total					

7.2 Additional funds or in-kind contributions secured

Matching funding has been secured from a number of sources over the lifetime of the project:

Source	Description	Estimated value (£)
EU (via MAP II project)	Support for regulatory/marketing activities	12000
	Air travel Bangkok – Paro	400
IDRC	Support for CBNRM study	2000
BIOTEC (Thailand)	Banner and bags etc. for workshops	800
Stapledon Memorial Trust	Travel fund for yak grazing study	2600
CABI	Extra salary and O/H costs	2674
Total		20474

7.3 Value of DI funding

CABI is an intergovernmental not-for-profit organization with only 3% of its budget given as core funding, so internal funds for research and development are very limited. Given that CoRRB's budget is heavily reliant on external funding, we can unequivocally say that the project would not have taken place. The outcome of this scenario would likely have been relaxation of the regulatory system for *Ophiocordyceps* harvest in the face of public pressure from the collectors, with uncertain prospects for long-term sustainability.

Annex 1. Report of progress and achievements against final project logframe for the life of the project

Project summary	Measurable Indicators	Progress and Achievements April 2005 – September 2008	Actions required/planned for next period
<p>Goal: <i>To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but constrained in resources to achieve</i></p> <p><i>The conservation of biological diversity,</i></p> <p><i>The sustainable use of its components, and</i></p> <p><i>The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources</i></p>			
<p>Purpose <i>Cordyceps sinensis</i> harvest in Bhutan protected and montane grasslands conserved through research and capacity building to achieve sustainable production</p>	<ol style="list-style-type: none"> 1. New knowledge on population and harvest levels, host/parasite relations and host requirements 2. Monitoring/impact scheme in place 3. Local stakeholders in support of conservation 4. Feasibility study and pilot programme for <i>Cordyceps</i> farming 5. Regulatory system in place/modified appropriately, leading to reduction in illegal harvest 	<p>Good outcomes have been achieved for all components of the project, apart from the pilot farming programme. There has been widespread support for the project at various levels of Bhutanese society, reflecting the importance of <i>Ophiocordyceps</i> to the local economy. The RGoB has committed to an active programme to continue monitoring and other aspects of the project, and is very supportive of policies to achieve long-term sustainability of this valuable natural resource</p>	
<p>Output 1 Knowledge of <i>Cordyceps</i> incidence and harvest, host/parasite relations and host biology</p>	<p>Reports published and circulated to Government and other stakeholders</p>	<p>Good progress on most aspects, with a long-term monitoring programme in place. Host biology research has continued to prove challenging but good outputs were achieved in 2008.</p>	
<p>Activity 1.1 Surveys for incidence and seasonality of <i>Cordyceps</i></p>		<p>Permanent transect-based survey plot set up at Namna, NW Bhutan with monitoring between early April – end July and data now available for 3 field seasons. Overall population density found to be broadly similar to surveys elsewhere in the Himalayas, but varies substantially between</p>	

		transects and between years – due to extreme patchiness of distribution. Long-term monitoring required to establish population trends. Two other snapshot-based surveys established, at Bumdeling in E Bhutan and Bumthang in NC Bhutan, with local staff trained in survey techniques. Seasonality studied in detail as important for establishing dates for legal collection. Dataloggers installed at Namna and Bumdeling, <i>Ophiocordyceps</i> appears roughly when shade temperature rises above 0°C, in early to mid May. Considerable variation in times of appearance, some stromata not emerging until early July. A forest ecotype discovered in 2008, its identity is still obscure. Molecular studies in progress to establish extent of genetic homogeneity of populations in different parts of Bhutan.
Activity 1.2 Studies of hepialid moths and their feeding habits		Capture of adult moths difficult due to short lifespan and lack of data on seasonality, but ~50 specimens caught at Namna 2006-8 using light traps. Almost certainly 2 species, one at least is new and is being published. Egg laying observed but infection process still uncertain. Caterpillars and pupae surveyed by digging them from the ground, size classes studied, take several years to grow to maturity. Food plant studies demonstrate lack of specificity, indicating probable high resilience levels of the fungus/host system.
Activity 1.3 Investigation of yak grazing patterns		Achieved with external financial support, grazing does change vegetation composition – in particular a suppression of grasses and sedges and enhancement of moss coverage - but may not affect <i>Ophiocordyceps</i> production. Harvest leads to both increase and decrease of yak populations as herders respond differently to increased wealth.
Output 2 Monitoring/impact scheme designed and implemented in consultation with local stakeholders	National Park and NCD/CORRB staff trained, harvesters/ traders mobilized, monitoring in place	Auction data analysed over several years, trends in harvest difficult to assess as some collections probably traded outside of the system. Interviews with collectors demonstrate economic impact on local livelihoods. Community-based natural resource management trialled, challenging due to poor protection from poaching. Being taken up by a separately funded project.
Output 3 Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc	Leaflets and policy documents produced, stakeholder meetings taken place	Various changes to the regulatory system have occurred in response to project outputs and the changing economic climate. There has been interest in the project from a wide spectrum of society, and public support for its activities. Quality of <i>Ophiocordyceps</i> presented at auction has improved, with few fully mature stromata on sale and fewer mouldy specimens.
Activity 3.1 Leaflets promulgated with messages on sustainability, best practice and quality control		Leaflet produced and widely circulated. Messages also transmitted verbally via gups (village leaders) etc. Local newspaper articles and

