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	15/001
Project Title	Bees, Biodiversity & Forest Livelihoods in the Nilgiris Biosphere Reserve
Host country(ies)	India
UK Contract Holder Institution	University of East Anglia/ODG
UK Partner Institution(s)	Bees *for* Development CAER, Reading
Host Country Partner Institution(s)	Keystone Foundation
Darwin Grant Value	275,308 GBP
Start/End dates of Project	1 June 2006 – 31 May 2009
Project Leader Name	Dr. Janet Seeley
Project Website	http://www1.uea.ac.uk/cm/home/schools/ssf/dev/people/academic/seeley/Research/Nilgiri Biodiversity
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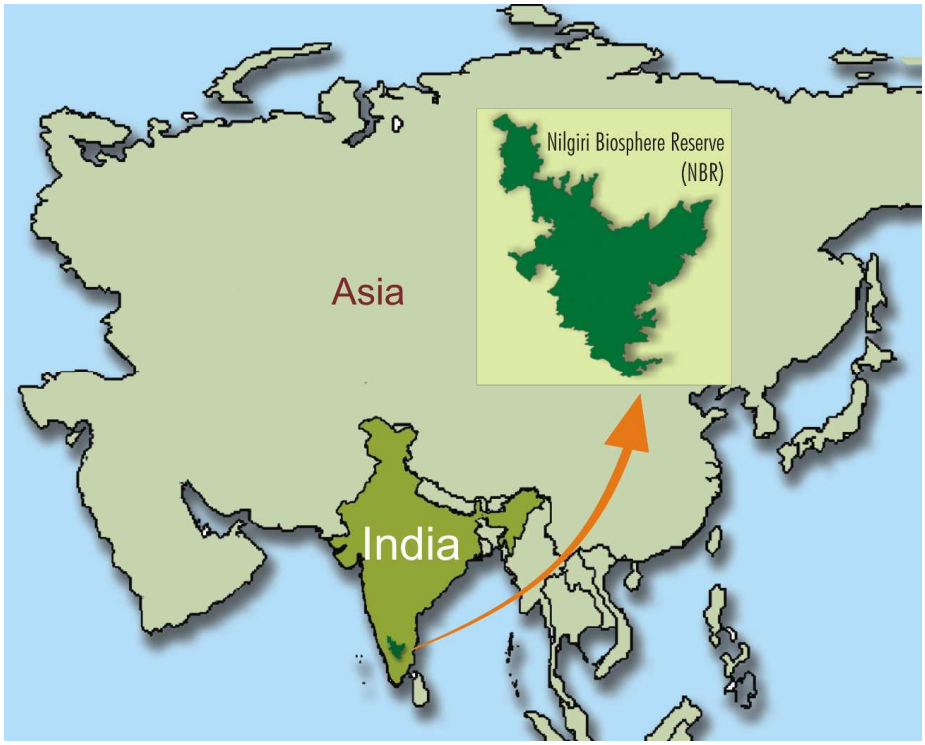
1. Project Background

Project location



Project purpose
This Project sought to elucidate interdependencies between bees, biodiversity and forest livelihoods in the Nilgiri Biosphere Reserve (NBR), Western Ghats, India. The indigenous bees of the mountainous NBR are known to play an important role in local livelihoods, yet had not been scientifically identified or classified, their populations and distributions were unknown, and their vital role in pollination and the maintenance of forest biodiversity had not been studied. This Project endeavoured to combine scientific data about the status of these indigenous bees and their ecology, with participatory livelihoods analysis. This was achieved by strengthening the research capacity of the local organisation, Keystone Foundation, working in partnership with three UK institutions, and with local indigenous communities and Forest Department staff.

Project outputs
A. Increased scientific and livelihood knowledge through research
B. Strengthened capacities of key institutions
C. Enhanced technical and professional skills in host country through training
D. Increased awareness and policy engagement in India and UK through dissemination and advocacy

Achievements:
Concerning output A
- Papers published/in press in international journals and others under-preparation.
- Knowledge of the genetic background of the indigenous species of *Apis.*
- Databases set up of biodiversity data related to bees and livelihoods.

Concerning output B
- 5 field centres and 16 field sites for research established
- Collection of bees, pollinators and a field lab set-up
- Expertise in livelihoods analysis established
- Experience of UK innovation in forestry practice and information services.

Concerning output C
- Skills in research methodologies built and used
- Mentoring in research rigour

Concerning output D
- Advocacy with the Forest Departments of three states – Karnataka, Kerala and Tamil Nadu.
- Tribal Advisory Committee strengthened.
- CBD internalised in the host organisation.

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

The Project – Bees, Biodiversity & Forest Livelihoods in the Nilgiris Biosphere Reserve has a strong basis on the CBD principles of Conservation, Sustainable Use and Benefit Sharing. The Biodiversity side of the project assessed the bees and forest linkages and the livelihoods side connected the biodiversity to benefit sharing and issues around sustainable use through understanding and analysis of household profiles and people's livelihood strategies.

The Project made possible interaction between different actors in India (through attendance at national level meetings and the final conference) as well as through visits to the UK Forestry Commission and discussions with resource persons in Scotland

dealing with CBD issues. During those visits our environmental lawyer in the project highlighted the steps taken by the Government in India and more specifically in this project and discussed the project components which directly connect to CBD.

In many ways work on the CBD seems to be ahead in India compared to UK. However, much remains to be done in India in the implementation of CBD principles. This project has provided an opportunity for the India host institution, Keystone Foundation, to build their expertise in CBD and become advocates for the Convention in their area and in national fora more generally.

3. Project Partnerships

The partnership between the UK partners and Indian organization was on the whole productive and mutually beneficial. There were occasions when both Indian and UK researchers were aware that approaches to research often differ and the language and understanding is not always the same. This was not only an international issue, but also one of the challenges of working across disciplines. This sometimes led to very interesting and stimulating discussion. At other times frustration when concepts and approaches were not always clearly understood by everyone in the team. However, there is no doubt that a lot was learnt across disciplines and a greater appreciation for other skill sets has been built. A number of people have put a considerable amount of extra work, beyond what we had planned, into this project. Without that input we could not have achieved as much as we did. Not everyone had the flexibility to give all the extra time we needed `for free', since our budget for the UK time in particular was limited. In retrospect we think it would have been helpful to have had a post-doctoral student stationed with the host institute to support the project. We did manage to place a `livelihoods intern' with Keystone for three months, but this was not as successful as it might have been because the person who took the position was quite inexperienced himself (although he worked very hard).

Staff changes resulted in setbacks when skills were lost (particularly in biodiversity and entomology). This did put a strain on the partnership at times, when team members needed for training new staff were unable to give the inputs needed because of lack of time. We did manage to shift some funds across to cover extra UK-inputs, as agreed with the Darwin Initiative administration, but time was still short. This experience illustrates how difficult it is to keep trained researchers with much sought after skills in relatively remote locations, particularly when the remuneration and facilities we could offer, while in keeping with the host institution norms, could not compete with other offers.

No MoU was established for this particular project. This was not felt to be necessary at any point during implementation. Planning for activities was done during UK team member visits and over email and SKYPE. Authorship guidelines were drawn up and have been helpful in averting misunderstandings over authorship in the team. The annual team meeting, in December of each year, proved to be extremely useful for reviewing progress, taking stock of what needed to be done and taking the opportunity for training/mentoring inputs

4. Project Achievements

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

The purpose of this project has been two fold – first to build better understanding through the creation of new knowledge of the interlinkages between human use of

honey and indigenous bee populations and the biodiversity services that they fulfil. Second, and in doing this, build capacity of local researchers to generate new knowledge and to continue this into the future. The achievement of this purpose was seen as contributing to the goals of the project

- The conservation of biological diversity
- The sustainable use of its components
- The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

The project purpose can be defined more as the near term impact and the project goal as the longer term impact.

With respect to the project purpose, the project has created new knowledge about the role of honey in the livelihoods of indigenous people, about the indigenous bee species and of the pollination services that they provide. The building of that new knowledge has undoubtedly contributed to capacity building of the partner institution with respect to research methods, techniques, data handling procedures and analytical capacities. This potentially lays the foundation for longer term relevant and competent research on biodiversity – human interlinkages. However it has to be said that the research has made rather less progress on the knowledge base of 'interlinkages' although it has certainly challenged some implicit assumptions about 'dependency'. The reasons for this are several: first biodiversity – human linkages are extremely complex and a modest project of this nature has not had the resources of time or money to give to the problem. Second there are challenges of interdisciplinarity and different knowledge frameworks that this research project did not manage to overcome, and the biological and social research did not achieve the intellectual engagement to tackle this head on. It would have been difficult to do this under the best of conditions.

This project was not designed to have a direct impact on biodiversity so even near or mid-term beneficial biodiversity outcomes are not to be expected. However note should be made of several of the assumptions in the logical framework linking outcome to goal levels and in particular those concerning market forces and institutional arrangements and practices (both legislation and collaboration with forest departments). The institutional arrangements around the Nilgiri Biosphere Reserve – and in particular the absence of a unitary authority over the NBR, give rise to a number of contradictory practices and objectives between the three state forest departments that give rise to dysfunctional markets pressures. The violation of this key assumption weakens the purpose-goal linkage.

4.2 Outcomes: achievement of the project purpose and outcomes

The project was largely successful in achieving its ambitious purpose: `the interdependencies between indigenous bees, biodiversity and forest livelihoods in the Nilgiri Biosphere Research (NBR), Western Ghats, India, elucidated and the capacity of local researchers, indigenous people and government staff strengthened.' The reference collections of bees and pollen samples have been established (pollen database submitted with this final report). These are being maintained at Keystone Foundation and form a permanent bee reference collection and pollen library. The research and information on livelihoods of the people has yielded detailed information on people's lives in the NBR. The data are being kept at Keystone Foundation and form a small archive that can be used by other researchers in future. Analysis of the data continues and will be published in a series of papers over the coming year. Mentoring on research methodologies has enhanced research knowledge and built capacity of local staff in generating information and maintaining records. The project

has been less successful in strengthening the capacity of government staff. A few forestry department staff have had skills built and have benefitted from engagement with the research, but it has proved challenging for the project to engage with senior foresters, much of our engagement with them has been in sorting out clearances for data collection. However, senior government officials did participate in the final workshop (see attached newspaper cuttings) and were very supportive of what we have done. This will help Keystone Foundation in their future efforts to engage with the forestry departments in the three states and bureaucrats working in tribal affairs and other related departments.

4.3 Outputs (and activities)

We believe we achieved the outputs set out in our log-frame. The output level assumptions largely held true: loss of trained staff did affect our progress and the rebuilding support among senior forestry staff when officers were transferred did take up precious time, for example. Activities to achieve the outputs include: Biodiversity: The bees collected through the pan traps have been processed and stored in the laboratory. The bees have been identified to family level, with the exception of the honey bees (Apis), which have been identified to species. The plant specimens and pollen slides have been catalogued and a permanent pollen slide library established.

The social maps, which were first prepared in Oct/Nov 2006, have been kept under review and changes in settlement noted in each site, providing a series of maps showing settlement changes. Data on a range of topics have been collected from all households residing in the villages associated with the study sites, such as settlement history, social structure, the things people do to make a living and their relationship with the forests. More detailed information on the livelihoods/bee and biodiversity interface was collected during the final year of the project and a valuable collection of case studies of different households, including people's life histories, established. A very interesting study of honey marketing was undertaken. The findings from this study have fed into some of the data presented elsewhere in this report and in annex 7.

Project staff at all levels have benefited from a range of capacity building opportunities during the project including `in-project' inputs from senior UK and Indian staff and courses available in India. Local people have engaged with the project in a number of different ways, not only through helping in data collection and providing advice on the project approach, but also through opportunities for training and mentoring in different skills for biodiversity management, for example.

The papers prepared, and under preparation, set out our emerging results. Discussions with government officials and other policy makers in South India and at meetings in New Delhi have provided platforms for the sharing of our findings.

4.4 Project standard measures and publications

Code No.	Description	Year 1 total	Year 2 total	Year 3 total	TOTAL
6A 6B	Number of people to receive other forms of education/training Number of training weeks to be provided	17 (project field team) 7 (entomology, social science and ecology)	20 5 (plus informal mentoring)	12 5	49 17
7	Number of (ie. different types - not volume - of	1 manual field	-		2

	material produced) training materials to be produced for use by host country	methods for entomology 1 manual social science methods			
8	Number of weeks to be spent by UK project staff on project work in the host country	8	7	9	24
15A 15B	Number of national press releases in host country(ies) Number of national press releases in UK	2 1 (in Bees for Development Journal)	3 (one for Apimondia conference in Australia and two in Bees for Development Journal	3 (as a result of final conference)	8
17A	Number of dissemination networks **established**	1 (National Honey Tribal Network)	1(Tribal advisory Committee) Interactions with Ford Foundation project partners		2
17B	Number of dissemination networks to be **enhanced/extended**	2 (networking with Ford Foundation project partners)	2 (networking with Ford Foundation project partners)	2 continued	2
21	Number of permanent educational/training/research facilities or organisations to be established and then continued after Darwin funding has ceased	2 (at Keystone headquarters and in Ooty)	2 (at Keystone headquarters and in Ooty)	2	2
22	Number of permanent field plots to be established during the project and continued after Darwin funding has ceased	16 (distributed between the sites)	16 (distributed between the 16 sites)	16 (distributed between the 16 sites)	
23	Value of resources raised from other sources (i.e. in addition to Darwin funding) for project work	£41,250	£30,405	£30,000	£101,655

Already published papers:
- "Social bees and food plant associations in the Nilgiri Biosphere Reserve, India" - Tropical Ecology
In press and accepted after revision:
-"Dependancy of cultivated plants and NTFPs on pollinators"-Biotropica
-"Characteristics of trees used as nest sites by *Apis dorsata* (Hymenoptera, Apidae) in the Nilgiri Biosphere Reserve, India" - Journal of Tropical Ecology
Recently submitted:
-"Nesting requirements of the rock bee *Apis dorsata* Fabricius in the Nilgiri Biosphere Reserve, India" - Current Science - April 2009.

In addition a number of project papers are published in the final **Conference proceedings**:

Project paper "Biodiversity and Livelihoods in the NBR – what is happening?"	P. Mulley and Sneh Nath
Conceptual overview paper "Researching Livelihoods, Bees and Biodiversity Linkages"	Adam Pain
Overview: The story on the bees	Nicola Bradbear
Bees and biodiversity in the Nilgiri Biosphere Reserve – an overview	Anita Varghese
Pollination services to cultivated and NTFP species in the Nilgiri Biosphere Reserve	Priya Davidar
Overview "What is the story on Livelihoods Linkages"	Sneh Nath
"What have we learnt on forest livelihoods in the project?"	Janet Seeley
Overview – "What is driving change?"	Adam Pain

See attached sample pages from Proceedings which include the first three of these papers.

Databases were prepared on

1. Forest and Agricultural Crop Plants of the Nilgiri Biosphere Reserve and their Pollinators.
2. Bee Flora of the Nilgiri Biosphere Reserve.
3. A key to the bees of the Nilgiri Biosphere Reserve.
4. Pollinators of the Niligiri Biosphere Reserve
5. GIS database on physical, ecological and weather data has of 16 sites in the Niligiri Biosphere Reserve
6. Landuse cover around 16 sites in Niligiri Biosphere Reserve

4.5 Technical and Scientific achievements and co-operation

4.5.1. Site Selection Processes

The use of Case Study Sites

The research approach that the project has followed is essentially a case study one with cases selected as points of contrast between different social groups, potential importance of NTFPs in their livelihoods, linked to relative 'remoteness' and different agroecological settings. There is a tradition at least within the sciences of following random selection procedures with random or stratified sampling to avoid systematic bias in the sample and seeking appropriate sample sizes to enable generalisation. Data collected from such an approach is largely quantitative. Theorising about causalities is largely based on mathematical modelling and statistical techniques and explanation is provided through the detection of regularities derived through regression analysis. This is not the approach that this project has followed, but and this is emphasised, this is also not a rejection of quantitative methods.

In part the reason for not following such an approach responds to the issues raised about qualitative complexity and uncertainty. There is so much variability, both social and ecological, within the NBR that the research specifically needed to maximise the information that it could gain in order to tease out deeper causalities. Further it needed to select study sites which would tell different stories about potential causal relations between livelihood, bee and biodiversity linkages. What was hoped was that the case study sites would capture the maximum variation that might exist in terms of the role of NTFPs in indigenous livelihoods, thus allowing the building of site specific stories around the potential interactions. Indeed the selection process of sites appears to have been successful – there is one site where indigenous livelihoods are entirely dependent on NTFP income sources (NM – see Table 1) and there are two where NTFP contribute nothing to household incomes (ChB and KT).

A more general comment needs to be made about case study research. First it is not a rejection of large random surveys or questionnaire surveys and the use of quantitative analysis with these. Such research is important and is needed to understand the significance or presence of certain phenomena and how they vary across larger populations or scales. Such approaches provide breadth but they do not provide depth. Given the complexity and the theoretical uncertainties discussed above, the need for detailed case studies to build understanding and theory is essential and if we are to make any progress in building understanding of the links between indigenous people and biodiversity, this can only be built out of good case studies.

Site Selection Process

The project purposively selected case study research sites in order to capture contrasts of biogeography, the distribution and honey collection practices of the major tribal groups as well as respond to practical and strategic considerations of coverage across the three Indian states (Tamil Nadu, Karnataka and Kerala) that are contained with the NBR[1].

