ZOO'S PRINT

Communicating science for conservation

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Cover photo: Chamba Sacred Langur *Semnopithecus ajax*. © Amrin Ansari.

An experience to cherish

The beautiful white Dhulahdar mountain range. © Sanjay Molur.

"Himalaya are young mountains and still growing". This one fact fascinated me and I hadn't envisaged the possibility to visit and volunteer in the Himalayan Restoration Project (HRP) a succession of the Himalayan Langur Project (HLP) in Chamba district, Himachal Pradesh. This conservation project is run by Zoo Outreach Organisation (Zooreach).

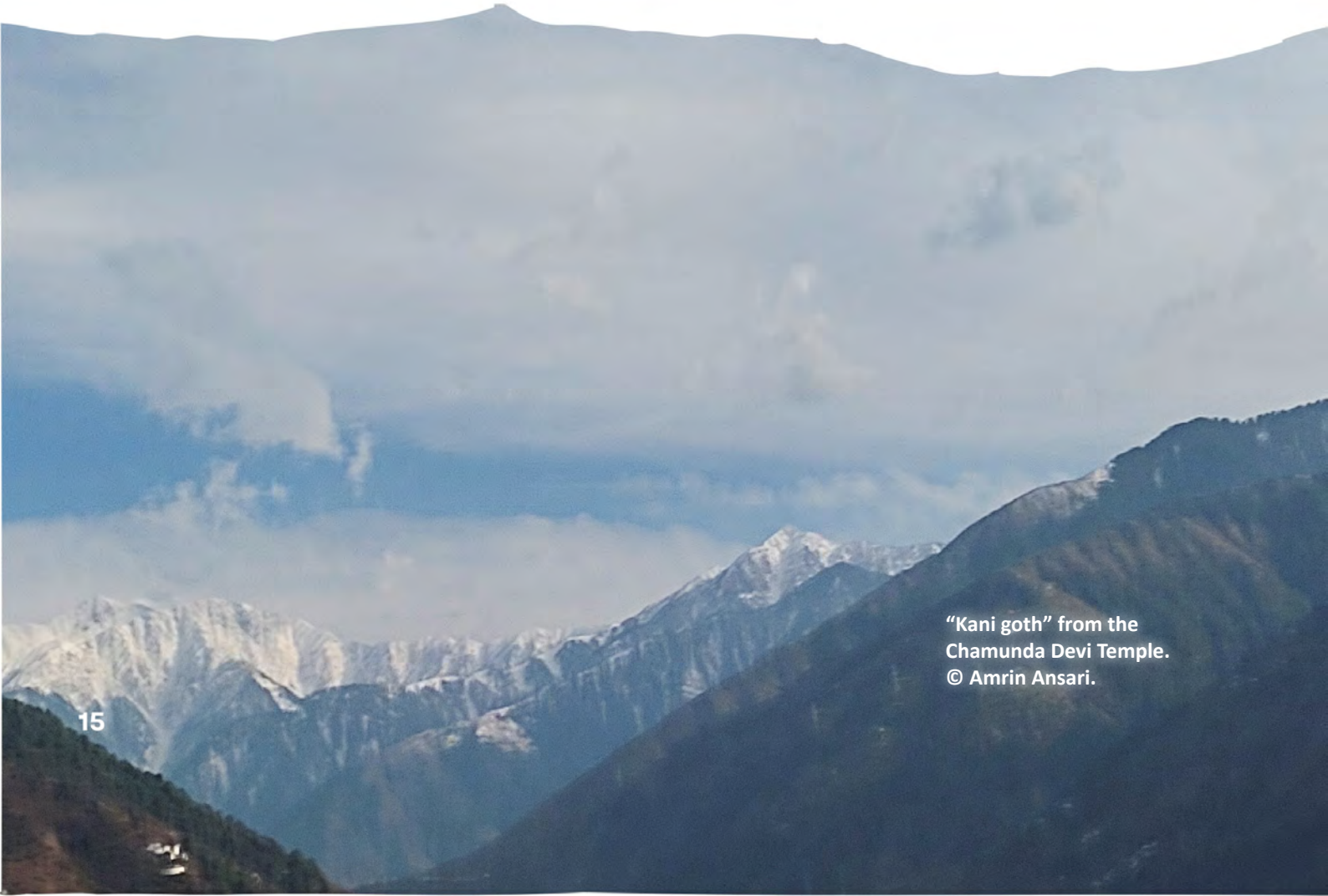
The mountainous journey began on 04 March 2024 as the sun rose, and I noticed the tussock grasses, gleaming under the sun on the steep slopes of the tall mountains. Grasslands being the theme for 2023–24 batch of the RHATC of which I was one of the 10 fellows, I couldn't help but notice these grasses all the way to Chamba and the mountains at

the far end, blanketed with snow. Before reaching Chamba I assumed that this place would be opposite of Ooty and would have pristine landscapes and untouched areas by humans. That was not the case, Chamba was well traversed by humans like most of the hill stations in southern India.

To get accustomed to the landscape, Amrin Ansari (my fellow-fellow at RHATC 23–24, and presently an intern with Zooreach in Chamba) and I went for a 2 km walk to the Chamunda Devi temple accompanied by Vishal Ahuja, the principal investigator in the HLP. Climbing up the hefty number of stairs to the temple, we saw the beautiful white mountain range "Kani goth". This peak, called Diamond Peak by Vishal, was glowing under the evening sun. He added that the Gaddis, a shepherd community, travel and camp for a few months during the summer for grazing their livestock at the grazing pastures surrounding this peak.

