Final Evaluation Report

Your Details	
Full Name	Ritesh Kumar Gautam
Project Title	Diversity, distribution and ecology of wild bee (Hymenoptera: Apoidea) communities along the elevational gradient in Western Himalaya, Uttarakhand.
Application ID	30409-1
Date of this Report	22-12-2022

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To assess the diversity and distribution of wild bees and flowering plants along the elevational gradient in different habitat types.				First, we did habitat characterisation with the help of GIS and remote sensing. Then, stratified random sampling using a transect of 250 m length was conducted for assessment of vegetation and wild bees. We deployed five plots (100 m^2) per transect for studying vegetation. We followed a standard method by Mishra, 1968 to quantify vegetation parameters like species richness, abundance, and diversity (Simpson's Index). We observed and collected bee individuals using a sweeping net to assess bee communities. We also conducted passive sampling by placing sets of three pan traps (blue, white and yellow) at 20 points along the transect. The coloured pan traps are plastic bowls filled with a soapy water solution. The collected specimens were initially stored and preserved in 70% alcohol, later mounted in wooden insect boxes by standard pinning method for identification and further analysis.
To study the pollination interactions of wild bees in different habitats.				To study the visitation rate of pollinators, we established permanent plots in the study area across different elevations and habitat types. The visitation rate of a specific insect group to a particular plant was recorded through direct sighting and using Canon PowerShot® cameras with a developed hack. The hack enables the camera to take a picture on sensing motion detection (based on a change in pixel value). Thus, cameras on a tripod can be used as point

				camera traps. The hack used a motion-detection script in CHDK (Canon Hack Developer Kit).
To impart the knowledge about pollination services and creating a bee-friendly environment through outreach and awareness programs.				We are also spreading awareness about the significance of bees through (1) informal discussions, (2) social media campaigns, and (3) community outreach programmes. We prepared a concise, informative speech in informal discussions for curious people who asked questions during the fieldwork. In social media (Facebook and Instagram), we consistently share engaging articles, fun facts and photos of bees and native flora. Further, we organised community outreach programmes at Anganwadi centres, schools and the forest department offices adjoining the forest areas of Kedarnath Wildlife Sanctuary. We explained wild bee ecological and economic significance through posters, a training resource booklet and oral presentations. We had also proposed to prepare a short documentary, but the editing and finalisation of the documentary is still under process. We will be done with it shortly in the future.

2. Describe the three most important outcomes of your project.

a) The study in the Kedarnath Wildlife Sanctuary, western Himalayas, has yielded promising results of diversity and distribution of wild bees. We collected samples from native flowering plants using sweep nets and by deploying pan traps as a passive sampling technique. We managed to successfully identify a total of 122 morpho-species belonging to five bee (Apoidea) families: Andrenidae, Apidae, Colletidae, Halictidae and Megachilidae. Furthermore, we found an association between bee species diversity with forest types and elevations. The species diversity is highest in moist temperate mixed deciduous forests of mid-elevational zones (1800m–2800m asl). In contrast, alpine meadows of extremely high elevation zones (above 3600m asl) and gregarious pine forests of lower elevation zones (below 1800m asl) represent low species diversity. This coalition results in pollination interdependency between bees and the plants: the high-elevation plants (*Bistorta*, *Potentilla*, *Taraxacum*) are majorly pollinated by bumblebees. Thus, most of the bumblebees are localised in high elevations.

b) We used a novel approach to understand plant-pollinator interactions by using point-and-shoot canon cameras as point-focused (to flower) camera traps. We used a hack script for the camera, enabling it to take pictures based on pixel value changes. The area to be used as trigger and threshold can be adjusted, allowing us to customise the set-up as per the environmental conditions like wind speed and flower size. We captured thousands of pollination interactions as photographs using this technique. Such information is crucial for understanding and highlighting the importance of pollinators and plant species interaction in a particular ecological community.