With respect to the biogeography, the selection process drew on available information on the distribution of the seven major vegetation types within the NBR, their distinctive distribution by state and recognition of considerable micro-level variability due to variation in altitude and localised water resources. In terms of biodiversity there appears to be little systematic data on comparative biodiversity richness by vegetation

[1] See BBL, 2007 for a detailed discussion of the site selection process available at http://www.uea.ac.uk/dev/BeesBiodiversityLivelihoods/documents .

type within the NBR so vegetation type were used as a proxy, on the basis of the wetter regions might be expected to be more biodiversity rich although it is recognized that this is a very crude measure. This was complemented by field observations and assessments by Keystone staff on the indicative presence and relative abundance of bee species by vegetation type. This indicated some degree of association of bee species by vegetation type – for example *Apis cerana* with grassland and shola (high-altitude stunted evergreen forest made up of endemic species) and distinctive bee species mix by vegetation type – which field data should now be able to corroborate or challenge.

Table 1 BBL Location, research sites, adjacent indigenous community and vegetation inside the research plots (vegetation surrounding the research plots)

BBL Locations (Forest Divisions & States)	**Code**	**Indigenous Community**	**Altitude m.a.s.l**	**Vegetation**
Chamrajnagar	ChB	Sholiga, Kannadiga	1304	SEG (DDF)[1]
Chamrajnagar & Satyamanagalam MD in Kerala & Tamil Nadu	ChG	Sholiga	1256	SEG (MDF)
	ChK	Irula	1250	SEG (MDF)
	ChP	Sholigas, Kannadiga[2] Badaga[3]	1013	DDF (DDF)
Coonoor	CM	Kurumba	1094	SEG (DDF)
Nilgiri North & Coimbatore, Tamil Nadu	CP	Kurumba	890	SEG (MDF)
	CS	Irula	582	DDF (DDF)
Kotagiri	KB	Toda	1831	Shola (grasslands)
Nilgiri North, Tamil Nadu	KK	Toda, Others [4]	1665	Shola (Cultivation)
	KT	Badaga, Others	1500	Cultivation
Mudumalai/ Sigur	SB	Kattunaicken	936	MDF (MDF)
Mudumalai & Nilgiri North, Tamil Nadu	SC	Kasava/Irula	877	DDF (DDF)
	SS	Kasava/Irula/Jenu Kurumba	875	DDF, Riverine (Scrub)
Nilambur	NA	Kattunaicken, Paniyas	198	MDF (SEG)
Nilambur North & South, Kerala	NM	Cholanaicken	258	MDF (MDF)
	NMu	Padinaickens, Paniyas	96	DDF (MDF)

Legend

[1]The vegetation type inside the plot is identified and vegetation adjacent to the plot is given in brackets. SEG - Semi-evergreen, MDF – Moist Deciduous Forest, DDF - Dry Deciduous Forest, EVG – Evergreen, Others – agricultural land;

[2] Kannadigas are the residents of Karnataka state and have been living in the mentioned villages along with indigenous groups.

[3] Badagas are the single largest ethno-linguistic population in the Nilgiri Biosphere Reserve and one site in which they are present has been selected for comparative purposes.

[4] Others refer to those who were settled in the Nilgiri district since the coming of the British or those who have populated the district since the advent of the British. These would also include those who have been recently settled following the ethnic conflict in Sri Lanka.

Drawing on the known distribution of indigenous groups and their reported honey collection practices (by species of collection) a mapping exercise, again largely drawing on observation and field experience of Keystone field staff, allowed an identification of patterning of community by vegetation type by bee species. Finally a comparison was made of the management divisions operated by the three State Forest Departments across the NBR. Management divisions where National Parks are located are areas where in theory honey harvesting activities do not take place and where gaining research permission is also difficult. Logistical issues and questions of accessibility as well as of questions of balance across the states finally reduced the potential 13 divisions across the NBR to seven divisions and from these five research BBL locations, four of which cross the Forest Divisions were identified within which the research sites should be selected.

Finally, within the five locations a process of selection of research sites was initiated. Research sites are defined as places where the following activities were carried out:

- Studies and sampling of bees and vegetation in one hectare plots;
- Livelihood studies in villages located near the plots including the assessment of honey collection practices;
- Additional studies on bee nest densities in the vicinity of the research plots.

Sixteen research sites were selected in total across the five locations. Three ranked criteria were used in their selection. First the distribution of sites had to be proportional to the vegetation cover within the location, second indigenous communities who used the resource of the areas and contained honey collectors had to be located adjacent to the site area (but no closer than 500 m for reasons of disturbance) and third the research plot had to be close to a water source (for bees to visit these areas).

4.5.2. Bees

We were interested to learn about the presence of bee species and their value both to pollination and more directly within people's livelihoods. In addition, we are interested to gauge whether current levels of honey hunting of these bee species can be considered sustainable or whether any of these species are being harvested at levels that threaten their species' survival. NBR represents one of increasingly fewer places left on earth where research on indigenous populations of honey bees can be done, i.e. areas with neither introduced honey bees nor introduced, exotic predators and diseases, and as far as we know, this is the first attempt to assess both Meliponini and Asian *Apis* species in the same habitats. NBR represents a particularly useful area for this study as hunting of bee colonies is not practised throughout the whole area, with some areas where bees are undisturbed by humans.

In summary, this is the information gained during this Project concerning bees and their habitats:

1. Identification of bee species and the development of a key to their identification
2. Genetic analysis of *Apis* spp
3. Knowledge of typical numbers of *Apis dorsata* nesting sites (2007)
4. Numbers of honey bee and Melipona species at six project sites 2008 and 2009
5. Knowledge of insect diversity at 15 sites in relation to landscape and season
6. List of foraged plants from 15 sites (12 months, 30 focal patches)[2]
7. Floral calendars at 15 sites
8. Reference collections of pollen and plant specimens from 15 sites

[2] Collection of biological samples was not possible in one site because of restrictions imposed by the Kerala Forest Department.

9. Knowledge of bee dependent NTFPs and crops in five locations of NBR
10. Typical unit prices and trade of pollinators
11. Effect of landscape on pollination, using Sapindus (2008) and coffee (2009) as examples
12. Plant diversity in four sites.[3]

The identification of bee species and the development of a key to their identification

A bee key is being prepared in the software LUCID (under the guidance of CAER at Reading University).

The genetic analysis of NBR's *Apis* spp

Samples of all the NBR *Apis* species have been sent to two international laboratories (Bieneninstitut Kirchhain, Germany and University of Kansas, USA) for characterisation of mitochondrial DNA. The Project has also collected and sent samples of *Apis cerana* and associated *Varroa* mites – these can be used to research the genetic co-evolution of *Apis cerana* and *Varroa* mites.

Preliminary results may indicate that the 'red' *Apis florea* differ from other samples at a single base in the cytochrome oxidase II gene. These bees seem to be nearly identical to Apis *florea* samples from Saudi Arabia, and different from the *Apis florea* samples from Thailand-Laos-Cambodia. The non coding sequence differs a bit (3 bases shorter in India than in Arabia) but four 'oddball' samples match the coding sequence of the Arabian bees. The indications are for two big lines within *florea*, a western line that extends from Arabia to India, and an East Asian group that includes Thailand, Vietnam, and Cambodia etc. The boundary areas will be interesting.

The samples of *Apis dorsata* from NBR have been sequenced along with a large selection of 'giant' bees from Thailand, Malaysia, Borneo, Palawan, Luzon, Pakistan, Andaman Is., Sulawesi, with seven samples from south India-Bangalore and four from NBR. Despite the fact that Sulawesi and Philippine giant bees have been suggested as separate subspecies, the most divergent ones are those from India. They are uniformly quite different from the other locations.

Therefore, we have three groups of bees that say India is unusual: giant bees, *Apis cerana* (yellow and black types, and black somewhat different from the black mainland bees of the rest of Asia) and the florea more allied to those of points west, rather than to the *Apis florea* of Thailand-Cambodia etc.

What we have learned concerning bees in NBR

For the livelihood relevant bee species: we have created a list of bee species of NBR with a key to their identification. By providing samples to wider studies, we have contributed to knowledge of the origins of these bees.

We have knowledge of the numbers of colonies of some of the species in some of the sites, and other areas of NBR. Also knowledge of where the bees are, and their distribution patterns in relation to vegetation.

The livelihood studies will contribute considerably to our knowledge of the extent to which these bees are exploited, and new information has been gained from local people concerning bee management, for example from Nilambur, that people clear vegetation towards encouraging the nesting of *Apis dorsata*. Thus NBR represents an

[3] Four sites were chosen representing different plant mixes for concentrated work on this.

area showing all stages of bee management – from opportunist use of nests, through management to encourage wild nesting colonies, 'bee having' of *Apis cerana* colonies in trees by Toda people, and to standard beekeeping of *Apis cerana* in wall and frame hives.

4.5.2 Biodiversity

The studies on role of bees as pollinators with particular reference to non timber forest produce (NTFP) and crop produce has been completed and has brought out interesting insights about the economic value of services rendered by pollinators. This study has added to our pollen reference collection that now contains 1000+ slides of bee pollen. (see Exel attachment containing database [Rehel et al.]).

4.5.3 Livelihoods

The NBR needs to be considered as both a social and economic resource of households that live in and around it. Through this project we investigated the significance of the forest, and Non Timber Forest Products (NTFPs) in particular, as a household resource, and how it varies between individuals, households, social groups and locations. With respect to the forest as a social and cultural resource we explored the role of the forest, and different forest `products' in people's lives, finding that seemingly similar people, from the same `community' may view a resource, or for example a social activity to gather a forest product (such as honey hunting), in very different ways. Differences in background, experience as well as gender and age, result in different perceptions of the social value of the forest and NTFPs.

On the economic role, based on an assessment of household income portfolios, we found that the contribution of NTFPs in general and honey in particular to household income is highly variable and differentiated both by site and by differences between households within sites. There are a few sites e.g. Mancheri in Nilambur in Kerala where all household income is drawn from NTFP collection. However even here household income on average obtained from honey does not amount to more than 20% of total gross household income. In most other locations NTFP derived income is 20% or less of gross household income and honey derived income a quarter of this or less. Factors that appear to affect the role of NTFPs in household income include both supply considerations as well as the availability of different economic opportunities.

4.5.4 Interlinkages

Conceptually two broad areas of human activities can be identified as potentially having an effect on honey bee populations. The first is the direct hunting activities and the collection of honey. The second more indirect effect is through land clearance that could be either positive (increasing food sources) or negative. Biodiversity in some cases may well be maintained or even encouraged by disturbance regimes such as land clearance that might reduce biodiversity locally but promote it more widely.

A first question to be asked since it is potentially a crucial link between honey harvesting and *A. dorsata* populations, is 'what is the effect of harvesting of *A. dorsata* on nest survival, subsequent honey production and swarming?' This question is not easily answered because much of the basic detail on the direct action of harvesting honey on bees is not known. Much may depend on the timing of the harvesting in relation to the life cycle of the bees' colony, and the method of harvesting, all of which will affect colony survival, recovery and likelihood of subsequent swarming and migration. One could assume the worst – that all honey harvesting is destructive, and contextual factors (weather conditions, pollen supplies etc) might play an equally important role in colony survival and recovery after harvesting. Even if harvesting activities are destructive, the effect of harvesting will depend on the proportion of nests that are harvested. For *A dorsata* where nests on rock faces tend to be clustered,

observational evidence suggest that only a portion of nests can be harvested. This is for reasons of physical access, the time limits on harvesting because of stamina issues of being suspended in the air, and the effect of the response of defensive bees who sting the hunter.

The issue of hunting pressure can also be approached from looking at nest densities and how they vary between sites and considering the extent to which these correlate with the known importance of honey collection activities. The survey of nest densities following a transect method in areas proximate to the research sites found that the Sathyamangalam/ Chamrajnagar areas had the highest number of nests per location but attributed this to the availability of appropriate nesting sites (cliff faces). Indeed Sathyamangalam had the highest levels of hunting pressure, consistent with the livelihood data, but the research concluded overall that the hunting pressure was low. In other words a significant number of nests remained unharvested and it might appear therefore that supply of honey is not necessarily a constraint on the amount that is collected.

A separate estimate of nest densities for four bee taxa (*A. cerana, A. dorsata, A. florea* and *Trigona spp*) undertaken in four of the research sites found higher values of *A dorsata* nest densities than found in the transect survey but attributed this more to the purposive selection of sites in relation to the importance of honey collection in contrast to the random placed transects. However what emerges from both of the studies was that for *A. dorsata* it may be the availability of suitable nesting sites that is more of a critical variable explaining nest density than honey collection practices although this cannot be robustly tested.

Taken together we are forming the opinion that the evidence on bee nest densities and bee activity do not support a picture that honey collection pressures by indigenous people are a key influence on bee populations. We believe that there are too many other variables to be considered. Further research is required on this.

4.6 Capacity building

Keystone Foundation has been working on biodiversity issues for 15 years. What has made the difference in this project is to bring in applied and pure science and the application of rigorous research approaches to biodiversity and livelihood issues and at the same time explore the linkages between human activity and biodiversity.

The professional team which has 6 postgraduates from the field of Ecology, Economics, Botany, Forest Management and GIS benefited from in house workshops which covered research tools, analytical writing and statistical analysis. The team also had opportunities to attend workshops and travel to UK, Australia and within India.

The field teams which had five graduates as research assistants have learnt much about implementing field research and also about managing the data sets. The field teams have also had to deal with local administration to get permits for fieldwork in forests and these interactions have helped them grow as leaders in their areas. The Forest department officials are often in touch with them and requested their help for many of their programmes too.

The team of five field assistants are from the local indigenous communities and have a minimum level of schooling. This team has been integrated into various projects within Keystone and have shown a great capacity for understanding research methods and in implementing many of the activities in the village, whether it was to organise meetings, make social maps, and interact with the children of the village about biodiversity issues.

The staff capacities at Keystone have been scaled up to a level such that well-trained people are now implementing the Conservation programme area within Keystone.

Therefore, the Project has achieved much in terms of increased institutional capacity at Keystone.

4.7 Sustainability and Legacy

The methodologies in Biodiversity & Livelihoods developed over the three year period through trials and experimentation will be used as a monitoring and evaluation tool for the future to understand further the linkages between bees, biodiversity and forest livelihoods.

Some project staff left after 30 May 2009, but this was largely because they had other opportunities to move on to. Field staff and village supervisors remain – they will incorporate new learning and training into the new activities, including an exciting new project funded by Critical Ecosystem Partnership Fund supporting the establishment of the Nilgiris Natural History Society, an advocacy group including indigenous people and a range of researchers working in the area, which builds on the work begun in this Darwin funded project.

The partners will keep in touch and may explore opportunities to work together again in the future.

5 Lessons learned, dissemination and communication

We have learned that Biodiversity views, perspectives and livelihood focus remain an area of non-convergence to some extent in India. Though CBD exists – practically it remains difficult to implement and measure. Often political and state government determines biodiversity research and priorities. Livelihood issues remain a priority – sometimes too generic and general to apply exclusively to biodiversity templates.

Dissemination of our findings has been undertaken with Forest Departments of Karnataka, Kerala & Tamil Nadu; Tribal Advisory Council; Communities at 16 different project sites; stakeholders dealing with honey and Non Timber Forest Produce Business; NGOs and Govt. ministry / departments dealing with livelihoods and biodiversity issues, for example the Ministry of Environment and Forests, Government of India, Delhi & Planning & Development Department, Government of Tamil Nadu, Chennai and the National Biodiversity Authority.

Proceedings of the final Conference (end March 2009) will be circulated widely. The field sites and 5 resource centres would continue to act as dissemination and action-research points for Keystone and the communities with which they will continue to work.

5.1 Darwin identity

Newspaper Articles in Indian local and national (The Hindu) newspapers

The project has achieved good visibility within NBR by the use of the Darwin logo, and other vernacular papers have covered extensively the Darwin Project in the last three years. All reports and papers published and brought out in this project have acknowledged the contribution of the Darwin Initiative. Darwin badges and stickers have been distributed widely – at the resource centres and during workshops. This has been particularly effective at this time when Darwin's bicentenary has been featured much in the media.

Internationally our project has been widely promoted in Bees *for* Development Journal - that is read in 130 countries. This resulted in a number of enquiries concerning the Darwin Initiative.

The International Apimondia Congress in Melbourne 2007 offered a unique opportunity to present this Darwin project to an international audience.

The Darwin Initiative support formed a distinct project with its own, a very clear identity was maintained at all times throughout the project.

We were able to talk about this Darwin Initiative Project through interactions with the Ministry of Environment & Forests (MoEF), Government of India in discussions on better management strategies for Biosphere Reserves.

6 Monitoring and evaluation

No major changes were made in the project design and the original log frame still stands.

The M&E activities of this project should be considered at two levels. First the more routine monitoring against the log frame indicators established in the log frame at output and outcome levels. Second monitoring outside the log frame which, as outlined within the project proposal, would require a more inductive approach, focusing around observations of significant change. M&E issues in relation to capacity building and advocacy were in particular noted in the project proposal.

At the level of the relatively straightforward 'within the log frame deductive' monitoring regular reporting procedures, supervisory visits from the key UK professional staff combined with back to project reports satisfactorily kept track on progress with respect to the key technical indicators in terms of activities and outputs. A monthly reporting system was initiated but a year into the project it was decided that it fulfilled no useful analytical purpose and it was discontinued. At the output level, the indicators suggested in the proposal were useful and applied.

At the purpose level the more physical indicators (e.g. reference collections of indigenous bee species) have also proved unproblematic and useful. It is with the softer issues around capacity and advocacy that measurable progress is less easy to indicate. In part this is because these are difficult aspects to monitor anyhow and there were also institutional capacity issues that made systematic monitoring of these dimensions challenging. These included for example, supervisory capacities and base line skills within the field teams. For example although the use of regular field diaries and observations were strongly encouraged these never really embedded themselves in the institutional culture because the demand for learning from the field was not systematic. In this particular case this was addressed by holding regular debriefing sessions of field staff teams during mentoring visits. Exercises held during the internal mid term review which involved analytical exercises drawing on field experience showed the depth of knowledge held by the field staff which more formal procedures and regular routines were failing to capture.