This peak falls in the Dhulahdar mountain range in Himachal Pradesh. Beyond it, in the horizon, was the uninterrupted Peer Panjal range and the Chamba Valley lies between these two ranges. It was a good start to comprehend this landscape that was taught briefly in geography classes back in school.

As we continued our journey, Vishal pointed out to the Chir Pine *Pinus roxburghii* trees. They are non-native trees that catch fire because of the resin, explained Vishal.
A few days later Sanjay Molur, executive director of Zooreach joined us and pointed out to an agriculture patch near the Chir



"Kani goth" from the Chamunda Devi Temple. © Amrin Ansari.

pine trees that was engulfed in fire the previous year and the devastating impact it had around.

Additionally, the Chir Pine trees were considered useless by the women of the Thukrel Village where the team from Zooreach (Amrin Ansari, Trisa Bhattacharjee, Kritika, Vishal Ahuja, and Sanjay Molur) had visited women self-help groups to create awareness about the importance and need of restoration. The women mentioned that the forest area (due to Chir Pine) has been increasing and also the crop raiding by wild animals. With decreasing species of native trees to feed on, the Black Bears, Rhesus Macaques, and the Chamba Sacred Langurs have no choice but to pay unannounced visits to agricultural lands and the communities are affected. During one of the meetings with the women self-help groups we noticed a group of Rhesus Macaques feeding on the flowering mustard crops. This leads to negative interactions and consequences for both the wild animals and the communities. It's unfortunate that species that do not belong to a particular region were consciously or unconsciously transported by humans and are now causing problems to the

Canopy of Chir pine tress. © P. Kritika.

The old Chamba Town, view from the Chamunda Devi Temple. © Amrin Ansari.

people, landscape, and the climate of the region. However, I was glad to see the efforts undertaken to develop a native plant nursery by the Zooreach team working in Chamba with the motive to propagate native trees like Horse chestnut *Aesculus indica*, Himalayan pear *Pyrus pashia*, Wild Himalayan cherry *Prunus armeniaca*, Walnut *Juglans regia* among other native species maintained in the nursery. All this is with the intention to reduce the negative interaction in the medium-term future by restoring the landscape with native saplings.

At the nursery, I was fascinated to learn from Vishal about the mountain terrain – the distinction between the southern and northern facing slopes. He pointed out that the southern slopes are characterized by their steepness and sparse vegetation, as they receive more direct sunlight, causing snow to melt relatively quickly. On the other hand, the northern slopes are typically more humid and lush with vegetation, featuring less steep inclines.

The agricultural plots are predominantly found on the northern slopes because of the moisture content. Vishal also explained this topography while we were heading towards the Khajjiar-Kalatop Wildlife Sanctuary enjoying the scenic drive. Initially, we saw snow covered mountains and patches of snow from Chamba and before long we were playing in the snow. An experience to cherish! Around 4 pm, we saw a group of six Chamba Sacred Langurs *Semnopithecus ajax* trying to cross the road. As they climbed down the tree waiting for the right moment, a speeding vehicle would pass by and the langurs would climb back on the tree. Vigilantly, one

Working at the nursery set up by Zoo Outreach Organisation.
© Sanjay Molur.

Vishal Ahuja explaining about the Himalayan Restoration Project to the women self-help groups at the Thukrel Village. © P. Kritika.

by one, they moved across to the other side. It was my first time observing the langurs and playing in the snow.
"I had last seen a good amount of snow over 8 feet in 2012 and never again", Vishal expressed to which Sanjay remarked "that would probably be the last time you will ever see". This one statement gives a stark reality of how the climate has changed over the years. With the expansion of human settlements in Chamba, the weather pattern has significantly changed. The Chamba town extended till the Chamunda devi temple but over the 10–12 years the other side of the temple has seen an increase in settled areas. The vehicular traffic nowadays surpasses what Chamba Town has ever seen before. The Ravi River flows across this town and witnesses the changing scenario. Dams that were constructed on this river have significantly contributed to the changes with danger of flash floods occurring during heavy rains. The expansion of roads and construction of highways are in full swing here. Why are such activities increasing when it's slowly destroying these fragile mountains? Conserving this landscape becomes more important and crucial considering damages that have been imposed and continues to be inflicted upon.

Agriculture patches. © Paridhi Modi.

The team at Chamba (left to right) – Amrin Ansari, Paridhi Modi, Vishal Ahuja, P. Kritika, Trisa Bhattacharjee & Sanjay Molur. © Sanjay Molur.

The Himalaya are renowned for their breathtaking landscapes and the vastness. Working and volunteering here meanwhile learning about the landscape was an amazing experience altogether. During my two-week stay, I understood the need

The vigilant Himalayan Grey Langurs in the Khajjiar Kalatop Sanctuary attempting to cross the road. © Amrin Ansari.

and importance of the restoration project through various stakeholders. It took Zooreach over a decade of research on the Chamba Sacred Langurs to ascertain the need and possibility of the Himalayan Restoration Project to conserve the species and this landscape by involving the communities and the forest department. I was glad to take part in the conservation efforts by working in the nursery, interacting with women self-help groups and the forest department.

Acknowledgements

Firstly, I would like to thank Payal Molur who encouraged me to write an article about my experience in Chamba. Amrin Ansari, Kritika P, Vishal Ahuja, who helped me with understanding the landscape and species. Thanks to Vishal Ahuja for going through the article and giving valuable feedback. A special thanks to Sanjay Molur and Trisa Bhattacharjee for involving me in the conservation project. Thanks to the women's self-help groups for providing insights about wildlife.

