

Darwin Initiative Annual Report

Important note:

To be completed with reference to the Reporting Guidance Notes for Project Leaders – it is expected that this report will be about 10 pages in length – Submission deadline 30 April 2007

Darwin Project Information

Project Ref Number	14-030
Project Title	Going for Gold – Cordyceps Conservation in Bhutan
Country(ies)	Bhutan
UK Contract Holder Institution	CAB International (CABI Bioscience)
UK Partner Institution(s)	
Host country Partner Institution(s)	Council for Renewable Natural Resources of Bhutan (CORRB), Ministry of Agriculture, Bhutan
Darwin Grant Value	£204 936
Start/End dates of Project	April 2005 – September 2008
Reporting period (1 Apr 200x to 31 Mar 200y) and annual report number (1,2,3..)	1 April 2006 – 31 March 2007; Annual Report no. 2
Project Leader Name	Paul Cannon
Project website	http://194.203.77.76/Cordyceps/
Author(s), date	Paul Cannon, May 2007

1. Project Background

Cordyceps sinensis is a fungus parasitic on Ghost moth (*Thitarodes*) caterpillars, widely distributed across the Tibetan plateau and adjoining areas of the eastern Himalayas. It is highly prized in Eastern traditional medicine with beneficial effects claimed to improve energy and general well-being, but it is also considered to boost the immune system, improve virility, benefit patients with heart and kidney problems, and it is used to treat hepatitis. The global market is difficult to estimate but probably runs into hundreds of millions of dollars, and it has been claimed that Bhutan supplies around 10% of the total natural market.

The Royal Government of Bhutan has put various conservation measures in place to protect the species and allow for sustainable harvest over the long term. It requested assistance from CABI to investigate the level of sustainable extraction, and other measures to protect the species and the fragile montane grasslands in which *Cordyceps sinensis* grows. The potential for farming using basic methods achievable by indigenous peoples in its natural habitat is also being addressed.

2. *Project Partnerships*

Collaboration between CABI and CORRB, the primary project partners, has continued positively. Both sides remain strongly committed to the purpose of the project, and this has been borne out by developments over the past twelve months. The project has good support from the Ministry of Agriculture (the parent Government ministry of CORRB), and we have recently discussed the potential for further project work in collaboration. There are numerous public and private sector stakeholder groups in Bhutan with interests in *Cordyceps* – as evidenced by the range of organizations represented at the April 2006 workshop described below – and in most circumstances these work together very positively.

The three-way partnership between CABI, CORRB and BIOTEC (Thailand) has operated very effectively, with the British consultant based at BIOTEC playing a full role in the project. Bhutan and Thailand have strong historic links (both countries are strongly Buddhist in religion and have strong monarchical systems), and BIOTEC has been very supportive of the programme in granting leave of absence and providing training and other support for CORRB staff. It is planned that the Scientific Director of BIOTEC will visit the project later on this year.

There have been some communication delays that have caused frustration, but which have not materially affected outcomes of the project. Much of the problem is caused by unreliable telecommunications links (affecting telephone, fax and email) between CORRB headquarters in Thimphu and their research station at Yusipang where the project is based. This is an intractable problem that the project is not in a position to fix, but we are working around it by requesting that urgent or important documents be carried by road between the two sites.

Further frustration has been caused by delays in export of experimental material for examination in the UK, especially of the *Thitarodes* specimens collected during the 2006 field season by light trapping. Following ratification of the CBD, Bhutan put strict controls in place governing the export of biological material. While there is technically a mechanism in place to allow samples to be sent out from the country for bona fide research purposes, its implementation is problematic and we are aware of other organizations that have experienced similar problems. We have been led to believe that the problem is caused by misunderstanding on a personal level rather than covert Government policy. CORRB are aware of the difficulties that this causes, and the Darwin project has circumvented the problem by samples being exported by CORRB staff and technically remaining under their direct control while they are examined. We are sympathetic to the legitimate desire of the Bhutanese to protect their own biodiversity, but it would simplify our work significantly if the permit system could be implemented fully.

Other Collaborations:

Synergies continue with the EU-funded project on medicinal plants in Bhutan (BTN/AIDCO/99/0081) referred to in last year's annual report. The CORRB Director is on the steering committee of both projects, and ensures that the objectives of both projects are met without unnecessary duplication. The Darwin project has now taken over all responsibility for the field-based research on *Cordyceps* originally intended for the EU programme, in return for

support on IP and marketing issues. This has enabled us to spend more time on the field biology and sustainability components of the project.

A new collaboration has been forged with the Royal Botanic Garden Edinburgh, giving the project access to information and images on the montane plants from the *Cordyceps* harvest areas. CORRB and CABI have agreed, subject to agreement by the Darwin Initiative, to develop a field guide to the mountain flowers of Bhutan, as an alternative objective to development of farming technology which we are now agreed is too ambitious within the project timeframe. The arguments for this change are made in the project report below.