Indeed the decision to hold a robust internal mid-term review was seen to be a critical part of the monitoring approach of the project and it revealed, as discussed in the review report,[4] some major areas for attention within the project. These included problematic issues associated with both the technical side of the project – for example the procedures associated with *A. dorsata* nest density population estimates as well as gaps in the social science understanding which led to the identification of the need to develop more in depth household histories.

[4] Available at http://www.uea.ac.uk/dev/BeesBiodiversityLivelihoods/documents

6.1 Actions taken in response to annual report reviews

Annual report 1 requested that we address the following areas:

1. an elaboration on how the research methods are actually being conducted would be helpful e.g. what does `observation research' entail?
2. an elaboration on the new staff hired and on why the actual amount that was spent was greater than budgeted for the equipment purchased for the 5 field centres.
3. In general, more quantitative information would be useful to provide an insight into the scale of some of the achievements/activities e.g. duration of specific trainings, actual estimates of number of people from indigenous communities involved in meetings at research sites, estimates of number of people visiting the bee museum in Ooty.
4. Although only in the first year of the project some indication of interim findings with regards to scientific and livelihood knowledge would be helpful.

Detail on research methods was appended in Annex 3 of the 2007-2008 annual report. We also provided a detailed list of the new staff hired. The over-spend was a result of the LCD TV which was purchased for IBBRU so that visitors could, apart from the photos and exhibits, see films related to honey hunting and the NBR and also benefit from presentations made through this media.

We provided more quantitative information in the mid-term review report (which we appended to the Annual Report for 2007-2008) and in Annex 4 of the 2007-2008 report.

We presented emerging findings in the 2007-2008 report. At that point we observed that for the livelihood studies.

- There appear to be major differences between locations in terms of the significance of honey collection in the livelihoods of people living in these locations;
- Certain factors, possibly linked, appear to contribute to a significant role of honey collection (and NTFPs) in the livelihoods of forest users including relative remoteness, maintenance of cultural practices and relative lack of market penetration;
- Conversely certain factors appear to be associated with a relatively insignificant role of honey collection in forest user livelihoods including significance of non-forest income sources, availability of public goods and the nature of the settlement

For the entomology we reported at that point that findings were slow to emerge because of the lack of a qualified entomologist on the project for a number of months. However, the pan trapping had gone well and that material had been sorted and stored pending, at that point, identification.

For botany, pollen slides had been produced and plant specimens of bee foraged plants placed in the herbarium.

Annual report 2 asked for the following action:

1. Any additional publications that may be missing from the report should be submitted in the next Half Yearly report (the leaflet shared at the Apimondia congress in Melbourne for example).

2. On the social science side more evidence would be welcome that research participants (particularly the indigenous groups) are aware of the project purpose, how local people feel about it and the methodology for and nature of their involvement.
3. on the biological research side, it appears that a lot of work has to be done on catching up and on the rigour particularly of the entomology. For the research findings to be taken seriously by policy makers and academic it must have a high level of rigour. More evidence and analysis of this rigour is expected over the following year.

Mention was also made of the need to sustain efforts to build conducive relationships with the Forestry Departments as well as find out why local people may be reluctant to take part in research (in Bedaguli).

We provided additional material on the publications requested with the half-yearly report (2008).

As regards research participant engagement and understanding of the research, we have been fortunate that five of the staff employed over the duration of the project were local people:

Mahadesha B	Indigenous person / Soliga	Research Assistant	Chamrajnagar Location Field Research
P. Chandran	Indigenous person / Kurumba	Field Assistant	Pudukadu & Marikode (Coonoor) Site Field Research
Vellian	Indigenous person / Irula	Field Assistant	Situguni (Coonoor) Site Field Research
Murugan	Indigenous person / Irula	Field Assistant	Chamrajnagar Site Field Research
Arhadkuttan	Indigenous person / Toda	Field Assistant	Kotagiri Site Field Research

Other local people have been employed for shorter periods of time as field assistants, for example. These people have provided invaluable support in spreading information on the project and engaging with local people in the villages in which they live and work about the purpose of the project, and the wider agenda of Keystone Foundation. The breadth of their understanding was demonstrated when they took part in the preparation and presentation of posters for the final conference Keystone hosts an annual day of presentations, song and dance at their Centre each year. The last two occasions have afforded the opportunity for research findings to be shared. We know that paying attention to people's stories, particularly their life stories, has been valued (as demonstrating that we have thought people's knowledge and experience is worth recording).

We assume that the reviewer's concern about local people's engagement was raised because of the reference to people's reluctance to participate in Bedaguli. That experience was a good lesson for us. The problem lay in the approach of the field assistant to the livelihoods research. He was a person much more comfortable collecting biological samples than in talking to people. While he managed to collect some useful information on people's livelihoods the art of keeping people interested in the topic and sustaining conversations on different topics was difficult and in retrospect he required much more consistent support right from the beginning of the field research, which staff in Keystone did not have the time or skills to give. Collecting qualitative data is not as simple as it appeared to some of our biological science colleagues. It was important for us to recognise that undertaking such data collection is

not `common sense'. Some people have a gift for participatory and ethnographic research others do not. Once we had recognised this we were able to provide additional support and also ensure that people were deployed in their areas of strength.

As for point 3, we hope that the research outputs we have attached provide evidence of the attention to rigour. This was an area we discussed throughout the course of the project, at great length during the annual reviews, and was a key area for mentoring and training. However, this lack of staff with sufficient experience of research and data analysis was ultimately a significant problem for a project that contained a large element of field research requiring meticulous analysis. Towards the end of the project an ecologist with appropriate skills was appointed full time by Keystone, unfortunately she remained in post only for three months.

7 Finance and administration

7.1 Project expenditure

Final Project Expenditure

Item		
A REMUNERATION [Staff costs]	**BUDGET**	**SPENT**
UK staff		
A1 Team leader/livelihoods and poverty J SEELEY		
A2 Apidology adviser N BRADBEAR		
A3 Biodiversity management and MandE A PAIN		
A4 Development organisations adviser P BURGON		
A5 Pollination and biodiversity adviser S POTTS		
A6 Expert entomologist and pollination S ROBERTS		
Local staff		
A7 Entomologist (Advisor)		
A8 Ecologist Sumin George		
A9 Information officer Kunal SHARMA		
A10 Sociologist Snehlata NATH		
A11 Market researcher T SAMRAJ		
A12 Botanist Shiny REHEL		
A13 Field assistants		
A14 Legal adviser BJ KRISHNAN		
A15 Local coordinator/accounts P ROY/MJOHN		
A16 GIS expert S PRASAD		
TOTAL [A] Remuneration		
B REIMBURSABLE COSTS		
Rents, rates, heating, cleaning, overheads		
Office costs eg postage, telephone,stationery		
Travel and subsistence		
Printing		
Conferences and seminars		
Capital items		
Other costs		

TOTAL [B] Sum of reimbursable subtotals
GRAND TOTAL [A+B]

2008-2009: We requested a virement of funds between budget headings in the last quarter. From the travel budget we asked to vire £3000 to cover additional UK staff time and from the capital items budget vire £1667 to cover additional UK staff time.

UK team members had already given significant inputs `for free' and there was a limit to how much we can expect this for substantive inputs into on-going work.

The fall in the rate of the pound had also severely limited any opportunity to draw on funding set aside for Indian team members and caused some considerable variation in the GBP amounts paid to Keystone personnel across the life of the project.

2009-2010: We requested a virement of funds between budget headings in the last quarter of the project (first quarter 2009/2010). From the travel budget we asked to vire £3000 to cover additional UK staff time and costs of printing and dissemination of the March conference proceedings

At the time of the application, the number of days for this financial year was under estimated and we had a large amount of data to work with during the final few months as we prepared the final report and publications. We decided to devote our time to analysis and writing in UK (by the UK team) and in India (by the India team) rather than waste money on travel. Email and SKYPE kept us in contact. The project has overall been much more demanding of UK staff time than we had anticipated.

7.2 Additional funds or in-kind contributions secured

Additional funds were secured for setting up the functional capacity for IBBRU – the Bee Museum 10,084.45 GBP (this was received from Green Hotel, Mysore). Additional inputs to resource centres, staff capacity building etc provided through Ford Foundation USA, Both Ends (the Netherlands), India Environment Trust UK, NTFP-EP, Philippines and IDRC Canada -- total £137,834

7.3 Value of DI funding

The DI funding has led to a number of outcomes that would not have been possible without the funding, among them:

- Keystone Foundation staff, existing and those recruited for this project, have built skills in entomology, livelihoods analysis and biodiversity research that the organisation did not have before.
- Awareness of CBD principles has been heightened in Keystone Foundation and has led to interactions with government officials and other policy makers (including the National Biodiversity Authority) regarding biodiversity.
- Bees *for* Development and Keystone Foundation have benefitted from the research outputs which they can use in their future work on bees and biodiversity in India.
- CAER, Reading, have been able to build experience and valuable contacts through this project which they are feeding directly into research with other university based-groups in Southern India.
- We were able to host an international conference which brought basic and social scientists together with local campaigners and indigenous people to share our

findings. The event was unusual for the mix of people that attended and was extremely productive.

- The establishment of the Bee Museum and resource centre in Ooty is a lasting legacy of the DI funding which will continue to grow in the future.

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

Project summary	Measurable indicators	Progress and achievements	Important assumptions
Goal To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but poor in resources to achieve: • The conservation of biological diversity, • The sustainable use of its components, and • The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources		The Project has taken steps towards understanding of the role and utilisation of bee resources by human communities in NBR. This is an important stage towards gauging whether they are being used sustainably.	
Purpose The interdependencies between indigenous bees, biodiversity and forest livelihoods in the Nilgiri Biosphere Reserve (NBR), Western Ghats, India elucidated, and the capacity of local researchers, indigenous people and government staff strengthened.	A reference collection of relevant indigenous bee species established. A reference collection of pollen slides established. Analysis of links between bees, biodiversity and forest livelihoods by Yr 3. *Indigenous Bee and Biodiversity Resource Unit* established. 5 Field Centres, State Forest Depts and Tribal Advisory Council (TAC) strengthened by Yr 3. Partners trained in research methods, information systems, livelihoods analysis, local governance and mountain biodiversity by Yr 3 Participatory capacity assessment.	The following exist: Pollen slide reference collection Bee reference collection Project technical reports Resource Unit established, and annual progress reports Training reports Event proceedings, publications, media reports and policy documents	Existing legislation remains favourable. That market forces do not undermine informal systems of regulation of resource extraction. Findings indicate that the current use and livelihood benefits are sustainable. Exotic bee species and/or

			associated pathogens are not introduced. Collaboration and co-operation with 3 State Forest Depts sustained. Other current natural conditions prevail. Project budget estimates hold true.
Outputs			
A. Increased scientific and livelihood knowledge through research			
Characterisation and science of livelihood-relevant, indigenous bee species - their taxonomy, genetics, population, habitat, and distribution (of selected species) - studied and documented. Data collected on habitat and melliferous flora, mapping. Pollination studies in both natural forest and crops. Livelihood studies undertaken with indigenous people, and market and trade studies on bee products.	Experimental protocol designed for collection and analysis of specimens and data at the 5 research sites. A reference collection of selected indigenous bee species established. Data (morphometric and genetic) to assist correct classification of indigenous *Apis* bee species, (or placement within genera). An interactive key for identification of *Apis* bee species (using LUCID software), and for other relevant bee genera as far as possible. Data and analysis of bee diversity and abundance: population data for *Apis dorsata.* A catalogue and database of melliferous flora at 5 sites created (using GIS). Data on pollination requirement of some local crops and non-timber forest products. Traits analysis completed to compare data for key species collected at five sites. The role of bees in local livelihoods analysed. Market assessment by Yr 3.	The following have been achieved: Permanent *Apis* and other bee reference collection established. Permanent pollen slide library established. Research and survey data, genetic data and reports. GIS maps, electronic database, and reports. Published documents Still in preparation: (by CAER Reading): Interactive key for bee identification established (to species level for at least *Apis*).	That project partners remain committed to research and capacity building, and have appropriate expertise. That realistic market data is accessible.
B. Strengthened capacities of key institutions			
Indigenous Bee and Biodiversity Resource Unit established as a Regional Resource	New staff and facilities provided to create the *Indigenous Bee and Biodiversity Resource Unit* within existing campus of Keystone in NBR,	All these outputs have been achieved	That the local partner

Centre for mountain communities of Western and Eastern Ghats and capacity of existing Field Centres, State Forest Depts and Tribal Advisory Council enhanced	and at 5 field centres. Forest Dept personnel trained by Yr 3. Tribal Advisory Council trained in institutional development and local governance by end Yr 3		organisation has commitment and capacity to develop the new Unit and associated centres. That State Forest Depts remain supportive to the Project
C. Enhanced technical and professional skills in host country through training			
Training on bee science, mountain biodiversity with respect to CBD, and information systems undertaken in UK. UK technical input concerning entomological research design, methodology, livelihoods analysis and local governance provided in India.	4 people trained on bee science for a total three weeks in UK by end of Year 2 4 people (3 senior staff from State Forest Department and 1 legal CBD advisor) trained for 2 weeks in UK by end Year 2 2 persons trained at Bees *for* Development for a total three weeks each in UK by end of Year 2 5 people trained for 4 weeks on livelihoods analysis and local governance by UK expert by end of Year 1 Supervision of research by local staff designed, implemented and analysed at five distinct ecological sites by end Year 2.	These activities were changed during the course of the Project, with more training provided in-country. UK training for forestry staff took place. 2 persons were trained for three weeks at Bees *for* Development in Year 2. Livelihoods analysis training was provided	That people remain in post following training in UK.
D. Increased awareness and policy engagement in India and UK through dissemination and advocacy			
Stakeholder workshops held in NBR. Darwin Initiative Project aims and achievements explained and promoted through various forms of media in UK and India Policy recommendations concerning the *bees - biodiversity - livelihoods* linkages developed. International conferences attended. International workshop on *Darwin Initiative Project on Indigenous Bees, Biodiversity and Livelihoods*, held in India in year 3.	Each year, 50 participants from NBR informed about the Project and its progress. Web pages for partner organisations, media reports in UK and India. Policy document prepared and peer reviewed at end of Yr 3. International environmental and development community gain appreciation of links between bees, biodiversity and livelihoods.	3 Seminar reports and documented feedback. Number of web site hits, number of media events and documented feedback. Policy documents. Back to office reports Conference proceedings. Workshop documents and Proceedings	<u>That there remains commitment to pro-poor biodiversity policies in India and UK.</u> Media reports etc. reach and effectively influence target

			audiences. Stakeholders participate fully in workshops and dissemination events.

Annex 2 Project's final logframe, including criteria and indicators

See above (no change)

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	30	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	20	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	10	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	10	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.

Article No./Title	Project %	Article Description
15. Access to Genetic Resources		Whilst governments control access to their genetic resources they should also facilitate access of environmentally sound uses on mutually agreed terms; scientific research based on a country's genetic resources should ensure sharing in a fair and equitable way of results and benefits.
16. Access to and Transfer of Technology		Countries shall ensure access to technologies relevant to conservation and sustainable use of biodiversity under fair and most favourable terms to the source countries (subject to patents and intellectual property rights) and ensure the private sector facilitates such assess and joint development of technologies.
17. Exchange of Information		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	30	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		
1a	Number of people to submit PhD thesis	0
1b	Number of PhD qualifications obtained	0
2	Number of Masters qualifications obtained	2 (one of these will be completed in September 2009)
3	Number of other qualifications obtained	0
4a	Number of undergraduate students receiving training	0
4b	Number of training weeks provided to undergraduate students	0
4c	Number of postgraduate students receiving training (not 1-3 above)	5
4d	Number of training weeks for postgraduate students	Approx 20
5	Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification(ie not categories 1-4 above)	20
6a	Number of people receiving other forms of short-term education/training (ie not categories 1-5 above)	100 (local communities/other stakeholders)
6b	Number of training weeks not leading to formal qualification	Approx 20
7	Number of types of training materials produced for use by host country(s)	2 plus many informal presentations/handouts
Research Measures		
8	Number of weeks spent by UK project staff on project work in host country(s)	24
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (s)	0
10	Number of formal documents produced to assist work related to species identification, classification and recording.	2
11a	Number of papers published or accepted for publication in peer reviewed journals	3
11b	Number of papers published or accepted for publication elsewhere	8

Code	Description	Totals (plus additional detail as required)
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	2
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country	0
13a	Number of species reference collections established and handed over to host country(s)	1
13b	Number of species reference collections enhanced and handed over to host country(s)	0
Dissemination Measures		
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	1
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.	2
15a	Number of national press releases or publicity articles in host country(s)	2
15b	Number of local press releases or publicity articles in host country(s)	2
15c	Number of national press releases or publicity articles in UK	2
15d	Number of local press releases or publicity articles in UK	0
16a	Number of issues of newsletters produced in the host country(s)	0
16b	Estimated circulation of each newsletter in the host country(s)	0
16c	Estimated circulation of each newsletter in the UK	0
17a	Number of dissemination networks established	2
17b	Number of dissemination networks enhanced or extended	2
18a	Number of national TV programmes/features in host country(s)	0
18b	Number of national TV programme/features in the UK	0
18c	Number of local TV programme/features in host country	0
18d	Number of local TV programme features in the	Keystone reached the final of a BBC World Challenge programme

Code	Description	Totals (plus additional detail as required)
	UK	featuring their work with honey hunters. A television programme was produced by the BBC for this. The programme was not directly on this project but it certainly generated considerable interest in Keystone's work both nationally and internationally.
19a	Number of national radio interviews/features in host country(s)	0
19b	Number of national radio interviews/features in the UK	0
19c	Number of local radio interviews/features in host country (s)	0
19d	Number of local radio interviews/features in the UK	0
Physical Measures		
20	Estimated value (£s) of physical assets handed over to host country(s)	£4258.60
21	Number of permanent educational/training/research facilities or organisation established	5
22	Number of permanent field plots established	16
23	Value of additional resources raised for project	Additional inputs to resource centres, staff capacity building etc provided through Ford Foundation USA, Both Ends (the Netherlands), India Environment Trust UK, NTFP-EP, Philippines and IDRC Canada total £137,834
Other Measures used by the project and not currently including in DI standard measures		

Annex 5 Publications

Provide full details of all publications and material that can be publicly accessed, eg title, name of publisher, contact details, cost. Mark (*) all publications and other material that you have included with this report

Type * **(eg journals, manual, CDs)**	**Detail** **(title, author, year)**	**Publishers** **(name, city)**	**Available from** **(eg contact address, website)**	**Cost** **£**
Journal	Pages 9-12, Bees *for* Development Journal 85, December 2007	Bees *for* Development, Monmouth	PO Box 105, Monmouth, NP25 4AB www.beesfordevelopment.org	£5
Poster	A3 poster concerning the project, 2007	As above	As above	£5
Journal	Pages 4-13, Bees *for* Development Journal 87, June 2008	As above	As above	£5
* Paper, in press	Social bees and food plant associations in the Nilgiri Biosphere Reserve, India SUMIN G. THOMAS, SHINY M. REHEL, ANITA VARGHESE, PRIYA DAVIDAR, SIMON G. POTTS	Tropical Ecology		
Paper, in press	Correlates of nest densities of the rock bee (*Apis dorsata*) in the Nilgiri Biosphere Reserve, India Pratim Roy, Robert Leo, Anita Varghese, Sumin George Thomas, Kunal	Current Science 2008		

	Sharma, Senthil Prasad, Nicola Bradbear, Stuart Roberts, Simon G. Potts, Priya Davidar			
* Paper accepted April 09	Characteristics of trees used as nest sites by the rock honey bee Apis dorsata in the Nilgiri Biosphere Reserve, India Thomas, Sumin; Bradbear, Nicola; Potts, Simon; Davidar, Priya	Journal of Tropical Ecology		
* Paper – in press 2009	Dependency of cultivated plants and non timber forest products on pollinators in the Nilgiri Biosphere Reserve Rehel et al			
* Book (sample pages)	Biodiversity and Livelihoods – conference proceedings	Write-Arm, Bangalore, India		
*MRes Dissertation	Exploring the contribution of NTFPs to livelihoods: the case of the Nilgiri Biosphere Reserve , India. Rajib Biswal		School of International Development, University of East Anglia or the author.	