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One month of work in the landscape: March 2024 news update

The past month since I came to Chamba, it has been very eventful. To start with, I visited the nursery after a long time being away from here during the winter. Almost all the saplings had lost their leaves (dormant). The nursery and the surrounding area were looking dry. But by the end of the month as spring approached, the saplings came back to life after several months of dormancy. Everything seemed green, bursting with life, as spring should be.

Some new plants were added to the saplings by sowing seeds of native species of the Hill Neem *Melia azedarach*, Walnuts *Juglans regia*, 930 and 247 seeds, respectively. Some stubborn seeds which require special treatment to germinate, like the Ban Oak *Quercus leucotrichophora* were kept in a manure mixture for 30–40 days. The seeds, by the way, were collected in March from trails where footfall is more, and there are very rare chances of regeneration. Other species like the Himalayan Poplar *Populus ciliata* and Himalayan Mulberry *Morus serrata* were propagated by grafting stems in the bags, 310 and 161, respectively; which, by the way, are sprouting with new leaves. It is always good to see the add ons in the nursery. For more additions of the plant species, which we have yet to sow, we collected seeds of the Wild Himalayan Cherry *Prunus cerasoides*, which recently started to come up.

Moving on, we had a lot of meetings this past month – the meetings with the women's

New sapling of Horse-chestnut (*Aesculus indica*) in the nursery. © P. Kritika.

Seed collection of *Quercus leucotrichophora*. © P. Kritika.

Visit to the Forest Department nursery. © P. Kritika.

Camera trap training session with the forest department. © P. Kritika.

Camera trap set up with the forest department. © P. Kritika.

self-help groups where we interacted with the locals and introduced our project along with getting their opinions on the ongoing issues regarding the crop loss. In the process I also introduced myself and my work in their landscape, and asked them for their help in gathering valuable information. We met with the pradhan of Rathiyar Panchayat who we have been working with for a while now, the conservator of forests, Chamba, to discuss the project and collaborate with them for our restoration project. The team also delivered a session on operating camera traps to the forest department personnel and installed it in areas where there could be possible bear movements. We visited two forest department nurseries in Chamba, where

Interaction with a caretaker in the Forest Department nursery, Udaipur. © Paridhi Modi.

Sowing seeds of *Melia azedarach*. © P. Kritika.

Interaction with the Randoh school kids. © P. Kritika.

Planting sapling during HRP inauguration. © Trisa Bhattacharjee.

different techniques of seed germination and propagation were shared with us.

And a very exciting news! The official inauguration of the Himalayan Restoration Project was conducted in Randoh School which falls in the Rathiyar Panchayat. The principal, the pradhan and the panchayat board members, school staff, and some people from the local communities participated and planted 12 saplings in the school. We interacted with the kids, telling them about our work. It was a fun interaction, with them being enthusiastic in the idea of helping us in the plantation work – when it happens in June or July.

Interaction with the women in WSHG meeting. © Paridhi Modi.

That's all the news update for Chamba in March from me. More to come in the future.

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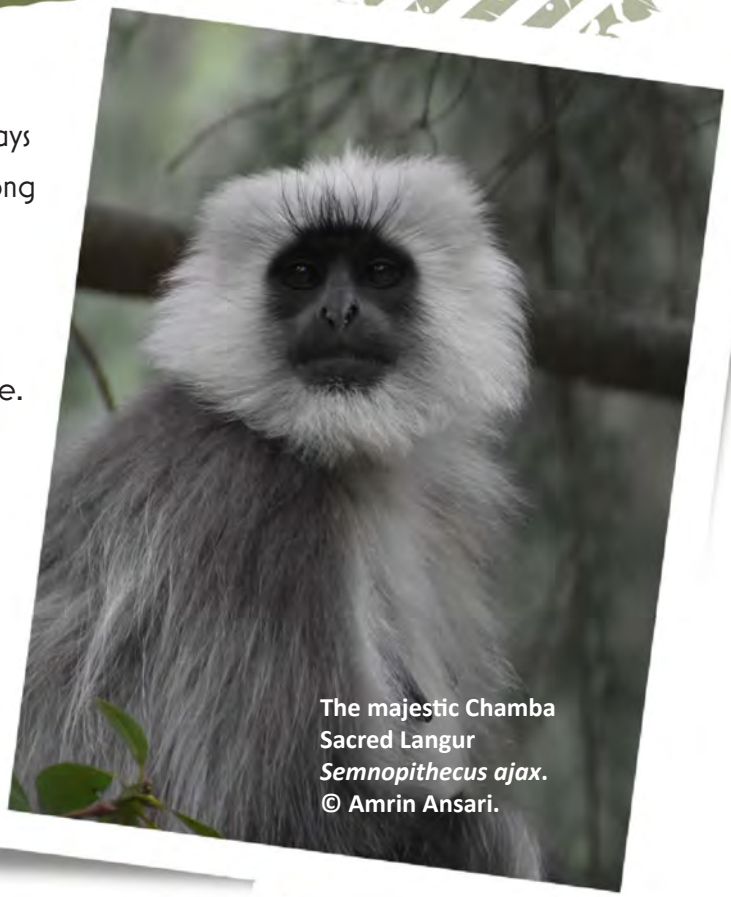
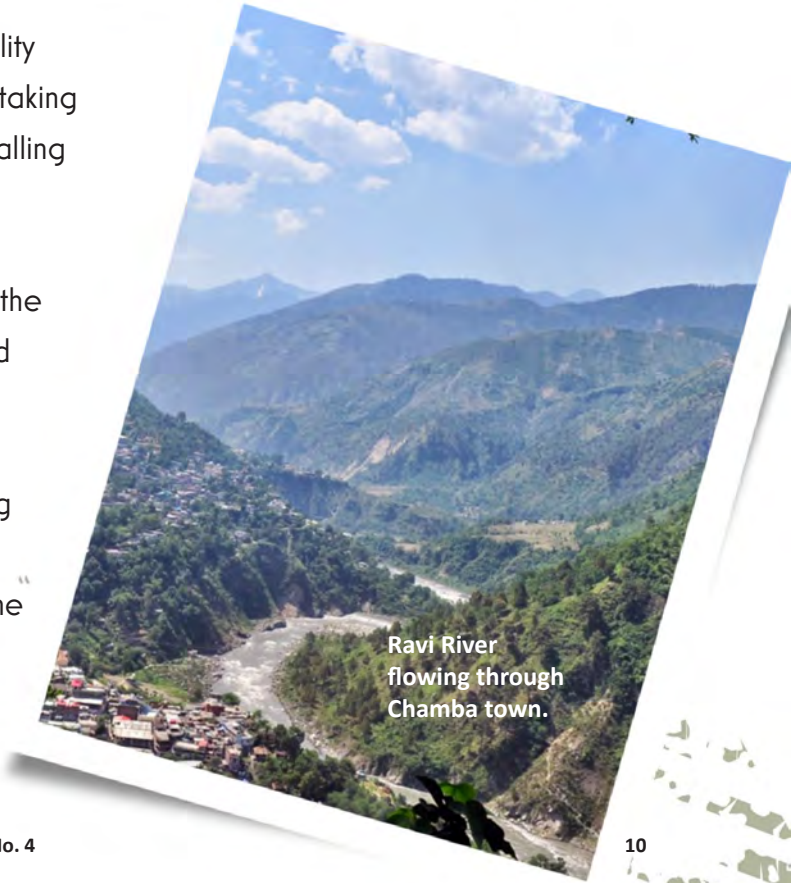
One Month of Working in Chamba