There have been several further requests for access by film crews to *Cordyceps* harvesting, and while we are generally sympathetic to such requests assuming that project staff have extra costs reimbursed, permission has to be obtained from the Royal Government for any film projects in Bhutan and none has so far made a formal approach.

The project does not currently have formal links on a personal level with the CBD focal point in Bhutan (the National Environment Commission), but communication is maintained by the normal interdepartmental governmental processes.

3. *Project progress*

3.1 *Progress in carrying out project activities*

The project purpose is as stated in the logical framework:

“Cordyceps sinensis harvest in Bhutan protected and montane grasslands conserved through research and capacity building to achieve sustainable production.”

The main project outputs are as follows:

1. *Knowledge of Cordyceps incidence and harvest, host/parasite relations and host biology*
2. *Monitoring/impact scheme designed and implemented in consultation with local stakeholders*
3. *Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc*
4. *Pilot project for low-tech Cordyceps farming in place*
5. *Training and capacity building (fungal and insect biology, techniques)*

Most project outputs remain as originally proposed, but we have reviewed progress on output 4 (Pilot project for Low-tech *Cordyceps* farming in place). We have concluded although we will continue to gather information that will be critical to development of possible farming activities, we are unlikely to make sufficient progress during the lifetime of the project to reach a formal pilot stage. The reasons for this are discussed below. We have agreed in principle, subject to approval by the Darwin Initiative, to replace this objective by development of a field guide to mountain flowers of Bhutan. This proposed output is described below in more detail.

The project has made solid progress in most areas. Activities included:

- A successful stakeholder workshop in April 2006 leading to change in Government policy regarding *Cordyceps*, attended by two CABI/BIOTEC staff
- Establishment of permanent survey plots for *Cordyceps* incidence and seasonality, with continuous presence by project staff in the field throughout the *Cordyceps* season between mid May and early August

- Two four-week field trips by CABI/BIOTEC staff to advise on survey procedures and entomological aspects of the project
- Capture and initial identification of adult hepialid moths (on whose caterpillars which the *Cordyceps* grow), and further sampling of hepialid caterpillars
- Initial food preference/farming experiments at the CORRB Research Station at Yusipang (at a lower altitude than the study sites)
- Production and promulgation of a full-colour leaflet on *Cordyceps* conservation and harvest
- Extension and awareness campaign for sustainable harvest
- Monitoring and feedback of the 2006 auction procedures
- Study visits to Thailand and Hong Kong by CORRB staff to familiarize themselves with the end markets for *Cordyceps*

1. Knowledge of Cordyceps incidence and harvest, host/parasite relations and host biology

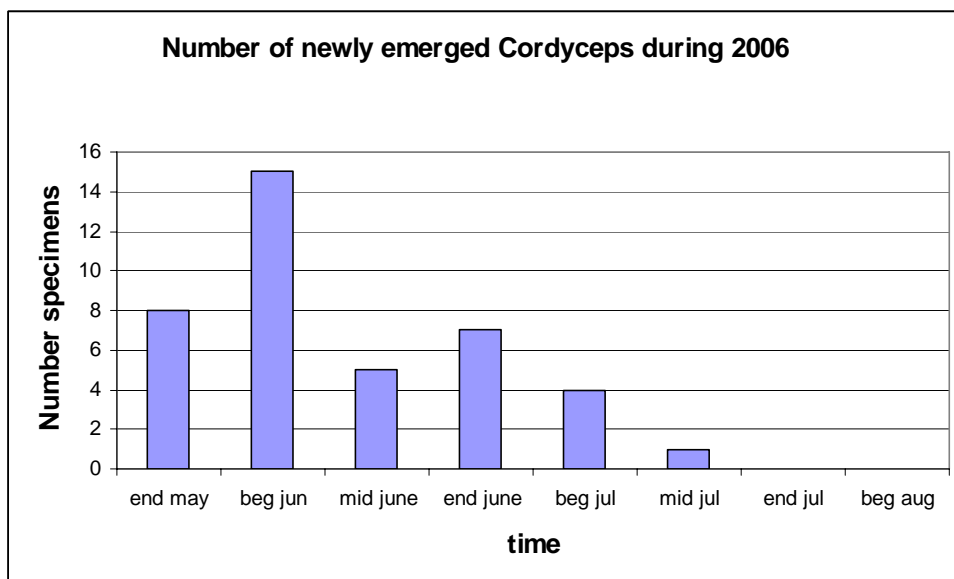
The work in support of this objective focused on design and implementation of a long-term survey programme for incidence and seasonality of *Cordyceps*, to gain knowledge of populations and likely impact of harvest at current levels. *Cordyceps* distribution is highly scattered, with little initial knowledge on a systematic basis of the extent of populations in either numerical or geographical terms. In the first year of the project, five sites in the Soe and Lingshi regions known to harbour *Cordyceps* were surveyed with a view to establishing permanent plots to monitor population levels. All are a minimum of three days' trek from the nearest road, making logistics complex and survey work time-consuming, but we are not aware of more accessible collection sites. As described in the Year 1 report, Namna was chosen as the primary study site, as it was known to be rich in *Cordyceps* and the local yak herders were particularly supportive of the sustainability research.