Annex 6 Darwin Contacts

To assist us with future evaluation work and feedback on your report, please provide details for the main project contacts below. Please add new sections to the table if you are able to provide contact information for more people than there are sections below.

Ref No	
Project Title	**Bees, biodiversity and forest livelihoods in the Nilgiri Biosphere Reserve**
UK Leader Details	
Name	Dr Janet Seeley
Role within Darwin Project	Livelihoods/social science adviser
Address	School of International Development, University of East Anglia, Norwich NR4 7TJ
Phone	
Fax	
Email	
Other UK Contact (if relevant)	
Name	Dr Nicola Bradbear
Role within Darwin Project	Apidology adviser
Address	Bees *for* Development, PO Box 105, Monmouth NP25 4AB
Phone	
Fax	
Email	
Partner 1	
Name	Pratim Roy
Organisation	Keystone Foundation
Role within Darwin Project	Host institution project leader
Address	Keystone Centre, PB 35, Groves Hill Road, Kotagiri 643 217, Tamil Nadu, India
Fax	
Email	
Partner 2 (if relevant)	
Name	Professor Adam Pain
Organisation	Overseas Development Group/School of International Development

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Annex 7 Additional findings (material being developed for publications)

Livelihoods.

Introduction

This research project on Bees, Biodiversity and Forest Livelihoods (BBL) has set out to build understanding of the inter-relations between bees, biodiversity and honey collection practices by indigenous people in the Nilgiri Biosphere Reserve (NBR). This section summarises what has been learnt about the indigenous people and the role and importance of honey collection practices in particular and non-timber forest products collection (NTFP) collection practices in general in their lives. Previous studies (Keystone Foundation, 2007) have indicated that bees and non-timber forest products (NTFPs) are a resource for indigenous people of the NBR and has talked of these as 'forest dependent' communities. However the significance, both social and material, and role and contribution of these as resources to the people's livelihoods has been far from clear and the concepts of both 'forest dependency' (Byron & Arnold, 1999) and 'community' (Agrawal & Gibson, 1999) need to be subject to critical scrutiny.

This research project is fundamentally about the relations between poor people and natural resource management. It has aimed specifically to build understanding of the significance of biodiversity to the diversified livelihood activities of poor people and the potential effects of indigenous people's activities on the conservation of natural ecosystems. In this sense it is of direct relevance to the broader policy agenda of linking poverty alleviation with biodiversity conservation. It should be also noted that the long term or chronic poor tend to live in the relatively remote areas and for India the greatest levels of recorded poverty are to be found amongst people living in forest areas. As Mehta & Shah (2003: p499, 501) have noted 84% of India's ethnic minorities (designated 'tribal' in the Indian administrative lexicon) live in forest areas.

For some (Sunderlin et al, 2005: p1384-5) the shared and overlapping space of forest areas and chronic poverty can be more attributed to 'islands of comparative stability that are relatively untouched', a history of forest dependence that predates modernity and 'not necessarily an outcome of contact with modern economies' and forests as a place of refuge. The environmental history of the Nilgiris in particular (Cederlöf, 2008) does not support such an interpretation and an account and understanding of poverty in the Nilgiris has to acknowledge the effects of the rule of the colonial and independent Indian state and particularly its forest bureaucracy, the dynamics of capitalism and the combination of these to creating of deep long term structural inequalities that have marginalised the ethnic minorities of the Nilgiris. In this sense the poverty of the social groups in the Nilgiris needs to be seen as an outcome of historical processes and fundamental power inequalities (Mosse, 2007) and not simply a coincidence of location. Further these is a need to be alert to the fact that a marginalisation of these people within forest areas may have locked them into a poverty trap – in this sense 'forest dependence' may be poverty creating and reinforcing rather than an opportunity for poverty reduction.

Much of the policy and programmatic response to the poverty of these indigenous people has focussed more on the symptoms of their poverty – the lack of education or health services – rather than focus on the underlying causes that have contributed to their poverty and marginalisation in the first place. While the origins of the marginalisation of indigenous groups are to be found in deeper history, and part of that is British colonial history and its settler culture in the Nilgiris, closely related to that has been Forest policy and the effect that

Forest policy has had in reducing indigenous people's endowments (rights) and entitlements (benefits) from forest resources. In the light of this the recent 2006 Act on Recognition of Forest Rights (The Scheduled Tribes and Other Traditional Forest Dwellers Act 2006) represents an attempt to redress one structural dimension of the marginalisation of forest indigenous groups and their loss of endowments and rights through previous Forest Acts. What is far from clear though is how (or even if) and to what extent this Act will actually be implemented in practice. Thus the way the State behaves in practice – whether through the Laws of central government or the behaviour of State Forestry Departments has a critical bearing on the context in which indigenous people lead their lives and the ways in which they utilise forest resources.

Central to much of the debate about the linkages between poverty, forest conservation and biodiversity maintenance has been the enduring hope that both poverty reduction and conservation objectives can be met at the same time. However the achievement of this goal has proved elusive. In part this has been because many of the studies and interventions that have sought to investigate and realise this goal have been handicapped by severe limitations of method and approach. As Agrawal and Redford (2006) have argued, much of the literature on programmatic interventions e.g. policy responses designed to jointly address poverty alleviation and biodiversity conservation have worked with very limited and simplified understanding of poverty and biodiversity. These assessments have been determined more by what can be measured rather than attempting to investigate the complexity of these dimensions as evidenced by the theoretical literature. Thus poverty has tended to be defined and measured simply in terms of its material dimensions while a focus on income and biodiversity has been characterised in terms of species diversity, often reflected in the presence or absence of indicator species or groups (Agrawal and Redford, op.cit: 29). In addition, these studies have generally paid little attention to history and context and accordingly have offered little scope for generalisation beyond the empirical case study.

As Agrawal and Redford (op.cit: p33) note:

"What is even more troubling is that if the most widespread and frequently used analytical approaches to understand and document the relationship between poverty alleviation and biodiversity conservation continue to be used, it may not be possible to throw greater light on this relationship. Case study approaches based on evidence that is collected from a single time period and without careful and systematic consideration of the causal mechanisms at play are ill suited to generate policy relevant insights into the tradeoffs between poverty alleviation and biodiversity conservation."

There has been a particular hope that NTFPs offer particular potential for improving the circumstances of people who use forest resources. But as Belcher & Schrekenberg argue (2007) it is far from clear that NTFP commercialisation is a simple answer to either achieving biodiversity conservation or supporting poverty reduction. Many of the characteristics of NTFPs – their dispersed and seasonal nature for example – may lend themselves highly suitable for subsistence and consumption purposes but severely limit the extent to which they can be commercialised (Belcher et al, 2005; Belcher & Scherckenberg, 2007). In sum the examples of successful NTFP market system as support for livelihoods are few and far between.

This research has aimed to build understanding of the livelihoods of these tribal people but caution is needed in thinking through how such understanding is built. There is much about the standardised sustainable livelihoods framework (SLF) and the way in which it has been applied that is entirely consistent with a neo-classical model of utility maximisation by households and assumes a pervasiveness and persistence of liberalised market relations. The idea that poor households having livelihood strategies carries with it assumptions that they have awareness, choice and freedom of movement, that is very far from the reality in

which most poor rural household lead their lives (Johnson & Start, 2004). Many of the rural poor live in contexts in which assets are far from fully commoditised and where access to assets depends not on 'free' market relations but much more on dependent social relations. As Whitehead (2002) has noted the whole livelihood framework in its neo classical language and its assumptions of market exchange strips context and relations out of people's lives. It is precisely these dimensions that provide the means by which people handle risk and maintain access to resources and institutions (de Haan & Zoomers, 2005). For many of the poor it is the maintenance of dependent patron-client relations that provide the means to their survival (Wood, 2003) in a context where the state fails to provide that security or may be the key source of risk.

Second, and linked to this, much of the discussion on poor people, particularly within biodiversity management has tended to treat collections of people as communities (and in the context of the NBR labelled them as 'tribals' or 'adivasis') with assumptions of them being socially undifferentiated and unchanging – the language of 'forest dependent communities' exemplifies this. Comparative field evidence and theory (Agarwal and Gibson, 1999 and as will be seen in the empirical evidence from this research) points to as much social and economic differentiation within many of these groups of people as between them and others and how they have both shared and conflicting interests according to social and economic status. Further, the language and perspectives towards these indigenous groups has tended to see them as either victims or innocents in the face of wider processes of change and ignores their individual capacities to work against domination, challenge or subvert the processes that act on them to find room to manoeuvre. Thus despite the apparent strictness of Forest rules as to what may or may not be done with forest resources, everyday practices, and the studies on the honey market evidence this, indicate many ways around the formal rules. Thus attention to what people do and how they behave, either within, outside or against the rules of the game is essential.

This brings us to the critical issues of risk and vulnerability. Vulnerability and risk within the standard livelihoods frameworks[1] are largely seen as external factors. In part this is a result of the idea of risk being drawn from the natural resources literature and risks or threats being seen mainly in relation to the occurrence of natural resources disasters – of which the 2005 tsunami in South East Asia is a classic example – and therefore random events (to which some element of probability assessment can or cannot be attached) and external to households. Two issues should be stressed here.

First, it is often the poor who are susceptible to risk from threats associated with natural resource disasters because they tend to live in the most risk prone areas – in areas that can be flooded for example[2]. Second, natural resource disasters (floods, frosts, droughts etc) are not the only sources of risks and for many of the poor a key source of risk and uncertainty is actually caused by markets (commodity and labour) in which they are relatively powerless actors. However in drawing its intellectual origins from the natural resources literature, the idea of vulnerability within the SLF ignores the important factor of human agency or action by others as a significant threat to many. For the poor, risk is a daily feature of life. It is not only just to do with income but also with access to assets (including health) and the ability to deploy what capabilities they have. Uncertainty in the ability of the State to deliver services of health, education and protection is a key risk for many. There is also widespread evidence (see Ellis and Freeman, 2004 for example) that deliberate action by the government and local authorities can be as much a source of risk. As Geoff Wood has put it (2003):

> " *the determining condition for poor people is uncertainty. Some societies perform better than others in mitigating this uncertainty. Elsewhere, destructive uncertainty is*

[1] Department for International Development, 1999 . See www.eldis.org/vfile/upload/1/document/0901/section2.pdf , accessed 01/03/2009.

[2] And the riskiness of collecting NTFPs in the NBR should not be underestimated, specifically for wild honey collection and the danger of being killed by elephants.

pervasive. Under these conditions the poor have less control over relationships and events around them. They are obliged to live more in the present and discount the future. Risk management in the present involves loyalty to institutions and organisations that presently work and deliver livelihoods, whatever the longer term cost. Strategic preparation for the future, in terms of personal investment and securing rights backed up by its correlative duties, is continuously postponed for survival and security in the present."

What Wood is emphasising, and this echoes the point made by Whitehead, is that many of the poor are locked in dependent social relations in order to survive in the present. At the heart of these are unequal power relations and, as many have observed, the SLF is particularly weak in addressing issues of power structure.

There are other areas in the SLF that have brought critical comment including the notion of sustainability and the difficulties and value judgements over its assessment and determination. While sustainability may indeed be a desirable objective, the reality is that for many of the poor they lead lives in which "choices" can only be made for the short term and in many ways these are not choices at all. Such choices may well undermine longer-term welfare. In that sense there is no choice and what characterises their life is livelihood insecurity and emphasis in the SLF on emphasising the opportunities and strengths may lead to an underestimation of the constraints and difficulties under which many of the poor lead their daily lives.

The emphasis on history and time needs to be stressed in building understanding of the livelihoods of indigenous groups. Much of the livelihoods research has classically been cross sectional, based on random or stratified sampling, collecting metric data at one particular point in time and through quantitative and statistical manipulations attempting to infer causalities on what are often more arguably correlations around what can be measured. Such methods, based on large or small scale sample surveys have a role but they are also deeply limited and tell us little about the processes of change and differences between households. For these reasons Murray (2002) has argued strongly for the need for livelihoods research to include a retrospective approach – seeking to reconstruct change over time to be complemented with dispersed but intensive research methods of micro-level field investigation. This research has partly responded to this through investigations of household histories which are reported on later in the conference.

Indeed research on chronic poverty – that is poverty which persists over time and across generations (arguably the condition of many of the indigenous groups in the NBR) - has been built out of the quantitative analysis of household panel data which has followed individual and household economic dynamics over time. This has been linked systematically to qualitative data trying to identify the proximate causes or drivers of rising household prosperity or decline through detailed household recollection of sequenced actions and events that have induced change. As da Corta (2009) notes such studies have provided detailed understanding of the character of poverty or its experience but have provided little understanding on the constraints of poor people's agency in constructing strategies, how poverty and vulnerability has been created in the first place or of the deeper processes of poverty creation based on unequal social relations generated through economic, social and political structures. In short there is a need to complement understanding of livelihood trajectories with the understanding of the dynamics of social structure and relations and concepts such as class. But it also requires, as with ecological research, attention to multiple levels. Not only is there a need for both quantitative and qualitative analysis of livelihood change through panel studies but these have to be linked to broader changes in social relations and institutional setting along with their transformation in relation to broader policy and economic trends. Nothing less will do.

This scope of research method and analysis has been beyond the resources of this project and the absence of household panel data, an acute gap in general in the literature of

indigenous people and forests, has been partly addressed through the reconstruction of household histories. Equally the attempt to link individual and household changes to broader changes in context – the dynamics of changes in social structures, economic relations and institutional context and how they affect household activities and choices – has been challenging. In part this will be built out of an environmental entitlements analysis (Leach et al, 1999) which will explore changing endowments (rights and resource of indigenous people) and entitlements (the range of benefits derived from environmental good and services) and how these have varied over time and by location. The analysis of the workings of the honey market in part contributes to this investigation as well as an exploration of the changing institutional context, specifically that of Forest Policy and its effects on legal endowments and entitlements of indigenous people.

Methods

Four different methods were used for the collection of data on forest livelihoods: mapping of settlements, general interviews using a checklist, indepth interviews to gather household histories and a honey market study. A research assistant and a field assistant familiar with the research area collected the information. All but one of the 10 research staff were men and six of these men were members of indigenous communities.

In each site a map of each settlement was drawn showing the dwellings and main physical features. The dwellings were numbered and these numbers used for systematic data collection from each place. Using a checklist the research team then collected information on specific topics through discussions with household members (a formal questionnaire was not used). Data was collected on : the history of the area, of both the people and biodiversity; the social structure in the area and the demographic composition of the individual household , socio-economic status of settlement and individual households; occupation or other things people do to make a living; people's relationship with the forests (including dependence, wildlife/NTFP); landuse/animal husbandry; culture and religion (particularly as it relates to natural resources; forest or other Government policy which might influence people's lives; interaction with institutions, such as government and non-government organisations; general infrastructure and natural resource distribution (geography of the area); overall well-being (health and sickness) in the household; risks and uncertainties that people face. This information was tabulated in a matrix for each site. Households for in depth study, to collect the household histories, were purposively chosen to represent people heavily engaged in honey hunting and NTFP collection and those who were not. The intention was to build up detailed portraits of households. The life histories of the adults (usually a man and a woman, where available) in the households were documented and day to day activities in the households were described. In addition an attempt was made to record significant events during the period of study, including any engagement household members may have with people in authority (including the Forest Department). Sixty nine life histories were collected from the five different locations.