c) In addition to ecological studies, we have conducted awareness and outreach programmes aimed at local communities, secondary-level schools, and concerned forest department personnel, where we enlightened the audience about the importance of wild bees' pollination services, the global conservation status, nesting behaviour, and their suitable habitat. We prepared PowerPoint presentations, posters and a Training Resource Material (TRM) booklet in English and Hindi language to use as outreach material. The TRM booklet is a concise (20 pages), easy-to-understand document used to distribute among students and forest officials as their reference manual. We also focused on connecting the audience as an impeccable helping hand and crucial driver for conserving the wild bee populations. In other informal awareness discussions mainly focused on tourists, we prepared an informative speech to advocate the importance of the management and conservation of bees in cities, as most tourists usually belong to cities. Further, we also used social media platforms to broadcast awareness and information about wild bees. On social media (Facebook and Instagram), we share ongoing project activities, outreach materials, engaging articles, fun facts and photos of bees and native flora.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

The COVID-19 outbreak has also tremendously affected our sampling timeline. The project was delayed almost 8 months due to the 2020 lockdown conditions. Also, the planned fieldwork for April to June 2021 couldn't be performed due to the further posed lockdown. The lockdown negatively impacted our fieldwork and our lab work accessibility, instruments and chemical availability.

Apart from COVID-19, there were some on-field challenges. The feasibility of the planned sampling location is one of the expected challenges; we did trade-offs in various aspects (accessibility, environmental conditions, human impact, etc.) and conducted our sampling. Wild animals posed the other unforeseen on-field challenge we faced while deploying the pan traps; cattle, goats, sheep, birds and even passing humans drank water out of our pan traps and trampled them. Eight of our samples were demolished, and we had to re-conduct the sampling for our study.

The unavailability of macro photography equipment to document and report the bee species is an obstacle we are facing now. We have proposed a grant for equipment support from IDEA WILD to address the same.

4. Describe the involvement of local communities and how they have benefitted from the project.

Outreach and awareness, field assistant hiring and local vehicle hiring, etc. The project has benefited the local communities in multiple different ways:

- In our awareness programmes and informal discussions, we explained the importance of bees with special reference to the functional aspect of pollination and crop yield. We used research-based examples to explain how crop yield depends on local farmers (mostly women). People showed interest in the same and initiated subsequent discussions led by questions. Further, we also suggested pollinator-friendly pest management techniques to maximise crop yield.

- We hired eight local people as field assistants and porters. We used local homestays as a base camp and had food there. This provided locals with a source of income generation for their basic sustenance.

- Our insect collecting equipment (sweep net) and sampling always ignited curiosity among children and elders. The discussion with local students and guardians gave them exposure to research as a career option. We also took a stereo-zoom microscope to our base camp, where we showed local villagers the unseen details of insects.

5. Are there any plans to continue this work?

Yes, we will continue this work and expand our study area to get more consolidated and versatile data on the ecology of wild bees. In our study, specifically, CHDK-enabled cameras proved to be a valuable tool for studying pollination interactions. Hence, using this tool, we would like to prioritise the endangered plant species in our further study to better understand their pollination. Since wild bee species are cryptic and morphologically difficult to observe; thus, we plan to generate DNA barcodes of the collected species for future reference. Further, we are also digitalising the bee specimen by producing high-quality detailed photographs to create an online bee specimen repository.

6. How do you plan to share the results of your work with others?

We have an audience-specific approach to share our results with the broad audience, including the research community, local stakeholders, students and the general public. Therefore:

- We have published one research article comparing the pollination efficiency of wild and domestic honeybee species on the black mustard crop. Also, we plan to publish (by June 2023) a minimum of two more peer-reviewed articles: one on the diversity of bees in the Himalayas against different elevational gradients and another related to pollination interaction.

- We also disseminate the information conference presentations (also necessary for the fulfilment of PhD degree) to the research community. We presented our work as an oral presentation at Rufford India Conference in Udaipur. As part of ongoing research on invertebrates, one poster has also been presented at the Wildlife Institute of India, Dehradun.

- We are sharing the TRM booklet with educational institutions, schools and the forest department. The booklet serves as a reference information guide for bees.