Detailed survey protocols were agreed during a short project visit in April 2006 (primarily to attend the stakeholder workshop described below in Section 3). Permanent transects were marked out at the beginning of the *Cordyceps* growing season in mid May, with the assistance of Dr Hywel-Jones (BIOTEC) during the first four-week project visit of 2006. At this point the survey area was still partially covered in snow. Surveys of *Cordyceps* operated on a more or less continuous basis until early August, when we concluded that no more fruit bodies would emerge, and CORRB staff were on station in teams (two weeks on, two weeks off) for the entire period. As the study site is at an altitude of nearly 4000m and nearly 2000m above the altitude of the roadhead, this represented a substantial achievement in physical energy terms.

Surveys were carried out twice each week, with individual fruit bodies mapped and measured to establish the time required for maturation. They were found to take an average of six weeks to develop from initial observation (around 10mm in height) to full size of up to 65 mm. The overall number of fruit bodies detected within the transect areas was only 49, underlining the scarcity of the resource and indirectly the time effort put into *Cordyceps* hunting by both researchers and harvesters. With the benefit of knowledge from the first field season, we are happy that the choice of collection site is a reasonable one; discussions with harvesters have indicated that this level of incidence is to be expected. Around 50% of the *Cordyceps* fruit bodies did not reach final maturity, either disappearing altogether or being top-browsed. The culprits are most likely yaks or marmots, although yaks were not seen grazing which tends to implicate the latter species. It is not practical to exclude either from the study site, and their presence reflects the situation elsewhere.

Analysis of the survey reports unexpectedly revealed a two-humped distribution with peaks at the end of May and the end of June (see graph below), possibly backing up claims by the collectors that there are multiple flushes of *Cordyceps* fruit bodies. We shall investigate this further in 2007, but it may be an artifact due to the low sample numbers, or some effect of the

changing weather patterns. The third possibility is that two genotypes (or even two cryptic species) are present. We also received reports in 2006 from the *Cordyceps* hunters in the north-east of Bhutan (Bumdeling National Park) that fruit-bodies from this area mature substantially later than in the western region – leading to requests that the regulated collection period be changed. In 2007 we will set up a new survey site in Bumdeling NP, and train the local forest officers to carry out surveys using the same protocol as at Namna.



In early May 2006 we set up two data recorders at Namna, measuring temperature and humidity throughout the year. We shall download the first year's supply of data in the next month or so, and attempt to correlate the appearance of *Cordyceps* with weather conditions. This should provide a more scientifically appropriate method for determining the legal collection period each year. The decision has to be made each year before data can be gathered on the spring warming, but we hope that a sufficiently close match can be made with data from Paro airport, at a substantially lower altitude but with data available all year. We shall also set up a data logger at Bumdeling to provide further information relevant to seasonality in that area.

Work on the insect side has continued to prove challenging, although we have made substantial progress during the 2006 field season. The work can be divided into study of the caterpillars in-situ and ex-situ, and of the adult moths.

Substantial numbers of hepialid caterpillars were gathered during the 2006 field season, extracted from the soil surrounding plant roots at Namna. We are now confident that they take several years to develop to maturity, and the lack of clear size groups corresponding to instars suggests that they do not have a tightly-defined life-cycle. The largest ones studied were around 30mm in length, corresponding to the size of the caterpillar cadavers from which *Cordyceps* fruit bodies develop.

Initial food preference studies were unsuccessful. We collected caterpillars from Namna and transported them to the CORRB research centre at Yusipang, where they were introduced into potted plants sunk into the ground containing five co-dominant species from the study site. Most of the plants grew well, but only one of the caterpillars survived longer than four months in these conditions. The research centre is at a substantially lower altitude than Namna and has significantly warmer summers which could have affected caterpillar survival. It is also possible that the soil at Yusipang, which has a somewhat higher clay content than that at Namna, could have impeded the movement of caterpillars and thus discouraged feeding. Further reasons for the failure could be delayed effects of physical damage caused by the transfer between sites, or simply to naturally high mortality levels. In 2007 we intend to modify the experiment by siting the experiment at Namna, sinking netted plant pots into the ground using soil from the study site and introducing caterpillars directly from the surrounding vegetation.

Progress in study of the adult moths has also been slower than we would have liked. Hepialids live for only a short time (often only a few days) as adults, which makes their capture in natural conditions challenging without detailed knowledge of seasonality. The literature-gathering exercise at the beginning of the project did not uncover substantial information on flight periods, and Chinese studies suggest that a number of different species are involved. These doubtless have subtly different life cycles, and none of the information on capture periods we were able to gather from insect collections referred to moths from clearly comparable habitats.