In addition, a honey marketing study was undertaken to find out how much honey was being exchanged informally and commercially in each settlement and who was involved in these transactions.

All data was coded manually by theme for analysis.

Findings

<u>Institutional Context</u>

This is not the place for a review of the long history of forest policy and legislation in India since the first Forest Act of 1865 under the British Colonial India and their continuity into Indian independence which is well covered in the literature[3]. The effects of forest policy and legislation on the removal of historic rights (endowments) and legal entitlements to the use of forest resources have also been well documented. It is also clear that the capacity of the state to enforce legislation has been variable and there has been a long history of contention between forest users and Forest Departments with many indigenous users managing through patterns of resistance and subterfuge to maintain *de facto* entitlements. The shift in thinking which downgraded the historical production emphasis of national forest policy and prioritized ecological protection and the meeting of the needs of the local forest population led to the 1988 National Forest Policy although significantly this policy remained as policy and was not buttressed with legislative support. Nevertheless a more general shifting towards more participatory processes in forest management driven both by international shifts in forest policy objectives as well as activism within India has contributed to the emergence of more participatory forms of management of forest resources although the degree to which State Forest Departments have moved beyond the sharing of management rights over forests and devolved effective authority is highly variable.

For the purposes of this project the recent Forest Rights Act (The Scheduled Tribes and Traditional Forest Dwellers [Recognition of Forest Rights], Act, 2006) is of particular significance given its attempt to resolve the historical injustice whereby the local rights of indigenous forest inhabitants and their use of forest resources were systematically reduced and removed through the assertion of state control. The Act's recognition of rights of traditional forest dwellers to make claims on forest land held before December 13th 2005, to access and use non-timber forest products (NTFPs) and grazing land within the forests and to also manage and conserve forest resources is a significant step forward in restoring the authority of indigenous people of the management and use of their resources. While there is much to commend about the principle of the Act, there are also deep concerns with respect to the modalities of its implementation and the extent to which it will be possible to restore those rights, and the consequences of this, given both differences in policy and attitudes of State Forest Departments and underlying structural social inequalities between indigenous people and others[4].

Springate-Baginski et al (2007) make clear in their discussion on the implementation of Joint Forest Management (JFM), that the state control of forests and the rise of the powerful Forest Department institution and its culture has been far from universal or omnipotent - in parts of India local resistance and forms of informal management of forests have persisted despite formal policy. Their case studies on the nature of implementation of JFM show that is has been diverse and context specific and it is difficult to talk generically of JFM practice. In part this arises, as Mosse (2004) has argued, from the way in which policy gets interpreted in practice – it is highly variable and depends on the local constellations of power and interests and how policy and law are actually interpreted.

What this indicates is a need to systematically analyze how forest policy is actually interpreted in practice both by State Forest Department and by District Forest officials, including staff on the ground. This would include a systematic analysis of the State Forest Policy documentation (and its comparison with Federal Policy), detailed field level investigation of how State Forest Policy is actually implemented by Forest officials – both at the District Forest Officer (DFO) level and at the more local level and on the daily interaction between forest users and Forest officials. Equally, attention would have to be given to understanding the three states that share the NBR between them because they not only have rather different forest ecologies but are also characterized by rather different political regimes with potential effects on welfare outcomes for the indigenous people. In this sense a

[3] See Guha, (1983) and a recent summary review by Springate-Baginski et al, 2007.
[4] See for example a recent discussion on this issue in Frontline, 26, issue 5, Feb. 28- March 13th 2009, 'Rights and Forests'; http://www.frontline.in/stories/20090313260508800.htm accessed March 10th. 2009.

systematic investigation of the three Forest Departments as institutions within their state context would have been an important investigation to undertake.

Within the scope of this study, such a systematic investigation has not been possible. What field evidence shows is that there is considerable variation between the states in terms of the rules and regulations with respect to forest use, the ways in which these are applied and differences also with states according to the ways in which rules are applied in practice and how they affect the endowments and entitlements of indigenous people with respect to forest resources. Non-timber forest products remain in a deeply ambiguous and highly variable legal position.

For example in the case of Karnataka there is no specific policy or laws or regulations that directly regulate NTFP collection, processing and sale. However within the Karnataka Forest Act of 1963 minor forest products (MFPs)[5] are defined as 'forest produce other than timber, sandal wood, firewood, charcoals, bamboos and minerals, and includes forest produce such as myrobolans, barks, fibres, flosses, gums, resin, dyes, grass, leaves, roots, fruits, seeds, creepers, reeds, moss, lichens, wood-oil, honey, wax, lac, wild animals, wild birds, horns, hides, bones, tusks etc.' There are certainly some rules on the extraction of NTFPs in the Karnataka Forest Manual and the collection of 45 items is allowed from leased forest areas although these are required to be sold through the LAMPS[6] at a price set by them.

The Tamil Nadu Forest Department allowed 23 items of NTFPs for collection from leased forest areas, which does not include honey in the list of allowable items. The price is fixed by the Tamil Nadu Forest Department. In the state of Kerala, the Forest Department allows the collection of 100 NTFPs by the Tribal Services Cooperative Societies (TSCS) from leased forest areas. The price fixation mechanism operating here is through Kerala Minor Forest Products committee. Honey and wax collection in the state is not banned but it is regulated through Cooperative Societies.

The highly variable and unclear legal status of honey collection has a number of effects. The first is that it gives rise to a honey market that is highly fragmented as evidenced by differential prices between locations, a point that is explored in more detail below. Second and related the honey market is highly regulated but regulated in diverse and complex ways, both formal and informal (although the blending of formal and informal challenges the notion of these being clear contrasts). In the case of Kerala where honey collection is legal, sales have to be made through Village Community Councils at a price determined by them. However there is some degree of competition between the VCC and the older Cooperative Structures which offer lower prices. In Tamil Nadu where honey collection is banned in law, practice varies according to site. In ChG where the DFO tacitly accepts honey collection, this is effectively regulated through a Village Forestry Committee (VFC) connected to Keystone enforced by a powerful village leader and forms of informal taxation that effectively restrict private sales. In SB illegal cross-state movement for 'legal' sale in Kerala occurs although much of the sale is to a few traders who pay below market prices but then trade it on to 'legal' buyers elsewhere. In the other two Tamil Nadu sites, Keystone is a key buyer of the relatively small honey production from these sites. In Karnataka, where honey collection is illegal because of the location of the villages in a reserve, the major route for honey sales is through traders who then trade it on to 'legal' buyers or to commercial buyers.

This murky environment obviously allows ample opportunities for individuals to find ways round the formal rules. But, and this is a third effect, it also allows ample opportunity for Forest officials to act as gatekeepers and extract private benefits from themselves as an interview from one village (see Box 1) where honey collection is officially banned illustrates

[5] The persistence of the term Minor Forest Products.
[6] LAMPS – Large and Multipurpose Society

Box 1 Payment of honey to Forest officials

The Forest officials coming in contact with the honey hunters are the anti poaching watcher, watcher, the forest guard, the forester and the ranger. The first three patrol the forests and come through the village at least once a day. They take some honey from the honey hunters occasionally. The honey hunters are unable to remember how much they actually give them. They also have to give honey to the ranger's office once a year, each group giving around 5 to 10 kilograms. A rough estimate of the honey flowing to the Forest officials must be around 50 kilograms a year (Source: interview with forest guard).

Source: James and Rajar, 2008.

In summary, the legal context within which indigenous people lead their lives is extremely uncertain. What the policies and law actually say and what happens in practice is clearly highly variable depending on how the specific State Forest Department interprets national legislation, the field practice of Forest officials and the relationships that are built between Forest officials and indigenous people. While this is not to downplay the significance of legislation and changing formal rights as important factors in indigenous people's lives and potentially of long term significance, perhaps the more important point that emerges is the context of risk and uncertainty in which indigenous people live their lives, given the unpredictability of the way in which the state and its representatives at various levels actually behaves towards them in relation to the access and use of forest resources.

Social & Cultural role of NTFPs and honey in households

Nearly all the people interviewed who mentioned that they gathered NTFPs, including honey, to make an income also stated that some was retained for domestic use. However, there were particular items that some people only collected for domestic use, such as *Apis florea* honey which was valued for its medicinal content. Some herbs, and the bark of particular trees, were gathered for home-based treatments of ailments. Certain tubers, bamboo shoots, wild green vegetables, fibre, and small animals were also gathered for the home and not for sale.

It is impossible to quantify the collection undertaken for household use for any NTFP since in many cases small amounts are taken from harvests that are intended for sale. Biswal (2009) who undertook a study in one of the Project villages, was told that one household kept, for use at home, five to eight kilos from the several hundred kilos of phoenix grass they had collected for sale to make brooms; but this type of precision is unusual. Few people provided information on quantities collected for their own use.

A man in village KB told us that his first priority after collecting honey was `home consumption', another in the same village said that any honey they managed to collect was consumed at home. Bees wax was also used for domestic purposes. It is apparent that during honey hunting, either from cliffs or trees, that a benefit of the hunt is the consumption of honey often at the site of collection. Stories were told of the camaraderie around the hunt and the enjoyment in sharing some of the honey when the collection was over. Another benefit of honey collection, that was mentioned as being only for domestic use, was the gathering of the bee larvae to make what one man described as `bee larvae curry'. He described how his wife would wait for him at night in a safe place (because he did not want to leave her alone in the house at night) while he was collecting honey. She would be close to where he was and when he had finished they would go home and cook the curry at once.

Honey hunters, all men, described how they learnt the skill from their father or an uncle when they were at the age of seven or eight starting with *Apis cerana* or *Apis florea*, which they did not have to climb to collect, so that they would overcome their fear of stings. These accounts were usually told with great pride, not only in describing the feat of collecting honey but also in explaining the importance to their culture of what was done. As is clear from the information on the economic significance of honey which for many households was not

large, the social and cultural importance may often have been of more importance for some than the economic return. Older men and women spoke wistfully of times when honey was plentiful and hunting yielded rich returns.

Not everyone who had tried to collect honey relished the role. One man from village NMu recounted the following:

> *In the first week of May 2005, he was coming back from the forest after collecting Apis cerana honey, carrying the honey carefully. Suddenly three bees attacked him, so he put the bucket down. He was very afraid. After the bee attack he never went near a bee colony. The honey hunting team normally takes somebody with it as a caretaker to watch for animals. So now he goes with the team as caretaker not as a honey taker!*

The importance of the `caretaker role' is illustrated in the life histories by the number of people who mention either losing a relative to elephant or bear attack or being attacked themselves. A man (V) from NA village gave this account:

> *One morning in 2006 V went with his son (who was under the age of 10) to collect an NTFP called padakkizhngu. They left the village at 8/8.30 am. The boy was walking behind his father at a distance of about 100 metres. They were climbing up a hill through shrubs so they were not able to see each other. Suddenly V saw something moving and thought it was a wild boar. The animal came straight at him before he could make any movement or sound. It was a bear which caught on to one of his legs and kept biting him for two to four minutes. V had a roll of rope with him so he tried to hit the bear with that and it let go.*

He goes on to describe how his son tried to stab the bear and then ran home as his father lost consciousness. Eventually V was found by villagers who came to look for him. He was disabled by the incident and can no longer work.

Therefore it is not surprising that those people living close to the forest, who collect NTFPs and fuelwood whether for sale or their own consumption, speak of the forest with reverence. The Cholanaickan people from Nilambur talk of the gods in the forest who protect them but can bring harm to others if they try to take forest produce. However, it was not only indigenous people who valued the forest in this way. In one case an in-migrant to village SB, who was not from one of the indigenous communities, told the interviewer that even though he did not collect NTFPs the forest was `a very precious thing' which he feared was disappearing. Another man who worked away from the forest to earn his living said that he valued the forest as a place to walk in and find peace when he was home.

These anecdotal references to the social and cultural significance of the forest provide some insight into the value placed on the forest by some of the people in our study. Of course, this was not the case for all. For some people in places where cultivation was the main source of livelihood and little, if anything, was gathered from the forest (as in village KT) people made no reference to the social, cultural or economic value of the forest. Biswal (2009: 46) was told by one family that they would rather borrow money from neighbours than collect tubers and wild vegetables from the forest when food was scarce.

Economic Role of NTFPS and honey in households

The assumption that is often made about social groups that live in forests and in the Nilgiris are that these are 'forest dependent' communities. Forest dependence as has been noted has complex dimensions with spiritual, social and economic aspects. Here we are concerned with the potential economic contribution that forest products make to households in the study sites and the extent to which households are 'forest dependent'. Dependency is a slippery word and must be handled with care. It could be that forest resources platy a critical role in subsistence – for food, medicinal purposes and fuel. It could be taken to mean that income

from forest products constitutes a major part of household income in cash or kind, without which households could not survive. Equally it could be a small percent of household income (in cash or kind) but as household income is low anyhow, its absence could push the household below the food security line, for example. Equally forest resources may function critically as a safety net – a resource of last resort (Byron & Arnold, 1999, p790) but to be abandoned when there are better options.

A particular issue that Byron & Arnold (op.cit. p790) attention to and this relevant here, is the question of 'how much of forest products actually come from forests'. To what extent, to be specific, does the honey that is collected actually come from bee species foraging strictly within the forest and how much from disturbed forest habitat or agriculture? Accordingly the idea of 'dependency' which is an evaluative term is deliberately avoided and we focus here on the concrete measure of income without drawing inferences as to whether this means dependency or not. The income in kind drawn from subsistence consumption of NTFPs including fuel are excluded from this assessment although where firewood has been collected for sale, this has been included.

As always assessment of household income in rural economies is an inexact science for reasons of method (based for example on recall and the difficulties associated with that and measurement, particularly if there is an 'in kind' component) and questions of reliability (willingness and ability of informants to give accurate data). The data that is presented here can be regarded as a best estimate. It has been collected at all sites (with the exception of Mancheri[7] in Nilambur) on the basis of household interviews using seasonal calendars to determine primary activities during that time. Since most income generating activities of most households are based on either activities in the informal sector or casual employment precision cannot be expected. Estimates of income from the collection of NTFPs, for example, have been assessed based on an aggregation of the number of harvesting trips made per month, estimates of the average weight or volume of product collected per trip and the reported price paid per kg for the product. These are then estimates of gross income and do not take account of income in kind for products consumed within the household. In particular no assessment has been made of the in-kind value of firewood collected by most households from the forest although in two sites cash income from firewood is included.

Three questions structure the summary analysis of household income and its sources and can be posed as follows:

- What proportion of household income in the study sites is derived from NTFP sources and honey[8] in particular and how does this vary between seasons and sites?
- How does this contribution of NTFP and honey sourced income vary between households within and between sites?
- What factors might explain the variability in the contribution of NTFP and honey sourced income between sites and between households within a site?

<u>What proportion of household income in the study sites is derived from NTFP sources and honey in particular and how does this vary between sites?</u>

Table 3 summarises the data on mean household income determined for each site and the proportions of income coming from wage work, agriculture, NTFPs and honey.

[7] In Mancheri given the mobility of households and the fluid nature of residence, it was difficult to get consistent or meaningful household data and group data was collected on seasonal activities.
[8] The contribution of bees wax to income is not discussed here, partly for reasons of space but also because the data on bees wax sales is less systematic

Table 3: Mean annual household income (IRS)[1] by site (N = number of households) and proportion of income derived by source.

Site (N)	Mean Annual Income (IRS)	% Income from wage work[2]	% Income from agriculture	% Income from NTFPs including honey	% Income from Honey
Chamrajnagar					
- ChB (10)	60000	1.00	0	0	0
- ChG (38)	36970	0.21	0.23	0.53	0.10
- ChK (20)	34407	0.16	0.19	0.65	0.13
- ChP (23)	36787	0.76	0.06	0.23	0.23
Coonor					
- CM (7)	21214	0.82	0.04	0.14	0.07
- CP (21)	44981	0.93	0.01	0.07	0.02
- CS (6)	25333	0.76	0	0.23	0.03
Kotagiri					
- KB (9)	39289	0.31	0.29	0.40	0.04
- KK (8)	53525	0.35	0.55	0.10	0.02
- KT (21)	75707	0.41	0.52	0	0
Sigur					
- SB (44)	34995	0.64 [+0.07]	0.03	0.25	0.11
- SC (39)	41665	0.70 [+0.14]	0.09	0.07	0.02
- SS (42)	40667	0.65 [+0.05]	0.18	0.14	0.02
Nilambur					
- NA (16)	46945	0.81	0	0.19	0.04
- NM*	60000*	0.00	0	1.00	0.34
- NMu (30)	56950	0.97	0	0.03	0.01

[1]: For sake of clarity Standard Deviation values are omitted but they are high in all cases indicated considerable variability between households.
[2]: Income from wage work includes wage labour (the major source), pension payments and in the case of the Sigur sites the additional income from salaried work is given in brackets. Note that there has been rounding up and down of figures.
*: In the case of Mancheri this indicates a maximum income that would be possible given NTFP collection activities; in practice it is likely to be less than this

A number of observations can be made drawing from this data set.

First there is enormous variability between sites both with respect to the mean annual household income, the major sources of that income and the contribution of NTFPs to income. That in itself invites extreme caution about making generalised statements about the role of NTFPs to the income of households that live in or near forests. With a median value of about IRS 41,000 (US$ 820) these are poor villages. Even the highest income sites (KT, NM, NMu and ChB) only manage a mean household income of IRS 60 – 75, 000 (US$1200 – 1500) while the poorest villages (CM and CS) has mean household incomes of IRS 21200 – 25000 (US$ 425 – 500).