		television interviews also used to emphasize sustainability message.
Activity 3.2 Stakeholder meetings		Three main stakeholder meetings held, focusing successively on Government staff/local business, village leaders and politicians. Participants directly involved in decision-making. Strong support for the project from all sections of society, including Ministerial level.
Output 4 Pilot project for low-tech <i>Cordyceps</i> farming in place [abandoned in 2007]	Experimental farm set up, caterpillars raised successfully, inoculation with fungus achieved	Formal progress abandoned in 2007 with agreement from project reviewer, though much of the information gathered on biology etc. will feed into this process in future. Main difficulties relate to difficulties in acquiring sufficient insects to make experiments viable.
Output 5 Training and capacity building (fungal and insect biology, techniques)	Number of National Park, NCD/CORRB staff participating	Two two-day workshops in November 2007 for a total of nearly 80 staff – primarily foresters and nature conservation staff but including a wide section of society e.g. army staff involved in border security. Around 12 CoRRB/NCD staff trained/mentored in fungal/insect collection and monitoring, stakeholder survey etc.
Output 6 Surveys of <i>Cordyceps</i> in lowland forests [added in 2007]	Survey results available to Royal Government and other stakeholders	Four surveys in E and SW Bhutan, partially achieved with matching funding. Almost all species newly found in Bhutan, several new taxa discovered. Collection conditions not ideal in some surveys.
Output 7 Plant surveys in montane Bhutan		Not part of the formal project, but images of ~600 plant species have been generated and will be made available to National Biodiversity Centre etc.

Annex 2. Project's full current logframe

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p>Goal:</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"> the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilisation of genetic resources 			
Purpose			
<p><i>Cordyceps sinensis</i> harvest in Bhutan protected and montane grasslands conserved through research and capacity building to achieve sustainable production</p>	<ol style="list-style-type: none"> 1. New knowledge on population and harvest levels, host/parasite relations and host requirements 2. Monitoring/impact scheme in place 3. Local stakeholders in support of conservation 4. Feasibility study and pilot programme for <i>Cordyceps</i> farming 5. Regulatory system in place/modified appropriately, leading to reduction in illegal harvest 	<ol style="list-style-type: none"> 1. Reports by National Park, NCD/CORRB and project partners, scientific papers 2. Protocols & survey reports 3. Participation by local population 4. Reports by project partners 5. Regulatory system publicised via meetings, leaflets, liaison with traders etc.; reports from regulatory authorities 	<ol style="list-style-type: none"> 1. Government continues to give high priority to <i>Cordyceps</i> sustainability 2. Local people support sustainability programme 3. Illegal poaching controlled 4. National agencies liaise effectively
Outputs			
<ol style="list-style-type: none"> 1. Knowledge of <i>Cordyceps</i> incidence and harvest, host/parasite relations and host biology 	<p>Reports published and circulated to Government and other stakeholders</p>	<p>Reports sent to Darwin Initiative, scientific papers, habitat management plan</p>	<p>Sufficient information acquired, seasonality issues successfully addressed</p>
<ol style="list-style-type: none"> 2. Monitoring/impact scheme designed and implemented in consultation with local stakeholders 	<p>National Park and NCD/CORRB staff trained, harvesters/ traders mobilized, monitoring in place</p>	<p>Reports and feedback from trainees and institutions, monitoring results collated /sent to Darwin Initiative</p>	<p>Local stakeholders agree to programme, good liaison with National Park and NCD/CORRB</p>

3. Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc	Leaflets and policy documents produced, stakeholder meetings taken place	Records of meeting attendance, documents sent to Darwin Initiative	Appropriate authorities liaise to modify regulation, stakeholders on board, effective enforcement of regulation occurs
4. Pilot project for low-tech <i>Cordyceps</i> farming in place abandoned as a separate task with agreement from project reviewer	Experimental farm set up, caterpillars raised successfully, inoculation with fungus achieved	Reports of progress, farmed <i>Cordyceps</i> available	Information on food plants available, food plant cultivation achieved, caterpillars successfully transferred to farm, inoculation with <i>Cordyceps</i> successful
5. Training and capacity building (fungal and insect biology, techniques)	Number of National Park, NCD/CORRB staff participating	Training materials available, student and manager feedback forms	Suitable staff released for training, staff able to put training into practice
6. Surveys of <i>Cordyceps</i> in low-altitude forests	Survey reports, publication	Reports made available to Royal Government and other stakeholders	Monsoon conditions allow good collecting
Activities			
Design and implement surveys to quantify <i>Cordyceps</i> habitat, distribution and patterns of exploitation. Investigate yak grazing patterns. Develop methods to locate and survey Lepidoptera host. Develop methods to collect and breed / rear Lepidoptera host (from adult, egg or larval stage). Conduct direct observations of Lepidoptera feeding behaviour and life-cycle and study caterpillar / fungus interactions under field / experimental conditions.		Design surveys and evaluate techniques, year 1. Habitat and exploitation survey years 1-4. Collect host adults (for eggs) and caterpillars from year 1 and continue annually through project. Conduct feeding & life-cycle observations years 1-4. Caterpillar / fungus interaction studies years 2-3.	

<p>Plan and implement policies to maximise participation of local stakeholders. Publicise concept of sustainability. Set up monitoring team and train field surveyors in stakeholder interview, habitat assessment and Lepidoptera survey techniques.</p>	<p>Participatory programme planned year 1. Project introduction meeting to engage local stakeholders by promoting concept of sustainability and inviting stakeholder discussion of community problems and solutions, year 1. Monitoring team established and trained year 1. Implementation of monitoring, years 1-4</p>
<p>Produce training materials; design and run training days on fungi and insects for stakeholders. Elicit trainee feedback.</p>	<p>Training days on fungi and insects, years 2-3.</p>
<p>Review current regulatory system and modify in the light of research findings, in collaboration with stakeholders at key stages. Develop a strategy to enforce the modified regulatory system.</p>	<p>Current regulatory system reviewed and modifications drafted as agreed/appropriate, year 3. Development of enforcement strategy, years 3-4.</p>

Annex 3. Project contribution to Articles under the CBD

Project Contribution to Articles under the Convention on Biological Diversity

Article No./Title	Project %	Article Description
6. General Measures for Conservation & Sustainable Use		Develop national strategies that integrate conservation and sustainable use.
7. Identification and Monitoring	10	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	10	Establish systems of protected areas with guidelines for selection and management; regulate biological resources, promote protection of habitats; manage areas adjacent to protected areas; restore degraded ecosystems and recovery of threatened species; control risks associated with organisms modified by biotechnology; control spread of alien species; ensure compatibility between sustainable use of resources and their conservation; protect traditional lifestyles and knowledge on biological resources.
9. Ex-situ Conservation		Adopt ex-situ measures to conserve and research components of biological diversity, preferably in country of origin; facilitate recovery of threatened species; regulate and manage collection of biological resources.
10. Sustainable Use of Components of Biological Diversity	75	Integrate conservation and sustainable use in national decisions; protect sustainable customary uses; support local populations to implement remedial actions; encourage co-operation between governments and the private sector.
11. Incentive Measures		Establish economically and socially sound incentives to conserve and promote sustainable use of biological diversity.
12. Research and Training		Establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components; promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries (in accordance with SBSTTA recommendations).
13. Public Education and Awareness		Promote understanding of the importance of measures to conserve biological diversity and propagate these measures through the media; cooperate with other states and organisations in developing awareness programmes.
14. Impact Assessment and Minimizing Adverse Impacts		Introduce EIAs of appropriate projects and allow public participation; take into account environmental consequences of policies; exchange information on impacts beyond State boundaries and work to reduce hazards; promote emergency responses to hazards; examine mechanisms for re-dress of international damage.
15. Access to Genetic Resources		Whilst governments control access to their genetic resources they should also facilitate access of environmentally sound uses on mutually agreed terms; scientific research based on a country's genetic resources should ensure sharing in a fair and equitable way of results and benefits.