We were able to capture a small number of adult moths in early July 2006, following an extended period of unsuccessful light trapping. We are unsure at present as to whether general population levels are at a low level, or whether our trapping methods are not sufficiently attractive to the moths. Our initial assumption was that the flight period of the moths will be correlated with spore release by the *Cordyceps*, as information from other species indicates that aerial infection of young instars is likely to occur followed by a long dormant period. We will continue the survey work throughout the 2007 field season using UV as well as visible-light lamps at attractants.

Initial analysis of the adult hepialid moths indicated that it is possible that our individuals belong to a separate, probably undescribed species to those reported from China. This is of course of considerable interest to the Bhutanese (who consider that *Cordyceps* from Bhutan is even more efficacious than that from China!) We do not have access to high-quality microscopes in Bhutan and dissection of genitalia is needed to confirm the identity of the moths, so the research could not be done by our entomology expert in-country. Getting permission to export the moth specimens for identification proved to be a long and frustrating process (see information above on project partnerships). We were only able to bring them to the UK in March 2006 when two of the Bhutanese project team visited CAB International for our annual project meeting to review progress and set priorities for the next field season. Four moth specimens are currently being set for observation and we hope to confirm the species in May 2006. The delay will not affect progress during the 2007 field season.

2. Monitoring/impact scheme designed and implemented in consultation with local stakeholders

This was implemented initially as planned in spring 2006, and at first focuses primarily on data gathering and assessment of *Cordyceps* offered for sale via the Government auctions. There have also been substantial efforts devoted to sensitization of the *Cordyceps* harvesters and trade stakeholders to the long-term benefits of sustainable harvest practices. The monitoring scheme also focuses on product quality to reduce the risk of non-saleable *Cordyceps* being harvested.

Direct monitoring of *Cordyceps* harvest in Bhutan is highly problematic due to the sparse population and inaccessibility of collection sites. Monitoring of the material sold is much more practical. We initially had concerns that substantial quantities of *Cordyceps* might be traded in Bhutan outside of the Government system. In 2005 there were some reports of buyers visiting the *Cordyceps* harvester communities in attempts to circumvent the official channels (which include a 10% Government levy on the purchase price). In 2006 by contrast, our surveys indicated that the harvesters believed that they would achieve better prices via the Government auctions, and buyers were happy to pay the levy for the convenience of purchasing stocks in places accessible by road. Doubtless some illegal trade does carry on (and this would be very difficult to quantify) but we are now happy that the *Cordyceps* offered for sale at the Government auctions is a good reflection of the trade overall.

There are various ways in which we are monitoring the *Cordyceps* at auction; quantity sold, price achieved, and material offered but not sold. Quality measures include level of maturity, proportion of damaged fruit-bodies, and extent of post-harvest deterioration (mould growth etc.)

In 2006, the overall quantities of *Cordyceps* offered for sale were substantially greater than for the previous two years (507 kg compared with 175 kg in 2005 and 157 kg in 2004). In addition,

the prices obtained were significantly greater (maximum 130000 ngultrum/kg [roughly £1600] in 2006 compared with 98000 ngultrum/kg in 2005 [£1200 in today's prices] and 87000 [£1100] ngultrum/kg in 2004). The figures are of course substantially less than the prices charged by retailers in Hong Kong – in 2004 prices ranged between £2200 - £4600 per kilo depending on quality.

The quantity and price measures are linked; our information is that informal cross-border trading has almost stopped as a result of the increase in prices. Quantification is very difficult, but for the moment we have no reason to believe that harvest (as opposed to official trade) has increased substantially over the last few years. Factors in the value increase may be higher world prices (information is difficult to obtain and we do not have more recent data than 2004) and increased competition amongst buyers, but there was a substantial improvement in quality compared with recent years and we believe that this is the primary reason for the higher prices. The quality increase was driven partly by experiences of previous years where a substantial proportion of the crop on offer was damaged or mouldy due to poor post-harvest practice, and either did not sell at all or fetched very poor prices. We have worked with the harvesters to reinforce these messages, resulting in a cooperative atmosphere in which messages about sustainability are more likely to be appreciated. Most of the harvesters have almost no income in financial terms apart from *Cordyceps* harvest and will gather the crop even if prices are very low, so we believe that their livelihoods are improving without a substantial deleterious effect on *Cordyceps* populations.

The change in collection dates resulting in harvest of less mature fruit bodies leads to price increases for the harvesters as these are favoured by the buyers. A further benefit is that immature fruit bodies are heavier as nutrient reserves for spore production have not been used, leading to increased weights offered for sale without increasing the number of fruit bodies harvested. We will be attempting to quantify this effect over the coming season.

There have been a number of awareness-raising exercises to promote the sustainability message, including a workshop with the Soe Yaksa community (close to the primary research site), a well-attended stand at the Renewable Natural Resource Exposition in Gedu in December 2006, and publication and promulgation of a full-colour leaflet linking sustainability and quality messages. The leaflet was produced in English (which is widely spoken in Bhutan), and we are considering the additional impact of production in Dzongka for the benefit of non-Anglophones. This might be less than expected as many of the yak herders cannot read either language, and we may decide to concentrate on promulgation of these messages by word of mouth.