Human-wildlife negative interactions have always caught my attention since a young age. I belong to West Bengal, a state where these negative interactions regularly pop up in the daily news. Hence, the spark for understanding these interactions and their mitigation has been in me. I was thrilled when I got an internship to work on the Human-Black Bear interactions in the western Himalayan landscape in Chamba, Himachal Pradesh.



The majestic Chamba Sacred Langur *Semnopithecus ajax*. © Amrin Ansari.

To begin with, I was surprised because Chamba is not what I imagined at all. I had the notion that the place would be a small, secluded, and quiet valley. But, the honking trail of cars jammed in heavy traffic in the middle of the crowded city gave me a reality check of the exploding human population that is taking over the remotest places, building shelters, and calling them home.



Ravi River flowing through Chamba town.

The mighty river Ravi flowing through the heart of the town, the picturesque landscapes of snow-capped mountain ranges, and the melodious song of the Himalayan Whistling Thrush are enough to make someone fall in love with this place. Despite being densely populated and the city core densely planted with non-native plant species like Chir pine *Pinus roxburghii*, Silky oak *Grevillea robusta*, *Eucalyptus*, etc, the Chamba valley is home to a wide variety of native plants like Ban Oak

HLP-HRP Update

Quercus leucotricophora, Himalayan Cherry *Prunus cerasoides*, Indian Spruce *Picea smithiana*, Deodar *Cedrus deodara*, *Pyrus pashia*, etc. Having a rich cultural significance, amazing food, and being home to the kindest and warmest people, Chamba is a very welcoming place for comfort seeking geeks like me.

Himalayan Bulbul *Pycnonotus leucogenys*. © Amrin Ansari.

My visit to the Khajjiar-Kalatop Wildlife Sanctuary allowed me to see a group of the majestic Chamba Sacred Langurs *Semnopithecus ajax* who were on the move while foraging. Sadly, what I also noticed was the unending traffic of tourist cars and enormous dumps of plastic waste inside the sanctuary which are not a good sign for wildlife or ecosystem health.

Chirping beauties on *Pyrus pashia*

Rufous Sibia *Heterophasia capistrata*. © Amrin Ansari.

As part of my internship, I devote 40% of my time to work in the nursery. Our team has successfully managed to sow 930 seeds of *Melia azedarach* and 200 seeds of Walnut *Juglans regia*. We have also grafted about 161 saplings of *Morus serrata*. Approximately, 3,400 Ban Oak *Quercus leucotricophora* have also been collected and put for pre-sowing treatment in the nursery until they begin to sprout. On 21 March, we successfully inaugurated the Himalayan Restoration Project (HRP) by planting 12 native saplings near the campus of Rajkiya Varist Madhyamik Vidyalaya, Randoh with the participation of the village pradhan, school faculty, and a few members from the local communities.

With the help of the forest department, we successfully managed to set up six camera traps at three different locations to get an understanding of the local fauna with special emphasis on the movement of mammals. Unfortunately, one of the traps got stolen so we had to take down the one adjacent to it. The remaining traps are actively working and are being regularly monitored.

Green-backed *Tit Parus monticolus*. © Amrin Ansari.

To date, our team has managed to organize four meetings with the local women self-help groups where we try to understand their problems regarding

Meeting with the WSHGs.