Second in only three (20%) of the sixteen sites (ChG, ChK and NM) is the contribution of NTFPs more than 50% of mean household annual income and in only one of these (NM) is it the only source of income. In nine (56%) of the sites NTFP income contributes 20% or less

of household income and in two of these (ChB and KT) they contribute no income. Note should be made that four sites have a mean annual household income in excess of Rs 55,000. One of these sites is NM where income is exclusively based on NTFP sources although this is based on estimation. The other three sites are NMu, ChB and KT and these are also the three sites where the contribution from NTFP income is least (respectively 0.03, 0 and 0 of mean annual household income) raising the interesting question of what the relation might be between overall levels of income and the contribution made by NTFPs. This is returned to later.

Third it is evident from the data that honey is not a major source of income. For those sites with NTFP income (14 of them), the contribution of honey ranges from 0.02% to a maximum of 34% of mean household income in NM. Indeed in 11 of these 14 sites (78%) it is less than 10% of mean site household income. In only one site, ChP, is honey the only source of NTFP income and even here it is only 23% of household income. This relatively small contribution is hardly surprising given, as with most NTFP collection, the seasonal nature of honey collection (over approximately a three month period). Further it is also clear that honey is far from being the most economically important NTFP that is collected. In only two sites (CM and ChP) does it contribute 50% or more of NTFP income. In 50% of the sites with NTFP income sources it contributes 20% or less of NTFP derived income. Nevertheless its value as an income source is not to be underestimated and it is the only NTFP to be named at each site. As the data in Table 4 shows, in 7 of the 14 sites with NTFP income it ranks as the top NTFP income source and in another 5 as the second most important income source.

Table 4: Ranking of NTFP income sources contribution to NTFP sourced income by site.

Site	First Ranked NTFP Income	Second Ranked NTFP Income	Third Ranked NTFP Income
- ChG	Gooseberry	Honey	Phoenix
- ChK	Gooseberry	Honey	Phoenix
- ChP	Honey	-	-
- CM	Honey	Canarium	Shikaki
- CP	Kapok	Firewood	Honey
- CS	Firewood	Honey	Nelli
- KB	Dung	Honey	-
- KK	Honey	Dung	-
- SB	Honey	Wild Coffee	Lichen
- SC	Honey	Passam	Phoenix
- SS	Tamarind	Lichen	Honey
- NA	Cheenika	Honey	Nutmeg
- NM*	Honey	Black Dammer	Ginger
- NMu (30)	Honey	Cheenik	Nellikka

The dimension of seasonality in relation to NTFP income is important. Honey collection as noted is highly seasonal and stretches at best over a three month period. Most of the other NTFP collection periods are also highly restricted relating to flowering, seed or fruit set as with Kapok, Tamarind and Phoenix.

In summary two points are worth stressing. First the enormous variation between sites with respect to the contribution of NTFP sourced income to mean household income and second the relatively low percentage of income derived from NTFPs in most sites. Note that these comments take no account of the variability of income from a given NTFP income source between years (and hence the reliability of it as an income source) and honey harvesting is known to show considerable variation between years.

How does the contribution of NTFP and honey sourced income vary between households within and between sites?

The second question to be considered is how the contribution of NTFP income varies between households. This question is important because it is often considered that NTFP and common pool resources in general are of particular importance to the poorest households. For the basis of this analysis the households in each site have been ranked by income and divided into thirds (terciles) with mean incomes for each of the terciles and the contribution of NTFPs and honey to mean income assessed. The data is summarised in Table 5.

Table 5: Mean household income (IRS) and the contribution of NTFPs and honey to that income by income tercile by site

Site (N)	**Bottom Income Tercile**			**Middle Income Tercile**			**Upper income Tercile**		
	Mean Inc[1].	% NTFP	% Honey	Mean Inc.	% NTFP	% Honey	Mean Inc.	% NTFP	% Honey
Chamraj Nagar									
- ChB (10)	N/A								
- ChG (38)	**22375**	0.44	0.06	**37333**	0.57	0.10	**51230**	0.60	0.10
- ChK (20)	**23571**	0.38	0.20	**34106**	0.73	0.05	**44550**	0.70	0.14
- ChP (23)	**27375**	0.11	0.11	**33500**	0.16	0.16	**49075**	0.22	0.22
Coonor									
- CM (7)	**9050**	0.17	0.06	**22476**	0.13	0.07	**31500**	0.13	0.06
- CP (21)	**28686**	0.09	0.03	**43043**	0.09	0.02	**63214**	0.06	0.005
- CS (6)	**18000**	0.61	0	**25000**	0	0	**33000**	0.21	0.08
Kotagiri									
- KB (9)	**24333**	0.16	0.08	**38133**	0.31	0.02	**55400**	0.40	0.04
- KK (8)	**35200**	0.14	0.08	**56400**	0	0	**69933**	0	0
- KT (21)	**33400**	0	0	**66149**	0	0	**127571**	0	0
Sigur									
- SB (44)	**12247**	0	0	**38514**	0.13	0.09	**54460**	0.41	0.16
- SC (39)	**25086**	0.08	0.05	**40567**	0.06	0.02	**62462**	0.02	0.005
- SS (42)	**22071**	0.19	0.02	**42428**	0.16	0.01	**55528**	0.10	0.02
Nilambur									
- NA (16)	**25815**	0.35	0.03	**44766**	0.17	0.05	**70688**	0.15	0.03
- NM*	**N/A**								
- NMu (30)	**39503**	0.03	0.01	**62400**	0	0	**68947**	0.06	0.03

[1] For clarity SD values have not been presented. As with the data in table 1 they are also high.

A number of summary statements can be drawn from this data.

A first observation would be to note the differences in mean income between the bottom and upper terciles of households in each site. In most sites the mean income of the upper tercile is at least twice that of the lower tercile. To consider these as economically undifferentiated households or to call them all equally poor is simply incorrect.

Second two distinct patterns of NTFP income contributions to household income can be observed. In one cluster of sites (CM, CP, KK, SS, NA for example) and these are all sites where the overall contribution of NTFP income to mean site income is less than 20%, the overall contribution of NTFP income to household income is greatest in the poorest tercile and declines with increasing income. NTFP income contributes from 8 to 61% of mean household income for the bottom tercile in these cases.

There is however a second cluster of sites (ChG, ChK, ChP, KB and SB) and these are the sites where the overall contribution of NTFP income is more than 23% where the contribution of NTFP to mean tercile income increases from bottom to middle to upper mean income tercile, consistent with the findings of Agrawal (2001). For example in ChK the contribution of NTFP income to mean tercile income increases from 44 to 57 to 60 percent for the bottom, middle and upper terciles. It should be noted that this is not only an increase in a percentage contribution to mean income but also an increase in the absolute amount given the increase in mean income as one rises through the terciles. For the example (ChK) NTFP income contributes Rs 9845, 21280 and 30738 to mean tercile incomes of Rs 22375, 37333 and 51230 for the bottom, middle and upper terciles of income respectively. It is evident therefore that in the NTFP 'rich' sites, the better off you are, the greater the contribution that NTFP income is likely to make to your overall income. This is clearly not a case where NTFPs particularly benefit the poorest households.

Does the contribution of honey to mean tercile income follow these two distinctive patterns? Is the contribution of honey to mean tercile income greatest in the 'NTFP' poor sites for the bottom tercile but least for this group in the NTFP 'rich' sites? In the NTFP poor sites the contribution of honey to total mean tercile income does not amount to more 8% of mean income and there are no consistent differences between tercile groups across sites. In the NTFP rich sites there are three sites (SB and ChG and ChP) where the contribution from honey is least for the bottom income tercile but there are also two (ChK and KB) where the poorest tercile obtain a greater percent of income and absolute amount of income from honey than the middle and upper income tercile groups.

In summary there are complex patterns of difference between and within sites on the economic contribution that NTFPs in general and honey in particular make to household income. We turn now to explore some of the factors that might underlie these patterns.

What factors might explain the variability in the contribution of NTFP and honey sourced income between sites and between households within a site?

The data does not lend itself to detailed statistical analysis and nor does correlation or regression analysis indicate causality. Attention is drawn here to three potential determining factors that may contribute to the patterns of spatial variability of the role of NTFP income in the site households.

The first is site or location factors (such as agro-ecology, potential bee nesting sites etc.) that might determine the availability of NTFP and honey sources. These are essentially supply issues but of course confounded by the impact of collection pressure and it is unknown what the balance is between supply and demand factors influencing actual NTFP harvest.

Only for honey is it potentially possible to begin the answer to this question with an analysis of bee nest density (an indicator of supply) and this is addressed in section 4.5. For the present data can be presented on the harvesting of honey and how this varies by site (Table 6) but there are limits to how this can be interpreted. With the exception of one site (NA) there appears to be a correspondence, as one might hope, between the reported volume of honey collected and the contribution of honey to household income. For those sites where income from honey contributes less than 10% of household income, honey volumes

harvested are consistently less than 500 kg per season. For those sites where honey provides more than 10% of income honey volumes collected are in the order of 1000 kg or more. The one exception of NA is where the estimate 2000 – 3500 kg of honey harvested is not matched by the contribution of honey to household income providing an estimated 4%. There is at present no explanation for this although this may be related to the higher wage rates for labour in Kerala.

A second factor to consider is the availability of other sources of income. The fact that three of the four sites (the exception is NM which has an exclusively NTFP based economy) with the highest mean household incomes have the lowest contribution from NTFP income (Table 7) is indicative and indeed there is a negative correlation factor of -0.53 between income level and proportion of income contributed by NTFP. This suggests that with rising income, NTFP income contributes a declining share to mean household income. This is not to say which is cause or effect and the correlation is confounded by legal factors (for example the banning of NTFP collection in CB). Nevertheless as other research indicates (see for example Hegde *et al*., 1996;) NTFP is a relatively low return activity and it is probable that with increasing availability of reliable wage labour opportunities either in the forest through labour on timber harvesting as in NMu or for labour work on tea or coffee estates then the attractiveness of NTFP as an income source may well decline. In this sense the earlier suggestion that a high contribution of NTFPs to household income may be more an indicator of poverty and a poverty trap may be closer to the mark.

Thirdly there are idiosyncratic or household specific effects that may affect the contribution that NTFP income makes to particular household income. These can include that lack of available male labour of the right age (which would exclude a household from collecting harvesting *Apis dorsata* honey) to the complete absence of male labour or household age. Indeed it is clear (Table 8) that only a proportion of households in each site reported being engaged in the active collection of *A.dorsata* honey although more are likely to have collected honey from *A. cerana* and *A. florea*.

Table 7. Sites ranked by percent of income from honey against mean annual household income.

Site (N)	Mean Annual Income (IRs	% Non NTFP Income	% Income from NTFPs	% Income from Honey
- NM*	60000*	0	1.00	0.34
- ChK (20)	34407	0.35	0.65	0.13
- SB (44)	34995	0.74	0.25	0.11
- ChG (38)	36970	0.44	0.53	0.10
- CM (7)	21214	0.86	0.14	0.07
- KB (9)	39289	0.60	0.40	0.04
- NA (16)	46945	0.81	0.19	0.04
- ChP (23)	36787	0.82	0.23	0.03
- CS (6)	25333	0.76	0.23	0.03
- CP (21)	44981	0.94	0.07	0.02
- KK (8)	53525	0.90	0.10	0.02
- SC (39)	41665	0.93	0.07	0.02
- SS (42)	40667	0.88	0.14	0.02
- NMu (30)	56950	0.97	0.03	0.01
- ChB (10)	60000	0	0	0
- KT (21)	75707	0.93	0	0

Table 8. Number of households harvesting honey at each site

Site	N	No. households harvesting honey	Site	N	No. households harvesting honey
ChB	55	(10)*	KB	9	3
ChG	48	44	KK	8	2
ChK	55	20	KT	51	0
ChP	52	24	SB	51	18
CM	7	4	SC	44	5
CP	34	5	SS	52	7
CS	10	2	NA	54	17
			NM	12	8
			NMu	29	5

* From A. cerana & A. florea.

In summary, drawing on the framework of Byron & Arnold (1999) sites can be compared with respect to the degree of reliance that households within the site (but note the differences between households) may have on forest resources. Three criterion are used to define this reliance – the allocation of labour to the collection of forest resources, the role of the resources in the livelihood system and the potential impact of reduced access to forest resources to their livelihoods – each with four subjective indicators. Perhaps only in the case of households within NM and within the cluster 2 sites could it be argued that the extent of reliance on forest resources would characterise the indigenous people within this location as forest dependent.

Table 9 A summary assessment of the degree of reliance on forest resources across the sites by sites, site cluster[2] and income tercile.

Criterion	Indicator	Sites / households
Labour allocation to forest resource collection	Year round	NM – all Cluster 2 – all
	Periodic	Cluster 1 – bottom tercile
	Occasional	Cluster 1 – top & middle tercile KT, NMu
Role in livelihood system	Central / fundamental	NM – all
	Major/ important	Cluster 2 – top and middle tercile
	Minor but significant	Cluster 1 – bottom tercile Cluster 2 – bottom tercile
	Declining	Cluster 1 – top & middle tercile KT, NMu
Impact of reduced access to forest resources	Critical	NM – all
	Severe	Cluster 2 - all
	Modest / transitional	
	Minimal/ none	Cluster 1 – top & middle tercile CB, KT, NMu

[1] Developed from Byron & Arnold, 1999, Table1, p.798
[2] Cluster 1 sites = CM,CP,CS,KK,SS,NA; Cluster 2 sites = ChG, ChK, ChP, KB and SB.

Markets

Thinking about markets

The term 'market' is widely used essentially as a metaphor for mechanism and 'marketing' is widely used as a synonym for market. This both emphasizes and prioritises aspects of 'competitive' pricing which are assumed to arise mechanistically out of forces of supply and demand. There are however many aspects of markets that are dependent on other 'extra-market' conditions, including history, institutions, and non-economic processes. Some features of markets, such as entry and exit reflect both mechanisms and institutions. As Gasper and Apthorpe observe (1996):

"Positions which proceed as if 'market' denoted mechanisms only are misleading; they make a machine of the ghost. Arguing as if market were institution only, makes a ghost of the machine"

Ignoring the institutional dimensions of markets abstracts markets from their context, idealizes how markets should work and ignores the performance of markets in practice in relation to the institutional structures in which they are embedded. As Harriss-White argues (2003b:481):

"Economic markets are vehicles for the exercise of forms of social authority, the origins of which lies outside markets and which operate outside markets as well as inside them. ... Markets do not perform 'subject to' institutions, they are bundles of institutions and are nested in others."

Understanding the honey market therefore requires looking at both the mechanisms and institutions within which the honey market operates. The honey market effectively straddles the formal and the informal and, as noted above, transforms the harvested honey from its status as semi-illegal in collection to a sort of legal existence in its sale. The 'informal' can be characterized as being that which is not formally recorded in official statistics. It is often assumed that the informal, which as a label also carries meanings of being 'not legal', also carries with it the status of not being regulated by the state. But it should not be assumed that it is not regulated and there are many non-state means of regulation operating in the informal sector. As Harriss-White (2003a) has argued with respect to the 88% of the Indian economy that lies outside the formal economy, there are key structures of regulation (ethnicity, religion, age, gender and geography) that characterise the way in which profit or 'surplus is accumulated, distributed, saved and invested' in markets.

Understanding the institutional dimensions of markets requires different conceptual and analytical approaches from that of idealising 'supply' and 'demand' and focusing just on the mechanisms of the market. Attention has to be paid to power relations and patterns of exchange and their regulation. The dominant conceptual approach to understanding markets is that of New Institutional Economics. This focuses on information and transaction costs in its analysis of contractual relations among households, farms and firms. It is largely abstract and pays little attention to contexts of time or place. (Harriss-White 2003b:491-492). There are three other major approaches to the study of markets – economic sociology, the politics of markets and the social structure of accumulation – all of which give weight to both history and geography in different ways[9]. With respect to the 'social structure of accumulation', which the following analysis of the honey market in the NBR draws on, this requires a particular focus on the informal or non-state regulative structures that operate although, as will be seen, these interact in complex ways with the incomplete and complex regulation that the three states seek to enforce.

The Honey Market in the NBR

[9] "Economic sociology focuses upon networks, labour markets, corporations and the state. The politics of markets requires analysis of the state as participant and regulator, of collective institutions, of assets and their relations to tactics of competition or collusion, of the social power in which markets are embedded – and in relation to the others. The 'social structure of accumulation' school has focused on regulation of each stage of transfer of property rights in the process of production, distribution and consumption" (2003b: 492)

Table 10 summarises by site the legal status of honey collection and the actual practices of honey collection in the face of its legal status. What this summary information points to is a complexity of legal status and actual practice. Only in two sites (ChB and KT) where honey collection is reportedly not legal, was honey collection not reported, although it should be remembered that these are two sites where mean annual household income is amongst the highest of the sites. In all sites where honey collection did not have legal status some degree of honey collection was reported.

Table 10. Legal status of honey collection and the actual practices by site. (Sites that are bolded were selected for detailed study).

Locations / legal status	**Site Code**	**Actual practice of honey collection.**
Chamrajnagar		
- informal	ChB	Collection is banned and collection not reported.
- formal	**ChG**	**Collection is banned in Tamil Nadu, but the Village Forest Council (VFC) collects honey from harvesters & other NTFPs.**
- formal	ChK	Collection is banned in Tamil Nadu, but the Village Forest Council (VFC) collects honey from harvesters & other NTFPs.
- informal	**ChP**	**Collection is banned but collection reported.**
Coonoor		
- formal	**CM**	**Honey is sold to "Green Shop "Keystone in Coonoor - both honey as well as beeswax. Occasionally sold to other local shops as well.**
- informal	CP	The Honey is sold to shops on the Coonoor- Mettupalayam highway.
- informal	CS	Sold to local traders, tourists and occasionally to Keystone's centre.
Kotagiri		
- informal	**KB**	**Honey is collected mostly for personal consumption.**
- informal	KK	Cerana honey collected for consumption but not regularly.
- informal	KT	None of the households are engaged in HH.
Mudumalai/Sigur		
- informal	**SB**	**The product is sold within the village, tourists and local customers or to Kallur cooperative society in Kerala.**
- informal	SC	Honey collection is banned. It is collected and sold to local traders or the numerous resorts adjacent to the Mudumalai sanctuary.
- informal	SS	Honey is sold to the cooperative society. Society has a captive market as selling outside is illegal.
Nilambur		
- formal	**NA**	**Honey is sold to the cooperative society. Society has a captive market as selling outside is illegal.**

- formal	NM	Honey is sold to the society Bees wax is also sold to the society. Society has a captive market as selling outside is illegal.
- formal	NMu	Honey is sold to the society and to the local traders. Bees wax is also sold to the society for Rs.120/kg. Society has a captive market as selling outside is illegal.