In the 2007 field season, we will be forging a new link with another programme based in Bhutan, the Community-Based Natural Resource Management (CBNRM) Project, which is also implemented by CORRB and which will use *Cordyceps* harvest as a pilot scheme. The project will be working with communities in Naro, Lingshi and Soe to initiate local management of the *Cordyceps* resource, with a strong focus on community decision-making to ensure sustainability. Outline agreement has already been obtained with the communities, and we are hopeful that this initiative can be expanded in following years into other *Cordyceps* harvesting areas. We shall be examining the impact of the scheme with some interest.

3. Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc.

Substantial progress has been made towards this objective. The second year of the project commenced with a stakeholder workshop in April 2006. The outcomes of the workshop contribute to several of the project objectives, but can most logically be discussed here. A wide cross-section of institutions and agencies with interests in *Cordyceps* participated in this event in addition to CORRB, including representatives from:

the Jigme Dorji National Park administration (location of most of the Darwin project research)

- the Bumdeling National Park administration (in the east of Bhutan)
- the Nature Conservation Division of the Royal Government of Bhutan (RGoB)
- the Forest Territorial Division of RGoB (District Forest Officers from Bumthang and Wangdue - also *Cordyceps* harvesting areas)
- Local farmers/*Cordyceps* harvesters (five participants from different communities)
- National Post-harvest Centre (concerned with quality issues after collection)
- Agricultural Marketing Services (responsible for the *Cordyceps* auctions)
- Bhutan Food and Agricultural Regulatory Authority (responsible for external quarantine regulation)
- Bhutan Chamber of Commerce and Industry (four businesses involved in purchase and export of *Cordyceps*)
- Institute of Traditional Medicine Services (responsible for commercial development of traditional medicines within-country)
- Policy and Planning Division, Ministry of Agriculture, RGoB

The objectives of the workshop were:

- To create awareness regarding sustainability and long-term utilization of *Cordyceps*
- Promotion of good harvesting and other management practices
- Promotion of best practice in post-harvest treatment
- National quarantine and export certification regulations
- Development of markets and marketing procedures
- To review and revise harvesting rules and regulations, especially dates and duration
- To discuss a basic users' manual on responsible harvesting and post-harvest treatment
- To discuss synergy of export certification procedures

During the workshop project staff from CORRB made two presentations on activities so far under the auspices of the Going for Gold project, Dr Cannon gave an introductory presentation on the overall project framework and objectives, and Dr Hywel-Jones explained some of the complexities of *Cordyceps* biology.

The workshop was highly successful with universal recognition of the importance of sustainability of *Cordyceps* harvest and good working relationships between those with primary interests in conservation/regulation and those involved in exploitation of the resource.

A key outcome was agreement that the regulated collection period needed to be brought forward from its original dates, from June 1 - 30 to May 15 - June 15. This was for the following reasons:

Cordyceps in an immature condition fetches better prices than mature material, as Eastern traditional medicine values fruit-bodies with the caterpillar cadaver still intact. By the time spores are produced the buried caterpillar has almost completely disintegrated as the parasitizing fungus's nutrient reserves are depleted.

There are claimed to be substantial amounts of *Cordyceps* harvested illegally in Bhutan by poachers coming across the border from Tibet, and this is borne out by interception of alien harvesters by National Park rangers. However, the number of rangers is grossly inadequate to regulate the illegal activity.

Prior to the 2006 collection season therefore, Tibetan poachers were harvesting the best-quality fruit-bodies, and Bhutanese collectors were only able to gather poorer-quality material

after the main flush of commercially valuable *Cordyceps*. This effectively led to two collection periods rather than one.

Bringing the collection period forward allows the local collectors to harvest the most commercially valuable crop, and their presence in the harvesting areas acts as a deterrent to collectors from across the border. By the time the legitimate collection period is ended, fruit-bodies not gathered are fully mature and therefore less attractive to illegal collectors, and may therefore release spores to infect the next generation of caterpillars.

The change of legal collection period was seen as a potential win-win situation by all, reducing the overall harvest levels but increasing income of legitimate collectors. Following the workshop, the Royal Government of Bhutan acted with commendable swiftness to make the necessary legislative changes, and the new collection dates were promulgated in official Government documents and in the press in time for the 2006 collection season. The impact of this action will clearly need to be carefully monitored, but we remain confident that the change in harvest date will be to the long-term benefit of the *Cordyceps* harvesters. Impact on the 2006 harvest is described below. Initial impressions are encouraging, and the project team agreed to maintain the new collection dates for the 2007 season.