Team members interacting with the participants. © Sanjay Molur.

the impact of climate change and wildlife on their agricultural practices. We learned that crop raiding by wild fauna is the main driving factor behind human-wildlife negative interactions in this landscape. Their livelihoods are at stake because of crop depredation which is mostly caused by Rhesus macaques *Macaca mulatta*, Chamba Sacred Langurs *Semnopithecus ajax*, and Asiatic Black Bears *Ursus thibetanus laniger*. Porcupines are rare nocturnal rodents in the agricultural grounds but they do not contribute to any significant crop damage. But the non-human primates impart damage throughout the year

Planting grafts of *Morus serrata*. © Sanjay Molur.

HRP Nursery at Dugli. © Amrin Ansari.

Planting on the campus of Mehla nursery. © Sanjay Molur.

while Black bears mostly raid maize crops during monsoon. We noticed a troop of macaques feeding on a crop field bearing mature mustard plants in Saun village while conducting a meeting. Apart from that, the sight of macaques feeding on anthropogenic food from garbage dumps is visible throughout this region. In the following months, I aim to study the perception of the local communities regarding Black Bears in detail and try to work a way towards mitigation.

Setting up of traps.

Trisa explaining the setup.
© Amrin Ansari.

Camera trap workshop with the Forest Department.
© Sanjay Molur.

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Farmer chronicles: Understanding perceptions of women on crop raiding in Chamba, Himachal Pradesh

The Himalayan Langur Project (HLP) is working to restore the extremely neglected, poorly known, deteriorated broad-leaf oak and pine forest habitat in Chamba, western Himalaya. This is a long-term project in partnership with local communities in 28 villages who are interested in growing native vegetation on their non-arable farmland to support local wildlife such as langurs, black bears, macaques, and porcupines to reduce their dependence on crops.

To fulfil the project objectives, we visit all the villages in the study area and interact with the women there to empower them and carry outreach activities to equip them with eco-based adaptations and educate them on climate change mitigation.

During the interactions we also carry out group perception studies to understand the needs of the people in the landscape and their understanding of the project & climate crisis. Knowing the areas specific perseverance's is very important to make any wildlife study successful (Dickman 2010). In some places human-wildlife interactions may lead to human-human conflict between people sharing different goals, cultures, attitudes, feelings, and wealth (Madden 2004).
Since 15 March 2024, the Himalayan Restoration Project (HRP) has conducted four outreach activities at Chittar, Saun, Jhille Nalli, and Mayari Gala villages. The groups have been a mix of young and old women who took part equally in the meetings.

Chamba, Himachal Pradesh—Himalayan Restoration Project has been working here since 2021, to restore the degraded forest and livelihoods. © Sanjay Molur.

All the discussion were open ended and instead of conducting individual surveys we discussed together in groups with everyone. Conversations were in Hindi and Chambyali. We tried to understand the major livelihood sources of the people, challenges they face, effect of climate change on their lives, and finally tried to understand the solution they want. A majority of the women we interacted with were associated with agricultural

activities, growing maize, barley, radish etc. People in all the villages said that they saw langur and macaque troops every day in their village. In Saun we saw a group of macaques going around the village and entering people's houses.

Chittar

A village under the Bakhatpur panchayat, 15 minutes trek away from the main roads was visited on 15 March 2024. We interacted with over 20 women from the self-help groups here. Here women are mainly associated with farming related activities. They feel there has been a sharp reduction in farming produce and thus livelihoods due to crop raiding in past few years. According to them the population of monkeys, langurs, and black bear have increased over the past few years along with increase in forest cover. But the women in the village agreed that forests lack food for wild animals. All the respondents felt that the Chir Pine plantations were useless, as neither animals feed on them nor is it of any use for the people. Some people felt that the animals have been introduced in the landscape by the forest department. In general, people were upset with increasing macaque population in the villages.

When asked about climate change and its effect, people acknowledged the changing rainfall patterns and snowfall. Though they agree that climate change is causing loss in crop produce, majority of the people thought loss caused by animals is more. Only a few women thought that crop loss caused due to climate change and raiding is similar.

Saun

We visited Saun village, under Rathiyar panchayat on 16 March 2024, to carry out a meeting with 15 women of self-help groups and understand their perceptions. All the women in this village work in their agricultural farms. All the women were very angry with the increasing population of macaques in their village and farms and feel that the crop loss is caused due to macaques and langurs. Crop raiding caused due to black bear is comparatively less. Women here said that the forest cover has reduced and there is no food for the animals in forest. People's livelihood

Himalayan Restoration Project team carrying out discussion and understanding women's perceptions at Chittar village. © Sanjay Molur.

has been affected severely due to increasing crop raiding.

The women in this village believed that crop raiding is lot more responsible for their crop loss than climate change. The people agree that there has been change in rainfall and snow fall pattern but were not ready to agree that it causes major crop damage.

Jhille Nalli

On 17 March 2024, we visited Jhille Nalli village in Bakhatpur panchayat region to talk to the women there. Most of the women in this village were farmers, while two of them were studying MBA & teaching kids. Surprisingly, in this village unlike the other two, the population of langurs was quite more than that of macaques. People said that this change had happened over last 10 years. People see black bears seldom as well but are not hostile or afraid of the animal. Women here agreed that the forest cover has reduced and so has the food for animals but did not know what to do.