The terms legal or illegal, formal or informal are problematic. The Darwin sites could be categorized into one of the three trade types – formal, permitted and informal. Informal trade is characterized as honey collection and trade through private traders (and so not billed or recorded) in locations where it is banned by law and is not (officially) allowed by the Forest officials. This kind of a trade can be seen on the Karnataka part of NBR. By 'informal' trade we refer to honey trade with private traders and the flow is through informal channels of trade not regulated or recorded by the state. Honey trade in Tamil Nadu is not allowed by law but it is permitted by the Forest officials. This is also essentially informal trade but honey collection and trade happens with the knowledge of the Forest officials and so can be considered as 'permitted' trade, but it is not documented. But 'permitted' trade can also be formal and in such cases it is billed and recorded. Thus in Tamil Nadu there is some formal trade with organizations like Keystone which is billed and in Kerala (where honey collection and trade is permitted by law) there is formal trade with the cooperative societies. These overlapping categories therefore have to be handled with care; for simplicity the terms formal and informal are used here but the limits of this categorization should be appreciated.

For a more detailed study on the honey market, six of these sites (three where honey collection is formal, three where it is not) were selected[10] for a more detailed investigation of the workings of the honey market looking at market structures, value chains and honey volumes. Drawing from Pain et al (2009) the summary characteristics of these sites with respect to the role of honey in household income is presented in Table 11 along with the estimated range of honey collection.

Table 11: Six study sites for investigating the honey market, the contribution of honey income to household and the estimated volume of honey harvest

Site	**Legal Status**	**% Income from NTFPs**	**% Income from Honey**	**Estimated Range of Honey harvest (kg)**
Tamil Nadu				
ChG	Legal	0.53	0.10	500 - 2400
SB	Non-legal	0.25	0.11	400 - 2250
CM	Legal	0.14	0.07	40 - 300
KB	Non-legal	0.40	0.04	20 - 80
Karnataka				
ChP	Non-legal	0.23	0.23	400 - 2000
Kerala				
NA	Legal	0.19	0.04	2000 - 3500

A summary of estimates, drawn from the honey market study, of the 2007 honey sales and the proportion that was sold through organizations, private traders and sold directly to customers by the honey collectors is presented in Table 12. Somewhat reassuringly the

[10] This section draws extensively from James and Rajar, 2008.

estimates of honey volumes recorded for each site based on the market study are consistent with the separate estimates derived from honey collectors reported in Table 11.

A number of observations can be made. In the sites of high honey volume (2000 kg or more) and where honey has a legal status (ChG and NA) most of the honey is sold to formal organizations. In the third site with legal status (CM) with sales of only 270 kg again sale to an organization accounts for 76% of sales while 24% of sales are through private buyers. In all three of these sites there is almost no trade through private traders.

Table 12. Summary Estimates of 2007 honey sales (kg) by site and buyer

State	**Site**	**Estimated*** **Honey (kg) sales 2007**	**% sale through organisation**	**% sale through traders**	**% sale private**
Tamil Nadu	ChG	2770	97	0	3
	SB	3300	38 (illegal?)	59	3
	CM	120	76	0	24
	KB	270	63	7	30
Karnataka	ChP	4250	37 (illegal?)	58	5
Kerala	NA	2000	95	4	1

* Numbers rounded up/down

In the three sites where honey collection and trade is not sanctioned (SB, KB and ChP) in the low volume site (KB) again the majority of the honey is sold through an organization (Keystone) which appears to be effectively allowed but again with a significant proportion of the honey sold privately. In the high volume sites (and note the volume of sales here is significantly greater than the legal high volume sites) the majority of the sale is through private traders but still a significant proportion is sold through legal organizations. What is happening here is that honey is being traded across state borders: in the case of SB within Tamil Nadu a proportion of the honey is sold in a cooperative society in Kerala. In the case of ChP in Karnataka, honey finds its way across the Tamil Nadu border to be sold to a Keystone centre.

What these contrasts between sites show very clearly is how attempts by the state at various levels to regulate collection and trade, particularly given the lack of consistency of regulations across State Forest Departments, are not effective and are unenforceable. They lead to action by honey collectors to circumvent the regulations.

But how do prices vary between states and by the point of sale?

The data presented in Table 13 points to considerable consistency across sites with respect to prices for sales to organizations and with honey collectors gaining some 65-80% of the final retail value. Private sales can provide the honey collector with a price some 60% greater than sales to private traders or organizations although the volume of private sales is limited. In the two locations where private traders handle the bulk of the honey sales prices paid to the collectors are some 5-10% lower than those that a collector might have obtained from an organization and gives the collector between 40-80% of final sale priced depending on location.

What this points to is the ability of private traders where honey collection is not legal to be able to set prices. Indeed it is in the two sites SB and ChP with a high volume of honey and where private traders handle the bulk of sales, selling on to commercial buyers that there is

a degree of monopoly control by two traders with considerable purchasing power. In the other two sites where the traders operate, the traders have a limited market and buy enough honey just to cater to the local demand. In the former case, the traders procure honey at a price that is lower than the price offered by the institutional buyer and in the latter case the traders procure honey at a price that is higher than that of the institutional buyers. Traders do not operate in ChG because of the presence of a strong village level leader. The absence of traders in CM is apparently because of the presence of Keystone. The institutional buyers decide the procurement price for a particular year at the beginning of the year and do not revise it until the end of the year; the traders fix their price after the institutional buyers have fixed theirs and of course have the option of revising it depending on the supply.

Table 13. Price paid to honey collectors according to first point of sale and as a percent of final retail price

State	**Site**	**Organisations**		**Private Traders**		**Private Sales**	
		Collector Price Rs/kg	**As % of final sale**	**Collector Price Rs/kg**	**As % of final sale**	**Collector Price Rs/kg**	**As % of final sale**
Tamil Nadu	ChG	60	80 – 100	-	-	100	100
	SB	60 - 70	65	60 - 65	40 - 85	70	100
	CM	75	65 – 75	-	-	200	100
	KB*	85	45	250	50 - 80	195	100
Karnataka	ChP	60	65 – 75	50 - 55	45 - 75	75	100
Kerala	NA	60 - 65	60	70	55 - 65	100	100

* note the honey sold in KB is from *Apis cerana*; in all other sites it is *A. dorsata*

The traders in ChP and NA provide credit in the form of reportedly interest free advance payments to the honey hunters. In NA, the honey being sold to traders is limited in quantity and is procured only from a few honey hunters, considered reliable by the trader. The traders also pay a price higher than the society. In ChP, the trader giving advance payments pays less than the society for the honey he buys. He buys honey from any honey hunter in the village but extends credit only selectively. In both the sites, the provision of credit serves as an incentive for the honey hunter to trade with the trader. Box 2 summarises the practice of one key trader in Coonor and is indicative of more widespread practices of traders reported in the study.

Box 2: Traders credit practices: a case study

The most prominent trader of honey in the Coonoor region before the entry of Keystone used to procure most of the honey. After the entry of Keystone he started acting as an agent of honey collection, collecting honey from honey hunters at a rate of reportedly Rs.30-40 per kilo and supplying it to Keystone at Rs.75 per kilo. However with increasing awareness of Keystone's prices honey hunters started supplying honey directly to it.

This led to a change in the trader's strategy. Reportedly with the help of Forest officials he locates honey colonies in the forests. He organizes honey hunters into various groups and provides them with financial assistance. He makes a group of five people and gives those bidis, food and expenses for honey hunting and they collect the honey. If the honey is sold for Rs.8,000 in total, and the advance expenses provided amount to Rs.2,000, the profit of

Rs.6,000 is divided equally between the trader and collectors (giving them less than 40% of the final sale price).

The honey hunters claimed that the trader also gives small amounts of money as loans. He does not charge interest but he buys various NTFP products from them at a price lower than the market rate. The various products bought from them are coffee, silk cotton, pepper, honey, soap nut etc. (based on interview with honey hunters).

Source: James and Rajar, 2008

In summary it would be difficult to argue that there is an open and competitive market for honey in the NBR. Where honey trade is legal, officially established organizations control the bulk of the market, creating a condition where multiple sellers have essentially only one buyer or an example of imperfect competition or monopsony. As the only purchaser this has the effect of the buyer effectively setting the terms to its suppliers. But the effect of this official monopsony and its variability between the three states gives rise to effectively monopsonic private trade as well which, because of its ambiguous status, is able to be even harsher in the setting of terms. The loser is the honey collector since monopsony leads to a redistribution of welfare gains from their effort to the purchaser.

The Interlinkages between Bees, Biodiversity and Indigenous People.

The preceding sections have discussed some of the issues and uncertainties around the role of honey and NTFPs in the livelihoods of the indigenous people of the NBR. What is clear is that there enormous variation between sites with respect to the contribution of honey sourced income to mean household income and that there is a relatively low percentage of income derived from honey in most sites. What linkages can be identified between the hunting activities for honey and its affects on bee populations and their pollination services.

Conceptually two broad areas of human activities can be identified as potentially having an effect on honey bee populations. The first is the direct hunting activities and the collection of honey. The second more indirect effect is through land clearance that could be either positive (increasing food sources) or negative. Biodiversity in some cases may well be maintained or even encouraged by disturbance regimes such as land clearance that might reduce biodiversity locally but promote it more widely.

Honey Collection Practices and Indigenous Bee Populations.

If one explores the specifics of the ecology of *Apis dorsata* given the seasonal migratory behaviour of the species and its relaxed nesting behaviour in terms of nesting sites (at least outside the NBR) building understanding of cause-effect relations on its population dynamics even within the NBR is fraught with methodological and conceptual difficulties. While it is known that there are marked seasonal fluctuations in honey harvested as evidenced from Keystone experience which is probably indicative of fluctuations in production, the causal factors of this are unknown. Here is a case where long term systematic records of A*. dorsata* nest counts within the NBR could provide insights but such data does not exist.

A first question to be asked since it is potentially a crucial link between honey harvesting and *A. dorsata* populations, is 'what is the effect of harvesting of *A. dorsata* on nest survival, subsequent honey production and swarming?' This question is not easily answered because much of the basic detail on the direct action of harvesting honey on bees is not known. Much may depend on the timing of the harvesting in relation to the life cycle of the bees' colony, and the method of harvesting, all of which will affect colony survival, recovery and likelihood of subsequent swarming and migration. One could assume the worst – that all honey harvesting is destructive, and contextual factors (weather conditions, pollen supplies etc) might play an equally important role in colony survival and recovery after harvesting. Even if harvesting activities are destructive, the effect of harvesting will depend

on the proportion of nests that are harvested. For *A dorsata* where nests on rock faces tend to be clustered, observational evidence suggest that only a portion of nests can be harvested. This is for reasons of physical access, the time limits on harvesting because of stamina issues of being suspended in the air, and the effect of the response of defensive bees who sting the hunter.

The issue of hunting pressure can also be approached from looking at nest densities and how they vary between sites and considering the extent to which these correlate with the known importance of honey collection activities. The survey of nest densities following a transect method in areas proximate to the research sites found that the Sathyamangalam/ Chamrajnagar areas had the highest number of nests per location but attributed this to the availability of appropriate nesting sites (cliff faces). Indeed Sathyamangalam had the highest levels of hunting pressure, consistent with the livelihood data, but the research concluded overall that the hunting pressure was low. In other words a significant number of nests remained unharvested and it might appear therefore that supply of honey is not necessarily a constraint on the amount that is collected.

A separate estimate of nest densities for four bee taxa (*A. cerana, A. dorsata, A. florea* and *Trigona spp*) undertaken in four of the research sites found higher values of *A dorsata* nest densities than found in the transect survey of Roy et al. but attributed this more to the purposive selection of sites in relation to the importance of honey collection in contrast to the random placed transects. However what emerges from both of the studies was that for *A. dorsata* it may be the availability of suitable nesting sites that is more of a critical variable explaining nest density than honey collection practices although this cannot be robustly tested.

A related but different assessment constructed a Bee Importance Index (BII)[11] as an approximate measure of potential pollination services provided by bees at 14 of the research sites (Thomas et al, 2009). Table 14 compares this BII with the evidence on the contribution of honey to household income and estimates of the amount of honey harvested from each site.

Table 14: Mean annual household income (IRS)[1] by site (N = number of households), % Income from Honey, Bee Importance Index[1] and Estimated Range of Honey harvest

Site (N)	Mean Annual Income (IRS)	% Income from NTFPs including honey	% Income from Honey	Bee Importance Index (BII)	Estimated Range of Honey Harvest (kg)
Chamrajnagar					
- ChB (10)	60000	0	0	9	
- ChG (38)	36970	0.53	0.10	5	500 – 2400
- ChK (20)	34407	0.65	0.13	7	
- ChP (23)	36787	0.23	0.23	5	400 – 2000
Coonor					
- CM (7)	21214	0.14	0.07	6	40 – 300
- CP (21)	44981	0.07	0.02	9	
- CS (6)	25333	0.23	0.03	4	
Kotagiri					
- KB (9)	39289	0.40	0.04	4	20 – 80
- KK (8)	53525	0.10	0.02	4	
- KT (21)	75707	0	0		

[11] The value of the index ranges from 4 to 9, the higher the value the greater the diversity and abundance of social bees.

Sigur					
- SB (44)	34995	0.25	0.11	5	400 – 2250
- SC (39)	41665	0.07	0.02	6	
- SS (42)	40667	0.14	0.02	-	
Nilambur					
- NA (16)	46945	0.19	0.04	4	2000 – 3500
- NM*	60000*	1.00	0.34	4	
- NMu (30)	56950	0.03	0.01	6	

[1] Drawn from Thomas et al, 2009.

Given the relative nature of the BII one should be cautious about reading too much into the contrasts between the importance of honey collection and the BII value. Indeed vegetation variability may be more important in explaining the variation of the BII between sites with higher values being found in the wetter sites than the dryer sites.

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Bees (extracted from paper prepared for the Final Conference in March 2009)

NBR represents well the wider Asian apicultural situation, with open-nesting and cavity-nesting honey bees and stingless bees represented, although at the start of this Project they had not to our knowledge been scientifically identified. NBR was believed to be an area still without exotic *Apis mellifera,* although this species has been introduced to other areas of Karnataka, Tamil Nadu and Kerala. Keystone has documented the existing honey hunting and beekeeping practises of the area in several publications, for example (Nath, 1994), (Roy, 1997), (Keystone, 2008), and has also documented many of the flowering plants and NTFPs that may be dependent upon bees (Rehel, et al., 2009). Interestingly, NBR provides examples of different approaches to bee use, from opportunist honey hunting, organised hunting, through 'bee having' as practised by the Toda (ownership and some management of *Apis cerana* nests in trees), to wall and box frame hive beekeeping.

Concerning the sustainability of honey hunting, the situation in NBR is that honey and wax are being harvested from wild colonies of bees, without knowledge of the population sizes, their reproduction rates, and what yields may be borne sustainably, and therefore with unknown consequences for these bee species and other plant and animal species that may be dependent upon them (for pollination or food production), as well as possible consequences for the sustainability of human livelihoods.

6. The aims of this Project concerning livelihood relevant bee species

We were interested to learn about the presence of bee species and their value both to pollination and more directly within people's livelihoods. In addition, we are interested to gauge whether current levels of honey hunting of these bee species can be considered sustainable or whether any of these species are being harvested at levels that threaten their species' survival. NBR represents one of increasingly fewer places left on earth where research on indigenous populations of honey bees can be done, i.e. areas with neither introduced honey bees nor introduced, exotic predators and diseases, and as far as we know, this is the first attempt to assess both Meliponini and Asian *Apis* species in the same habitats. NBR represents a particularly useful area for this study as hunting of bee colonies is not practised throughout the whole area, with some areas where bees are undisturbed by humans.

Hence the questions that we asked in this project about bees:

- Which are the livelihood–relevant bees?
- How many species are they?
- Where are they and how is distribution related to habitat?
- How populous are they? Is it possible to estimate population sizes for these species?
- What is the bee nest density at each site?
- What factors explain variations in bee nest density between sites?

7. Results

In summary, this is the information gained during this Project concerning bees and their habitats:

1. Identification of bee species and the development of a key to their identification
2. Genetic analysis of *Apis* spp
3. Knowledge of typical numbers of *Apis dorsata* nesting sites (2007)
4. Numbers of honey bee and Melipona species at six project sites 2008 and 2009
5. Knowledge of insect diversity at 15 sites in relation to landscape and season
6. List of foraged plants from 15 sites (12 months, 30 focal patches)
7. Floral calendars at 15 sites
8. Reference collections of pollen and plant specimens from 15 sites
9. Knowledge of bee dependent NTFPs and crops in five locations of NBR

10. Typical unit prices and trade of pollinators
11. Effect of landscape on pollination, using Sapindus (2008) and coffee (2009) as examples
12. Plant diversity in four sites

The first of the above (1-4) relate directly to the bees of NBR, while (5-12) concern bee-related biodiversity in NBR, and are described in a separate Workshop session.