Article No./Title	Project %	Article Description
16. Access to and Transfer of Technology		Countries shall ensure access to technologies relevant to conservation and sustainable use of biodiversity under fair and most favourable terms to the source countries (subject to patents and intellectual property rights) and ensure the private sector facilitates such assess and joint development of technologies.
17. Exchange of Information		Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge
19. Bio-safety Protocol		Countries shall take legislative, administrative or policy measures to provide for the effective participation in biotechnological research activities and to ensure all practicable measures to promote and advance priority access on a fair and equitable basis, especially where they provide the genetic resources for such research.
Other Contribution	5	Smaller contributions (eg of 5%) or less should be summed and included here.
Total %	100%	Check % = total 100

Annex 4. Standard Measures

Code	Description	Totals (plus additional detail as required)	
Training Measures			
6b	Number of training weeks not leading to formal qualification	37	Course on insect fungi 2006, 2 workshops on fungus and insect biology, molecular methods training
7	Number of types of training materials produced for use by host country(s)	4	Education leaflet, posters, website, CD for training course
Research Measures			
8	Number of weeks spent by UK project staff on project work in host country(s)	66	
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (s)	1	
10	Number of formal documents produced to assist work related to species identification, classification and recording.	2	Images of insect fungi and plants
11a	Number of papers published or accepted for publication in peer reviewed journals		1 submitted, 2 more in preparation
13a	Number of species reference collections established and handed over to host country(s)	2	Small collections of entomogenous fungi and <i>Ophiocordyceps</i> insect hosts
Dissemination Measures			
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	6	Stakeholder workshops for different client groups, 2 training workshops for foresters etc.
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.	3	Conservation conference, Cambridge 2006, Darwin workshop 2006, Mycological Society of America conference 2008
15a	Number of national press releases or publicity articles in host country(s)	4	
15c	Number of national press releases or publicity articles in UK	2	
18a	Number of national TV programmes/features in host country(s)	2	News features on stakeholder workshops
Physical Measures			
20	Estimated value (£s) of physical assets handed over to host country(s)	2000	
22	Number of permanent field plots established	1	
23	Value of additional resources raised for project		

Annex 5. Publications

Type * (eg journals, manual, CDs)	Detail (title, author, year)	Publishers (name, city)	Available from (eg contact address, website)	Cost £
Leaflet	Yartsa Guenbub: guidelines for collectors	CoRRB, Thimphu	Dr Lungten Norbu, RNRRC Yusipang, Post box 212, Thimphu, Bhutan	-
CD	Presentations from workshops, Nov 2007	CABI	Dr Paul Cannon, CABI Europe UK, Bakeham Lane, Egham, Surrey TW20 9TY, UK	-

Annex 6 Darwin Contacts

Ref No	14-030
Project Title	Going for Gold – Cordyceps Conservation in Bhutan
UK Leader Details	
Name	Dr Paul Cannon
Role within Darwin Project	Mycologist, project leader
Address	CABI Europe UK Centre, Bakeham Lane, Egham, Surrey TW20 9TY, UK
Phone	
Fax	
Email	
Other UK Contact (if relevant)	
Name	
Role within Darwin Project	
Address	
Phone	
Fax	
Email	
Partner 1	
Name	Dr Lungten Norbu
Organisation	CoRRB
Role within Darwin Project	Project leader, Bhutan
Address	RnRRC Yusipang, P.O. Box 212, Thimphu, Bhutan
Fax	
Email	
Partner 2 (if relevant)	
Name	Dr Nigel Hywel-Jones
Organisation	National Center for Genetic Engineering & Biotechnology (BIOTEC)
Role within Darwin Project	Cordyceps specialist
Address	Mycology Laboratory, BIOTEC Central Research Unit, 113 Paholyothin Road, Khlong 1, Khlong Luang, Pathum Thani 12120, Thailand
Fax	
Email	