When asked about climate change, people knew it was causing loss of crops but were unable to quantify or compare the damage with that caused by the animals. In general majority of the respondents felt that langurs are responsible for major crop damage.
One of the respondents Miss Puja, has been associated with the project for quite some time now. The HRP team planted saplings on her farm as a recce project earlier, but due to lack of rain, most of the saplings could not survive. This incident helped a few people among the respondents understand that lack of rain was also leading to major crop loss.

Himalayan Restoration Project team carrying out discussion and outreach activities with women at Saun village. © Sanjay Molur.

Mayari Gala

The 4th meeting with the women self-help group was held on 2 April 2024 at Mayari Gala. Eleven women from the same village enthusiastically participated in the meeting. As it was the advent of spring, the number of participants was restricted because most of the women were busy in farming activities. Macaques and langurs were the reason for major crop loss in this village. Women said that macaques were more in number and more frequent than the langurs and follow similar feeding patterns. People here saw bears during monsoon in maize farms and frequently in apple orchards. In this village four people had been attacked by bears in 2023 in their respective farmlands. Women here were scared to go to the farms since these incidents hence most of the people did not farm anymore affecting their livelihoods. People said that crop raiding problems have increased in past five to six years, forcing the villagers to restrict farming near their homes, to keep an eye on their fields.

The HRP team interacting with the women to understand the problems they face at Jhille Nalli. © Sanjay Molur.

When asked about climate change, women agreed that change in rainfall pattern has hampered their agricultural practices but were certain that crop raiding was a major issue. They felt that forests have reduced due to landslides caused by heavy rains.

People in general across the four villages understood the fact that lack of food in the forest is forcing the animals into the crop fields, but none of them were ready to coexist with the animals in the villages. People complained that increased raiding has stopped them from growing their own vegetables and thus now they must buy their daily greens affecting them financially. People wanted to get rid of the macaques and langurs as they caused major damage. Except in Jhille Nalli, macaque population and visits were more in all the three other villages and more.

Macaques were seen damaging crops, digging out sown seeds, and raiding shops and homes in search of food. Though black bears caused crop loss, people were not that hostile towards the animal. This maybe because black bears come at night and thus lack of sightings makes people less intrigued, or the size of the animal is too overwhelming for villagers and thus they fear the animals. Though only in one of the villages there was bear attack in recent years, all the people across the landscape were afraid and a lot of them felt that bears feed on people. While people in Saun were not as afraid of black bears. This maybe because they see the animal often and thus lack of any

attack or conflict makes them overwhelmed of the animal but not afraid. The only two of the respondents who understood that it was not animals' fault to raid the crops, but that we humans have degraded their forest were literate.

People understand that the climate has been changing over years and that it is affecting their crops, but only a few of them agree that it has equal or more effect on crop loss than raiding. People did not understand the reason behind climate change and thus don't know what action to take. People who have seen direct effect of rainfall leaving to failure of plant growth understand that climate change is impacting the crops. Women in Chittar felt that the area under forest has increased even though there is a continuous fall in forest cover. This might be because the people thought small scrubby patches to be forest, and since this forest are usually invasive plants, they spread quite fast, making the women feel that the forest cover is increasing.

It is usually seen that traditional practices and indigenous people are much more tolerant and considerate towards the idea of coexistence, with wild animals, compared to people who have no experience with living in multiuse landscapes (Songhurst et al. 2016), but in this landscape though people were living for a few generations still they were antagonistic towards the idea of coexistence. Also, at time occupational changes and technological advancement associated with modern contemporary ideas may tend to take people away from their sacred idea of wild (Manfredo et al. 2003).

The success of any conservation study depends on the role of the conservationists and researchers in influencing the behaviour of indigenous people associated and in properly enforcing the approach important for conservation in that area (Keane et al. 2008).

HRP team visited Mayari Gala to understand the perception of the women in this region and solutions they want. © Vishal Ahuja.

After understanding the perceptions of the women, we addressed to them the objectives of the Himalayan Restoration Project and that we needed their help to achieve success. The women were quite interested to understand the restoration program that we will carry out in the region before monsoon 2024. Some villagers offered us a piece of their land to carry out plantation as well. We were lucky to interact with a few young members who were keen to join the project and help us carry outreach activities with more villages in the landscape. The ladies agreed to help us plant saplings on their farms and take care of them.

The discussion helped them understand that how these native wild fruit trees will provide food to the animals and reduce crop raiding in the region.

The meetings have helped us understand the importance of education and outreach programs to explain the women and youth the importance of forests and coexistence to fight climate crisis which in turn will reduce the crop loss. Including community interests and educating the community as a part of conservation has a successful outcome towards positively changing the way people think (Waylen et al. 2009). We understand the need of the people and are collaborating with them as key stakeholders to take part in the Himalayan Restoration Project.