7.1 Concerning the identification of bee species and the development of a key to their identification

Methodology

At Project outset, field observations were combined with pan trapping at the 16 Project sites towards an overview of the bee species present. The Project's entomologists have identified most of the bee species. Stingless bees are a particularly difficult group, and the identities of the two stingless species were confirmed by Dr D Roubik, an authority on this insect group.

Results

The bees of NBR are as shown in Table 3 below.

Table 3 Bee species of NBR

	Species	English name	Number of types reported in NBR	Nesting habit	Livelihood relevance
1.	*Apis cerana*	Asian hive bee	3 'types' observed by local people: 'black', 'yellow' and 'red'	Multiple combs, cavity nesting. Nest inside cavities and human-made containers (hives)	Honey, beeswax, pollination
2.	*Apis dorsata*	The 'rock bee', 'cliff bee', 'giant honey bee'	2 'types' observed by local people – these differ in the way the midrib is constructed.	Each colony occupies a single comb, in the open (cliff or tree nesting). Sometimes nest in aggregates.	Honey, beeswax, pollination
3.	*Apis florea*	Little honey bee	4 'types' observed by local people. *Apis florea* red (mora kola, nai kola,	A single comb, in the open (nesting on a branch in shrubby vegetation)	Honey, beeswax, pollination
4.	*Apis mellifera*	European hive bee	One sighting in September 2006 of 180 transient colonies (colonies transported by truck from Himachal) during the project	Each colony has multiple combs, cavity nesting. Nest in human made containers (hives). No feral colonies found in NBR.	Not present
5.	*Lepidotrigona ventralis (Smith, 1857)*	Stingless bee	Dammer bee 1 of 2 types observed by local people. Identified for the Project by David W. Roubik,	Cavity nesting – in hollow tree trunks, or human made container, mud walls	Honey, pollination

			Senior Scientist, Smithsonian Tropical Research Institute, Panama		
6.	*Tetragonula bengalensis (Cameron, 1897)*	Stingless bee	Dammer bee As above	As above	Honey, pollination
7.	*Xylocopa sp.*	Carpenter bee	Identified for the Project by Santhosh Nair-Entomologist	Hollow stems, rotten wood	Pollination
8.	*Trigona sp.*	Stingless bee	As above	Cavity nesting – in hollow tree trunks, or human made container, mud walls	Honey, pollination
9.	*Ceratina sp.*	Small /dwarf carpenter bee	As above	Nest tunnels in the soft pith plant stems	
10.	*Braunsapis sp.*		As above		
11.	*Amegilla sp.*	Blue-banded bee	As above		Pollination
12.	*Amegilla zonamegilla*	Blue-banded bee	As above		Pollination
13.	*Amegilla anthophoridae*	Blue-banded bee	As above		Pollination
14.	*Lasioglossum sp*	Sweat bee	As above	Nest-earth, rotten wood	Pollination
15.	*Halictus sp.*	Sweat bee	As above		Pollination
16.	*Megachilidae*	Leafcutter bee	Identified for the Project by Santhosh Nair and Stuart Roberts Entomologist		Pollination

Apis mellifera

Colonies of *Apis mellifera* were observed in NBR during the course of the Project when the Indian company Darbur brought 180 colonies of *Apis mellifera* to take advantage of the rare flowering of 'kurunje' *Strobolanthes spp* in September 2006. The *Apis mellifera* colonies were observed to be in poor condition and were being fed sugar syrup by the attendant beekeepers. It seemed these *Apis mellifera* were unable to take advantage of the *Strobolanthes*, perhaps due to the cold weather. No samples of *Apis mellifera* were collected or otherwise observed during the project's field work to date and therefore NBR remains as one area in India that does not have permanent stocks of introduced *Apis mellifera* honey bees. *Apis mellifera* cannot persist as feral colonies in Asia, due to the presence of the indigenous Asian honey bee mites.

Concerning the bee key

A bee key is being prepared in the software LUCID. This will feature the bees shown in Table 3, and will be illustrated with the bees, their nesting habits and products.

7.2 Concerning genetic analysis of NBR's *Apis* spp

Samples of all the NBR *Apis* species have been sent to two international laboratories (Bieneninstitut Kirchhain, Germany and University of Kansas, USA) for characterisation of mitochondrial DNA. The Project has also collected and sent samples of *Apis cerana* and associated *Varroa* mites – these can be used to research the genetic co evolution of *Apis cerana* and *Varroa* mites

Preliminary results from Dr Deb Smith, University of Kansas:
Concerning *Apis florea*
Preliminary results may indicate that the 'red' *Apis florea* differ from other samples at a single base in the cytochrome oxidase II gene. These bees seem to be nearly identical to *florea* samples from Saudi Arabia, and different from the *florea* samples from Thailand-Laos-Cambodia. The non coding sequence differs a bit (3 bases shorter in India than in Arabia) but four 'oddball' samples match the coding sequence of the Arabian bees.
The indications are for two big lines within *florea*, a western line that extends from Arabia to India, and an East Asian group that includes Thailand, Vietnam, and Cambodia etc. The boundary areas will be interesting.
Concerning *Apis dorsata*
The samples from NBR have been sequenced along with a large selection of 'giant' bees from Thailand, Malaysia, Borneo, Palawan, Luzon, Pakistan, Andaman Is., Sulawesi, with seven samples from south India-Bangalore and four from NBR. Despite the fact that Sulawesi and Philippine giant bees have been suggested as separate subspecies, the most divergent ones are those from India. They are uniformly quite different from the other locations.

Therefore, we have three groups of bees that say India is unusual: giant bees, cerana (yellow and black types, and black somewhat different from the black mainland bees of the rest of Asia) and the *florea* more allied to those of points west, rather than to the *florea* of Thailand-Cambodia etc.

7.3 Concerning knowledge of typical numbers of *Apis dorsata* nesting sites (2007 field work)

We are not aware of any other published study in Asia to determine the numbers of *Apis* and Melipona bee colonies in natural habitat, and the Project needed to determine a methodology to undertake this work. The aggregate nesting by colonies of *Apis dorsata* makes it difficult to determine a feasible way to determine the density of colonies in a given area. In NBR *Apis dorsata* nest on cliffs, in large aggregations, but not exclusively so: it is possible also to find single colonies in trees. The presence of a cliff with bees means that any small area containing a cliff will show a high bee density, while large cliff-free areas will have low densities, yet not all cliffs are populated with bees. The following methodology was followed in 2007:

Methods [the following boxed text extracted from the paper submitted to Current Science by Roy et al. August 2008]
Study area
The study was conducted in the dry season of 2007 in six protected areas within NBR: Bandipur National Park (BNP), Nagarhole National Park (NNP), Mudumalai Wildlife Sanctuary (MWS), Sathymangalam Reserve Forest (SRF), Silent Valley National Park (SVP), and Wynaad Wildlife Sanctuary (WWS). Bandipur, Mudumalai and Nagarhole had predominantly moist and dry deciduous forests, whereas Sathymangalam, Silent Valley and Wynaad had a mixture of wet evergreen and deciduous forests.

Colony surveys
The sampling for *Apis dorsata* nests was carried out in the six sites between January and June 2007, the major flowering season for plants (Varghese et al. unpublished data). The

study was repeated for Mudumalai during the same season in 2008. After June, *Apis dorsata* leave the area towards lower elevations. Variable distance line transects were used to estimate nest densities (Emlen, 1971). The variable width method was used because the habitat type and vegetation structure differed in each site, thereby the probability of detecting nests at different distances from the transect line also differed. Surveys were conducted in the morning hours and a minimum of five hours were taken to complete each transect of 5km. Depending on the area to be covered, number of days spent in each area varied. In the protected areas of Bandipur, Nagarhole, Silent Valley, Mudumalai and Wynaad a minimum of two transects were done for each range, a management boundary of the forest department. Depending on the number of ranges for the protected area, the total length of transect varied (Table 4). By spreading the survey, we tried to cover the length and breadth of the area as against intensively looking for nests in one area. This strategy was adopted to obtain clear baseline information on nest densities. In the Sathymangalam reserve forest area, honey hunter villages were located based on the volume of honey collected. The five villages that ranked highest in volumes of honey were chosen. Transects were then chosen randomly in different directions from the village into the forests where the honey hunters would go. Three transects of five km were walked in the forests around the five honey hunter villages. Distance sampling is a widely used method to assess the density and abundance of populations. We used the line transect to estimate nest densities. A standard survey is conducted along a line of known length and the nests or cluster of nests recorded together with the distance from the transect line.

One fundamental assumption of the method is that all objects on the transect line are detected, and that the probability of detection decreases monotonically with increasing perpendicular distance from the transect line. The detection function can provide estimates of error and reliable estimates of density (Diefenbach, 2007). Therefore, the distance measurements can be used to fit a detection function to the observed distances, and use this fitted function to estimate the proportion of objects missed by the survey. This method is called conventional distance sampling (Buckland S. A., 1993) (Buckland S. A., 2001). If one object in a cluster is detected, then it is assumed that the whole cluster is detected, and the distance to the centre of the cluster is recorded. The data for each study area with the cluster size and distance from the transect line, was entered into the Distance 4.1 program and the Akaike Information Criterion. (Akaike, 1974), selected the best-fit model.

The survey was repeated in Mudumalai Wildlife Sanctuary in 2008 using the same transect route, and the density was estimated in the same manner. *Apis dorsata* nests are large and easily visible and the probability of missing nests with increasing distance is probably lower than for cryptic species. Linear transects of different lengths were established in each study area. The length of the transect was estimated with a pedometer. The nests or colonies (cluster of nests) were detected by experienced observers including local honey collectors, and the perpendicular distance of the nest to the transect line, was estimated subjectively by multiple observers (3+).

The length of all the transects in each study area were summed to give the overall transect length. However, since the observers were not standardised between sites, and in some cases, such as Sathymangalam, the observers were more skilled and the paths taken were not strictly random, the densities only give approximate values and are an indicator of the relative ranking of the different study area with regard to nest densities. As such, it is a valuable tool for management.

Categorisation of harvesting pressure, and levels of protection

A measure of harvest pressure on colonies was obtained by recording the number of nests that were harvested along each transect. Sometimes the nest was harvested by removing only the honey portion of the comb, in which case the left over pieces of combs indicated that the colony had been harvested. In many cases, the whole comb was removed leaving a clearly identifiable mark on the branch at the point of attachment of the comb to the bark surface. The ladders or ropes that are used for harvesting were also left behind at the spot giving more evidence of a harvest. This measure was converted to density estimates of harvest pressure by dividing by the area sampled in each site. We developed an indicator of

'honey hunting pressure' by estimating the number of specialized honey hunters in each site. Honey hunting is an expert skill and indigenous communities in each region differed in their method of harvesting honey. Based on household data from each region (Snehlata Nath personal communication), we estimated the number of honey hunters in each region and rated them on a scale of 1 to 6, from 1 being the site with the fewest honey hunting groups to 6, having the most honey hunting groups. In addition, the protected areas were assigned a numerical indicator of the level of protection. Reserve Forests that had a low level of protection were given a value of 1, Wildlife Sanctuaries, 2 and National Parks, 3.

Data analyses

Spearman's rank correlation was used to assess whether nest density was associated with harvest pressure, indicators of honey hunter abundance, and levels of protection and availability of cliffs in the different sites. Nest densities, cliffs, harvest pressure, honey hunter groups and levels of protection were independent variables. The data from Mudumalai for 2008 was excluded from the analysis. A Mann Whitney U test was used to see whether the numbers of nests on trees and cliffs differed significantly between sites.

Results

Table 4 Information pertaining to the study sites, nest densities of *Apis dorsata,* colony sizes and harvest pressure.

Site	Reserve size (km^2)	Transect length (km)	Nest sightings	Cliffs	Colony size (Mean± SD) No. colonies ha^{-1}		Harvest density (km^2)	Honey hunter groups
					Tree	Cliff		
Bandipur (?)	874	60	91	4	4.4±6	7.8±7	0	3
Mudumalai WLS 2007	321	40	220	2	18.2±26	47*	0.044	2
Mudumalai WLS 2008	321	40	217	2	8±15	13±11	0	2
Nagarhole NP	644	50	238	0	4±7	0	0.012	4
Sathymangalam RF	1360	75	1238	24	9±23	48±95[a]	0.192	6
Silent Valley NP	89.5	15	2	0	1	0	0.000	1
Wynaad WLS	344	60	181	0	2±4	0	0.019	5

* one sample point

[a] Mann Whitney U test= $p<0.05$

NP = National Park, WLS = Wildlife Sanctuary, RF = Reserve Forest
Where level of protection NP > WLS > RF

Table 5 Results of the conventional distance sampling method

Site	Estimated strip width (m)	Density, of *Apis dorsata* nests ha^{-1}	95% CI		Coefficient of variation
			Lower	Upper	
Bandipur NP	34	0.34	0.15	0.76	0.41
Mudumalai WLS 2007	47	0.78	0.27	0.49	0.6
Mudumalai WLS 2008	44	0.82	0.41	1.63	0.36
Nagarhole NP	16	1.58	0.98	2.5	0.21

Sathymangalam RF	25	2.1	0.8	5	0.44
Silent Valley NP	30	0.02	0	289	0.86
Wynaad WLS	24	0.56	0.28	1.14	0.36

Colony numbers in most sites were small with a few nests (Table 5). It was only in Sathymangalam and to a lesser extent in Mudumalai, that nests were aggregated in larger numbers. There was a four-fold difference in nest densities between sites. Sathymangalam Reserve Forest having the highest nest densities (2.1 ha^{-1}) and Silent Valley National Park the lowest (0.02 ha^{-1}). This is because the nests in Sathymangalam were in larger aggregations, sometimes in hundreds. Harvest pressure was generally low, with the highest levels of harvest being in Sathymangalam.

The nest densities at the landscape level were positively associated with harvest pressure (r_s =0.81, p<0.05), the number of honey hunter groups (r_s =0.71, p<0.05), and negatively with protected area status (r_s =-0.62, p=0.10). This is mainly because Sathymangalam had higher nest densities, and number of honey hunter groups (Tables 4 and 5). If the analysis is conducted without the Sathymangalam data, the results show a positive but not significant association with harvest pressure (r_s =0.67, p<0.05), but no association with the number of honey hunter groups (r_s =0.50, ns) and levels of protection (r_s=-0.29). The only data, which is significant and consistent even excluding Sathymangalam, is that the percentage of nests on cliffs was associated with the number of cliffs (r_s =0.94, p=0.01), and harvest pressure was negatively associated with levels of protection (r_s =-0.94, p<0.01). Nest densities in Mudumalai Wildlife Sanctuary were similar in 2007 and 2008 (Table 4).

7.4 Concerning knowledge of densities of honey bee and Melipona species at 4 sites (2 wet forest, 2 dry forest) 2008 and 2009 field work

Methodology to determine numbers of bee colonies

In 2008 and 2009 we looked at the nest densities of *Apis cerana, Apis dorsata* and *Apis florea* and the Melipona bees, in six sites with different vegetation types in NBR using 100, 10x10m quadrats randomly laid radiating from a hamlet with honey hunters. We assessed plant diversity and abundance using the same quadrats. We also quantified the bee flora in these six sites by estimating the densities of plant species visited by bees in each site and their floral output. [Full details described in draft paper by Thomas et al].

Results concerning bee nest densities [Table taken from draft paper: Determinants of bee nest densities by Thomas et al .2008]

Table 6 Differences in bee nest densities between sites

Sites	N	*Apis dorsata*	*Apis cerana*	*Apis florea*	*Trigona* sp.	Kruskal-Wallis One Way ANOVA
Overall density (mean ± SE, nests ha^{-1})	396	19±5	13±2	7±2	11±2	11.06*
Appankappu (no cliffs, wet forest)	93	26±13	15±4	2±2	6±5	13.3*
Bedaguli (no cliffs, wet forest)	100	34±13	15±4	4±2	4±2	3.6*
Kalidhimbam (+ cliffs, dry forest)	103	8±4	13±4	2±1	5±3	9.6*
Kurimande (no cliffs, dry forest)	100	11±5	11±3	20±5	13±4	3.3
Comparison between sites K (Kruskal-Wallis	396	4.89	1.03	22.9***	18.22**	

One Way ANOVA)						

*** p<0.0001, ** p<0.001, * <0.05

Discussion of data on bee nest densities

The variation in density of the different bee species at different habitat types is to be expected, and is discussed more fully in the biodiversity papers.

The figures shown in Table 5, show *Apis dorsata* nest densities between 0.02 and 2.10 nests per hectare, or 2-210 nests per $1km^2$. These figures are of the order expected.
The data for *Trigona* spp. are within the range expected: for example Roubik, comparing a number of studies, states that stingless bee nests number approximately 150 per square km (100ha). although 'an estimate of 2 to 6 colonies ha^{-1} seems to apply to larger or *detectable* colonies' (Roubik D. W., 2006).

However, the figures shown in Table 6 above (2008 field work) appear to give very high bee nest densities per hectare. For example, if the figures shown for bee nest densities in row 1 are combined, this would give 50 bee nests in one hectare. This seems much higher than occurs.

Results

A summary of what we have learned concerning bees in NBR

For the livelihood relevant bee species: we have created a list of bee species of NBR with a key to their identification. By providing samples to wider studies, we have contributed to knowledge of the origins of these bees.

We have knowledge of the numbers of colonies of some of the species in some of the sites, and other areas of NBR. Also knowledge of where the bees are, and their distribution patterns in relation to vegetation.

The livelihood studies will contribute considerably to our knowledge of the extent to which these bees are exploited, and new information has been gained from local people concerning bee management, for example from Nilambur, that people clear vegetation towards encouraging the nesting of *Apis dorsata*. Thus NBR represents an area showing all stages of bee management – from opportunist use of nests, through management to encourage wild nesting colonies, 'bee having' of *Apis cerana* colonies in trees by Toda people, and to standard beekeeping of *Apis cerana* in wall and frame hives.