4. Pilot project for low-tech Cordyceps farming in place

Much of the information gathered on *Cordyceps* and *Thitarodes* biology (described above) supports this objective, but we have now concluded that the project timescale is too short to establish a *Cordyceps* farm even on an experimental basis. We indicated in the original project application that this was a high-risk objective due to the lack of existing basic information. While we still feel that *Cordyceps* farming may be feasible in the long term, we feel that remaining project funds would be better spent on other aspects of the Going for Gold programme. We would of course continue to gather information on basic biology that will be essential to set up farms in the future, and we will investigate the potential for private-sector funding within Bhutan to develop this activity.

We shall therefore be writing to the Darwin Initiative to ask formally that this objective be removed from the Going for Gold programme, and that it be replaced by development of a field guide to the mountain flowers of Bhutan. Currently there is no field guide available on the Bhutanese flora for the benefit of either local people or ecotourists, and the only publication available is Polunin & Stainton's *Wild Flowers of the Himalayas*, which is focused on the flora of the western Himalayas and in which colour reproduction is very poor by modern standards.

We have been acquiring digital images of many of the flowers in our study areas as a byproduct of the project, and we have obtained permission from the Royal Botanic Garden Edinburgh to use data from their *Flora of Bhutan* (a much more technical publication than ours will be) which will greatly facilitate its production. They have also offered images of their own. We will also work with other agencies in Bhutan (especially the newly established National Herbarium and the Institute for Traditional Medicine) to include local knowledge, conservation assessments etc.

We would like if possible to publish the book in Bhutan. This may happen either through formal Government channels (if financial subsidy can be found), or as a commercial operation via a publishing house in Thimphu. If neither of these options prove practical then we shall approach publishers elsewhere, and the Royal Botanic Garden Edinburgh has shown some interest in this prospect.

CORRB has been fully consulted on this potential change in project objective, and is highly supportive of the proposal. The publication would of course include full recognition of the role of

the Darwin Initiative in its production, and the Darwin logo will be placed on the outside cover of the book.

5. Training and capacity building (fungal and insect biology, techniques)

Continuing efforts in training and capacity building are being made during the normal course of the project, especially in survey and analysis techniques. The training courses in fungal and insect biology are now planned for September 2007, and we hope that it will be possible to run courses in both the western and eastern parts of Bhutan. We will also be negotiating with BIOTEC (our partner in Thailand) for limited matching funding to support these activities.

An additional training exercise was organized during the winter of 2007, with four members of the project team from CORRB going on a short study trip to Bangkok and Hong Kong to examine the marketing and retailing of *Cordyceps*, at the other end of the supply chain. They investigated quality issues, medicinal claims, pricing and presentation of the product. Substantial benefits were achieved in terms of increased understanding of the commercial realities of the *Cordyceps* industry.

Summary of Workplan April 2006 – March 2007 (as described in the Year 1 Report)

April 2006 Stakeholder workshop to publicize sustainability concerns and to gather information from harvesters and buyers. **Achieved.**

May 2006 Dissemination of leaflet on *Cordyceps* sustainability and quality. **Achieved.**

May – August 2006 Survey and monitoring in Namna and surrounding areas to establish *Cordyceps* population size and seasonality. **Achieved.**

May – July 2006 Establishment of potential host plants at Yusipang. **Achieved, but now considered unnecessary.**

June – August 2006 Survey and study of host moths, including further attempts to rear caterpillars in captivity. To be continued if initially successful. **Some progress made on survey and study of host moths, successful rearing of caterpillars not achieved.**

July 2006 Review of *Cordyceps* auction process and quality of material on sale; impact assessment of leaflet. **Achieved.**

November 2006 Training of National Park staff [subject to identification of travel funds], review meeting. **Extra travel funds not identified, training activity will now take place in September 2007. Review meeting took place in the UK in March 2007 (in time for decision-making for the 2007 field season)**

3.2 Progress towards Project Outputs

Details are provided in section 3.1 above, but the table below summarizes progress.

Output	Progress	Important assumptions
Knowledge of	Good progress in most areas, on target for	Seasonality issues proving

<i>Cordyceps</i> incidence and harvest, host/parasite relations and host biology	achievement. Progress on knowledge of host biology has been slower than anticipated due to logistical difficulties and apparent rarity of adult moths in the survey area.	more difficult than anticipated, but should not significantly affect the project outcome.
Monitoring/impact scheme designed and implemented in consultation with local stakeholders	On target, complementary activities (including local management schemes) planned	Very good relations have been maintained with all local stakeholders
Regulatory system modified in line with project findings and IP concerns, publication of regulations, best practice for harvest etc	Achieved and on target	Enforcement of regulations may be problematic due to small numbers of NP staff, addressed through promoting self-policing by harvesters, local management schemes etc.
Pilot project for low-tech <i>Cordyceps</i> farming in place	Some work achieved but now considered too ambitious within the project timeframe	
Training and capacity building (fungal and insect biology, techniques)	Overall training ongoing, courses now planned for September 2007	As in proposal