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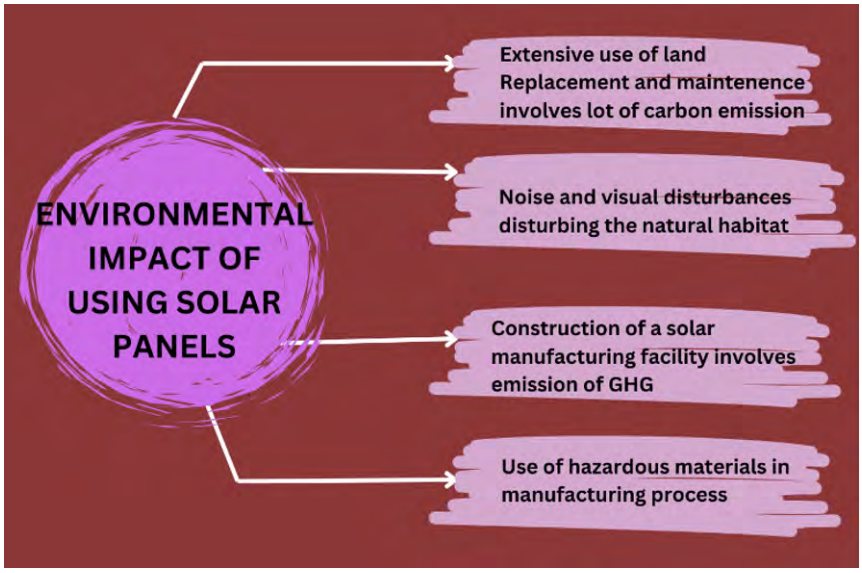
Understanding economic and ecological benefits by assessing the trade-off between solar farms and the grassland ecosystem

Introduction

Grasslands and solar farms share a common feature: both involve the absorption of sunlight (by grasses and solar panels, respectively), converting it into chemical and electrical energy, respectively. However, these forms of energy serve distinct purposes. Grasslands are natural habitats of perennial & annual grasses, seasonal herbs and shrubs, and occasional tree species providing various ecosystem services and some studies have delved into the economic worth of these services, while solar farms necessitate large amounts of investments and yield economic benefits for the manufacturing, installation, and electricity distribution companies. This article highlights the economic and ecological advantages of grasslands and solar farms.



Adapted from Tawalbeh et al. (2021). Illustrated by C.K. Arjun.

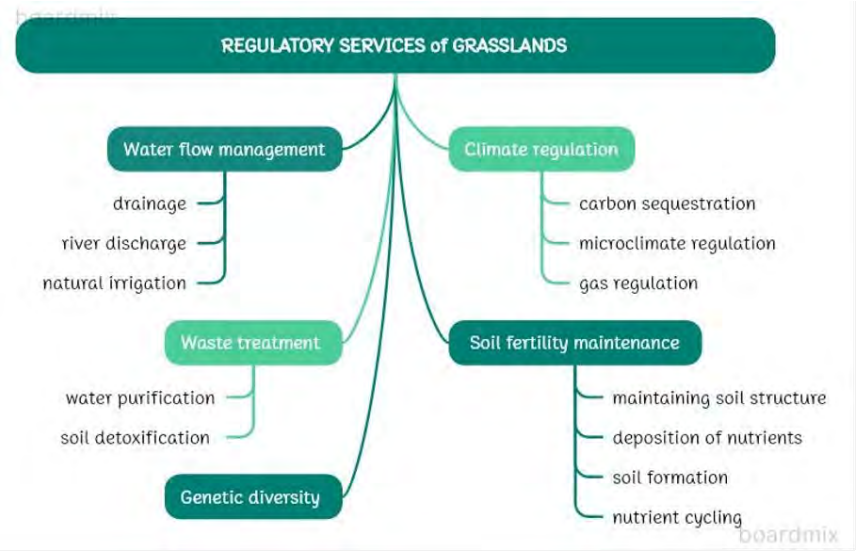
Ecological Advantages

Grasslands provide a high ecosystem service value called regulatory and cultural services like recreational value to humans; provisional services like food supply & raw material; and water supply services, erosion control, pollination etc (Liu et al. 2022).

Grasslands are also essential to the carbon and water cycles. They hold about 20% of the world's soil organic carbon (SOC) stocks (Dondini et al. 2023). On the other hand, the manufacture of solar panels involves processes such as casting, rolling, purification, foil extrusion, polymerization etc., for which raw materials such as silicon, aluminium, glass etc., are required (Nikalaos & Christopher 2013). Numerous scientific and policy reports have examined the harmful impact on the environment. Producing solar energy causes damage to the biodiversity, scenic landscape, water supplies, natural quiet, and cultural resources (Nagle 2013).

Economic value of grasslands and solar farms

According to Liu et al. (2022), the economic value of regulating services is, on average, four times more than that of provisioning services or eight times greater than that of food supply services for all grassland ecosystems across the world. They are



Adapted from Liu et al. (2022). Illustrated by M. Paridhi.

worth US$ 2,877 per ha per year, or 53% of the tropical grasslands' overall monetary value. The annual economic value per hectare of tropical grassland together of all services is US$ 5,466 per ha. On the other hand, a one-megawatt solar farm requires approximately 6–8 acres of land and a significant investment of US$ 890,000 to US$ 1.01 million. This would generate on an average US$ 40,000 annually for 6–8 acres (Coldwell Solar 2023). This means that approximately US$ 12,300–16,500 revenue can be generated per hectare per year.

The trade-off

Solar farms can be a great form of investment, however, installing solar panels in grasslands can have direct and indirect consequences on the environment. Clearing and levelling the land disrupts natural habitats for plants, insects, and small animals, leading to biodiversity loss and ecosystem disruption. Heavy machinery compacts the soil, hindering plant growth and soil health. Solar panels casting shadows can reduce grass and vegetation growth underneath, affecting photosynthesis (Gibson 2009; Kunhikannan & Rao 2013). Changes in the landscape alter water runoff patterns, increasing erosion and sedimentation in nearby water bodies. Maintenance practices involving cleaning agents can harm grass and vegetation if spilled.