- One documentary is also under preparation, which will talk about research techniques, execution difficulties and our achievements during the persuasion of the project.

- We also actively post updates about the ongoing project activities on online social media platforms (Facebook and Instagram).

7. Looking ahead, what do you feel are the important next steps?

Bees are an ignored taxon in ecological studies. Species identification is a big hurdle. Therefore, detailed photographic keys are essential to correctly identify the specimen by comparing morphological features. But due to a lack of photography equipment, techniques and expertise; the preparation of a reference photographic repository has not been achieved yet in India. To ease the process of identification, DNA barcoding can pose as a reliable tool. To study pollination interactions

To study pollination interactions, insect visitation and interaction specificity are important aspects that need to be considered. Since ocular observation is less reliable and requires entomological expertise, the CHDK-enabled camera trapping system proves to be reliable tool for the study.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

We used the Rufford Foundation logo and acknowledged The Rufford Foundation in multiple various ways:

- We used the logo in our training resource material and posters for in-person outreach programmes and online circulation.

- We acknowledged The Rufford Foundation for funding our research article published in the Current Science Journal. We will also acknowledge The Rufford Foundation in our future publications.

- We used the Rufford Foundation's logo in our conference presentations: both in slides of oral presentations and research posters.

- We acknowledged The Rufford Foundation in our social media page. We also mention the foundation's official handle in our posts.

9. Provide a full list of all the members of your team and their role in the project.

Dr V P Uniyal: (Mentor)	Project design, writing and administrative support
Mr Ritesh Kumar Gautam (Project Lead)	Project idea conceptualisation, application grant writing, sampling design, sampling methodology and techniques, conducting sampling, processing samples, specimen preparation, bee identification, report writing, manuscript writing, and conference presentations.
Ms Kratika Goswami (Project Intern)	Preparation of outreach material, conducting awareness programs, handling the social media page
Ms Meera Rai (Project Intern)	Pollination interaction observations
Ms Kiran Kaintura (Project Intern)	Field data sampling and pollination interaction observations
Mr Dheeraj Chandra Joshi (Volunteer)	Research questions, rationale discussions, writing assistance and technical assistance
Ms Ambika Gautam (Volunteer)	Graphic designing of the outreach material and project logo.
Ms Garima Mishra (Volunteer)	Hindi translation of outreach material
Mr Sumit Rawat (Field Assistant)	Field data sampling and sample processing
Mr Sanjay Rana (Field Assistant)	Field data sampling
Mr Manish Bisht (Field Assistant)	Field data sampling
Mr Ashish Rana (Field Assistant)	Field data sampling

10. Any other comments?

The project was a great opportunity for me as an early career researcher. Our team has gained immense experience in the planning and execution of an independent research project. We faced many hurdles in our project, but we tackled most of them and found substitutions for the rest. It gave me great confidence as an independent researcher. We are thankful to The Rufford Foundation for trusting us and providing us with support for our research project. Also, I am grateful to The Rufford Foundation for their continuing patience regarding my project delays. We hope our results can be helpful in further research and inspire others to work on such ignored taxa.


HOW'S THE BUZZ?
HIGH SIR...
The Rufford Foundation
www.rufford.org
Why PROTECT our Buzzing Buddies ?
BEE BOUNDLESS
Greater abundance and diversity of wild bees guarantees pollination of domestic crops.
BEE BEAUTIFUL
Our aesthetical gardens and forests will never survive without their buzzing buddies.
1/3
BEE BENEFICENT
1/3 rd of our food is pollinated by bees.
How Do we PROTECT our Buzzing Buddies?
GO ORGANIC!
Avoid pesticides.
A BEE-FRIENDLY GARDEN
Native plants can enhance the native bee population.
PLASTIC IS A CONMAN
Don't throw the colorful plastics outside of the trash cans, bees may confuse trash as flowers.
LET THE WILD BEE
Don't disturb wild plants in forests.
BEE KIND AND SPREAD THE WORD!
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Wildlife Institute of India
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