3.3 Standard Output Measures

Code No.	Description	Year 1 Total	Year 2 Total	Year 3 Total	Year 4 Total	TOTAL
6A/B	1-week training course on insect fungi for 3 Bhutanese scientists	3				
7	Education leaflet, poster, website	3	1			
8	Person/weeks spent abroad on project work	17	12			
14A	Stakeholder workshop for <i>Codyceps</i>		1			

sustainability			
14B	Conservation conference, Cambridge March 2006, Darwin workshop	2	
15A	National press release/article in Bhutan	1	1
15C	National press release/article in UK	2	
18A	News feature on stakeholder workshop		1
20	Value of assets	£1500	£500
23	Matching funding from EU Medicinal Plants project (estimated)	£8000	

No publications have been produced to date apart from a leaflet on *Cordyceps* sustainability. We anticipate that several publications will be submitted before the end of the project.

Table 1 Publications

Type *	Detail	Publishers	Available from	Cost £
(eg journals, manual, CDs)	(title, author, year)	(name, city)	(eg contact address, website)	

3.4 Progress towards the project purpose and outcomes

Good progress has been made towards all components of the Project Purpose, with the exception of the farming aspects of the programme, discussed in detail above.

3.5 Progress towards impact on biodiversity, sustainable use or equitable sharing of biodiversity benefits

All indications are that both the Royal Government of Bhutan and the project stakeholders (including *Cordyceps* harvesters) remain fully committed to sustainability of *Cordyceps* production. Establishing population levels and therefore sustainable harvest levels is challenging in a system where natural boom-and-bust cycles probably occur. Ultimately, the

project can only put mechanisms in place to ensure long-term sustainability, rather than achieving it by dictat. Indicators at this stage in the project are all good, although no stakeholder group as yet has been asked to make major sacrifices to ensure sustainability of *Cordyceps* supply.

4. Monitoring, evaluation and lessons

Discussed in detail in sections 3.1-3.4. Some aspects of monitoring and evaluation are complex for this project (e.g. the level of poaching and unauthorized trade) but we feel that we have sufficient other indicators and measurements to demonstrate success.

No specific lessons have been learned over the past year in terms of project management, though we were rather constrained by an inadequate travel budget for the 2006/7 project year that necessitated moving one activity into the next accounting period. If planning the project again with hindsight, we would have asked for more financial assistance to allow more project travel and more effective collaboration.

5. Actions taken in response to previous reviews (if applicable)

A response to the first annual review was sent to the Darwin Initiative in October 2006 following consultation with project partners, along with the second half-year report. The reviewer was happy with most aspects of the report, but raised two specific issues.

Firstly, that the Darwin Initiative could be seen to be supporting production of a medicinal product of doubtful efficacy. We did not consider that this concern was justified, as explained in our formal response. It is outside of the remit of the project to carry out pharmaceutical research. While there has been generalized scepticism in the West as to the value of eastern traditional medicines in general, there is increasing interest in the biochemical basis for their efficacy, and in partnerships between East and West to benefit from traditional knowledge. We are not aware of any credible claims that *Cordyceps* is dangerous, and there is a substantial body of evidence (some peer-reviewed) indicating at least potential benefits from its use. Whatever our position, the trade will continue, improving the livelihoods of some of the most resource-poor people in Asia. Sustainable harvest will contribute significantly to conservation of the ecosystems in which *Cordyceps* grows, as well as achieving a measure of long-term financial stability for its gatherers.

The second concern was in progress of the biology research aspects of the project. We are happy with progress on the fungus biology side of the work, but continue to have some concerns regarding progress on the entomology. We have given this side of the work increased priority during the 2006 field season and have made some useful advances. However, there are significant logistical and physical problems in extended research at high altitude in Bhutan, which could only be solved by a very substantial increase in budget (e.g. to allow for helicopters to transport materials). We are also hampered by an almost complete absence of baseline data regarding the host insect. As we have discovered during the 2006 field season the species in Bhutan appears to be distinct from those in China, and we have not been able to source any detailed information on related species from surrounding areas that would help us in our analyses. We also suspect that there is a natural cycle in population levels (probably mediated at least in part by *Cordyceps* parasitism) and the project may have begun at a trough in population. We are doing our best to overcome these obstacles and will continue to collect data as actively as we can.

6. Other comments on progress not covered elsewhere

None have been identified.

7. Sustainability

The project has a high profile within the country, due to the widespread interest in *Cordyceps* and the number and variety of stakeholder groups consulted. Activities have been reported in both the printed press and on television. There is already substantial interest and concern for biodiversity in Bhutan (largely a result of its Buddhist roots) and the Royal Government is active in promotion of sustainable solutions as the economy grows. CORRB, as an agency of the Royal Government, is committed to continuation of the survey work to establish long-term measurements of population and seasonality. It also has a formal remit to work with stakeholder groups within the National Parks and other sensitive areas to preserve biodiversity and manage human impact according to sustainable guidelines.

8. Dissemination

Stakeholder workshop for approximately 60 people from 11 different public and private sector groups, including representatives from the harvester communities and *Cordyceps* buyers.

Article in the national newspaper Kuensel relating to the stakeholder workshop, and a television feature on the same event.

Production and promulgation of a leaflet (2000 copies) promoting sustainable practice for *Cordyceps* harvesters, given to a wide range of people including village representatives, National Park staff, District Forest Officers, *Cordyceps* buyers etc.

Stand at RNR Exposition in Bhutan in December 2006 promoting good practice and sustainability; several hundred visitors

CORRB has limited internal funds for dissemination of information, and will be supported in this role assuming that the Royal Government continues its commitment to sustainability.

9. Project Expenditure

Please expand and complete Table 3.

Table 2 Project expenditure during the reporting period (Defra Financial Year 01 April to 31 March)

Highlight any agreed changes to the budget and explain any variation in expenditure where this is +/- 10% of the budget.

10. OPTIONAL: Outstanding achievements of your project during the reporting period (300-400 words maximum). This section may be used for publicity purposes

[I agree for ECTF and the Darwin Secretariat to publish the content of this section](#) (please leave this line in to indicate your agreement to use any material you provide here)

You may use text from this report for publicity purposes, but we would like to establish exactly what will be used before formal permission is given.

Annex 1 *Report of progress and achievements against Logical Framework for Financial Year: 2006/07*

Project summary	Measurable Indicators	Progress and Achievements April 2006 - March 2007	Actions required/planned for next period
<p>Goal: 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</p> <p>The conservation of biological diversity, The sustainable use of its components, and The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources</p>		(report on any contribution towards positive impact on biodiversity or positive changes in the conditions of human communities associated with biodiversity eg steps towards sustainable use or equitable sharing of costs or benefits)	(do not fill not applicable)
<p>Purpose</p> <p><i>Cordyceps sinensis</i> harvest in Bhutan protected and montane grasslands conserved through research and capacity building to achieve sustainable production</p>	<p>New knowledge on population and harvest levels, host/parasite relations and host requirements</p> <p>Monitoring/impact scheme in place</p> <p>Local stakeholders in support of conservation</p> <p>Feasibility study and pilot programme for <i>Cordyceps</i> farming</p> <p>Regulatory system in place/modified appropriately, leading to reduction in illegal harvest</p>	<p>Long-term monitoring programme in place for population studies, much new knowledge on harvest levels, some new knowledge on insect biology; widespread support for conservation and sustainable harvest by all local stakeholders;</p> <p><i>Cordyceps</i> farming not feasible within the project timeframe;</p> <p>regulatory system modified in 2006 following advice from project and supported by stakeholders;</p> <p>indications that illegal harvest has reduced</p>	<p>Continuation of population studies and monitoring of harvest levels; new survey site in eastern Butan set up; community based natural resource management for <i>Cordyceps</i> trialled; training days in fungus and insect biology for national park staff</p>
<p>Output 1.</p> <p>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, host biology research has continued to prove challenging</p>	
<p>1. Surveys for incidence and seasonality of <i>Cordyceps</i></p> <p>2. Studies of hepialid caterpillars and their feeding habits</p>		<p>1. Surveys designed and implemented, data loggers installed. To continue in 2007, and expanded by setting up a new survey in Bumdeling National</p>	

		Park 2. Ex-situ studies set up but unsuccessful due to caterpillar mortality. Alternative strategy for feeding experiments to be implemented in 2007.
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	Achieved in most respects, good support from stakeholders. Monitoring at auction stage much more practical than observations of harvesting
1. Monitoring and analysis of harvest at auction stage		Achieved, many data gathered. Too early in the process to monitor trends in harvest. In 2007 monitoring will continue, trialling of locally controlled sustainability methods to be developed.
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	
1. Leaflets promulgated with messages on sustainability, best practice and quality control		Good impact, quality of <i>Cordyceps</i> at 2006 harvest much improved; possible leaflet in Dzongka for 2007
2. Stakeholder meeting taken place in 2006		Very successful, led to change in harvest period on recommendation of project staff; implemented by Government in 2006
Output 4 Pilot project for low-tech <i>Cordyceps</i> farming in place	Experimental farm set up, caterpillars raised successfully, inoculation with fungus achieved	Progress difficult due to many factors beyond our control, primarily logistical challenges, difficulties in capturing adult moths and survival of caterpillars in captivity. We have proposed to abandon this component of the project and concentrate our efforts on sustainability of wild-gathered <i>Cordyceps</i> .
Output 5 Training and capacity building (fungal and insect biology, techniques)	Number of National Park, NCD/CORRB staff participating	To be addressed in September 2007 via short-term training courses in the eastern and western regions of Bhutan. Ongoing on-the-job training of project staff

Annex 2 *Project's full current logframe*

Not changed formally since the project inception. Assuming that the Darwin Initiative agree to the change in Output 4 a revised document will be produced within the next month or so.