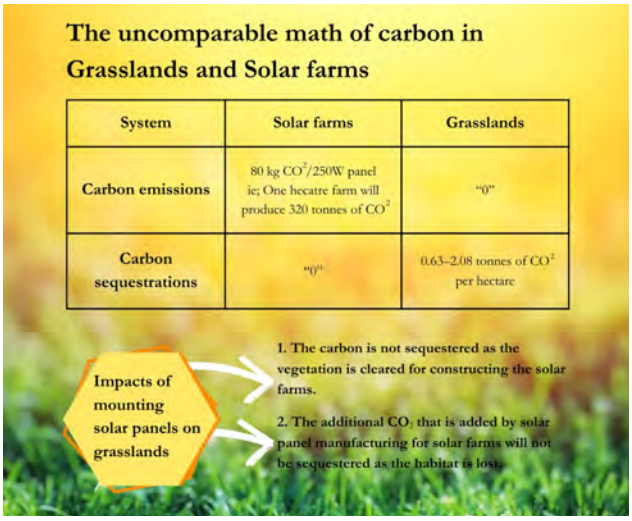
Fauna displacement due to construction and operation disrupts local ecosystems (Turney & Fthenakis 2011). In a study by Rawat & Adhikari (2015), grasslands make approximately 24% of India's total land area. Assuming if 10% out of the 24% of grassland area is converted into a solar farm will pose a significant risk of irreversible damage to the ecosystem, potentially resulting in detrimental consequences for both wildlife and humans.

Carbon sequestration by grasslands: According to Bai et al. (2022), the achievable SOC sequestration potential in global grasslands is 2.3–7.3 billion tons of carbon dioxide equivalents per year (CO_{2e} year−1) for biodiversity restoration, 148 to 699 megatons of CO_{2e} year−1 for improved grazing management, and 147 megatons of CO_{2e} year−1 for sown legumes in pasturelands. Grasslands cover 26% of the world land area covering 3.5 billion hectares of land (Ghosh & Mahanta 2014).

The approximate total sequestration potential of global grasslands considering the above data would be 2.5 to 8.1 billion tons of carbon equivalents per year. Following are the calculations:

	Range Carbon equivalents per year (In billion ton)	1 megaton CO_{2e} = 1 million ton 1 billion ton = 1,000 million ton 1 ton = 0.907185 tonne
Biodiversity restoration	2.3 to 7.3	
Grazing management	0.148 to 0.699	
Sown legumes	0.147	
Total	**2.595 to 8.146**	

In 3.5 billion ha of grasslands, the achievable SOC sequestration potential ranges from 2.5 to 8.1 billion tons of carbon equivalents annually. This equates to sequestering 0.7–2.3 tons (which is 0.63–2.08 tonnes) of carbon equivalents per ha each year.



Carbon emissions by solar panel manufacturing:
According to Stoppato (2008), the manufacturing of one panel ejects into the atmosphere the equivalent of 80 kg of CO_2 and one panel has a capacity of 250 W (A 250 W panel has the capacity to produce 1kWh power every day). The size of commercial 250 W solar panels is 2.31 sq.m. (Sykes 2024). Following are the calculations to derive the carbon emissions during the manufacturing stage.
1 hectare = 10,000 m^2
A size of solar panel is 2.31 m^2
$\rightarrow$ 10,000 m^2/2.31 m^2 = 4,329.004 panels
Considering that some space is required in between solar panels we are approximately estimating 4,000 panels are required in one hectare of land.
And 80 kg of CO_2 is released into the atmosphere by the manufacture of one panel
$\rightarrow$ 4,000*80 kg = 320,000 kg
320,000 kg = 320 tonnes of carbon emissions

Hence to set up 1 ha of land with solar panel 320 tonnes of CO_2 will be emitted just during the manufacturing process. Solar panels on grasslands will emit 0.63–2.08 tonnes of carbon equivalents per ha each year adding the carbon that would have been sequestered by undisturbed grasslands.
So where can we potentially place solar panels to ensure grasslands are conserved?

A fitting place for solar panels

Choosing the location for the installation of solar panels is a hypersensitive task. For a country like India, which is rich in biodiversity, it becomes more crucial. We have to consider the species diversity of the area and make sure that none of the species are affected as we know that the alarming situation of the climate crisis is increasing and the chance of species extinction is very high for the coming decades, which is around 33% by 2050 (Thomas et al. 2004). Even though solar energy is much lower in carbon emission compared to other energy sources such as fossil fuel and coal (Arcos et al. 2019), the incorrect placement of the panels can be highly detrimental as it takes a huge amount of landmass to set up and construct the solar panels. It takes away the habitat of many species, mostly grasslands becoming

Alternate spaces for instalment of solar panel

Solar panels can be best installed in occupied spaces such as parking lots, roofs, and landfills. This will be utilizing already disturbed or degraded land to install photovoltaic systems significantly lowering the impact on grasslands thereby actually contributing positively to mitigating the climate crisis.

Grasslands in focus

Grasslands are a prominent biome on Earth, covering about 40% of its land area. They are primarily characterized by grasses, herbs, some shrubs and very few trees, but they also host a variety of animals, fungi, and soil microbes, contributing significantly to the biodiversity. Grasses have developed unique characteristics that enable them to thrive in challenging environments, such as extreme climates, specific soil types, frequent fires, and grazing pressure, which collectively prevent the encroachment of woody plants and maintain the integrity of grasslands. These ecosystems can be found in nearly all climate zones, with the exception of the polar regions, extremely arid areas, and the highest mountain ranges (Petermann & Buzhdygan 2021).

the holocaust for all so-called technological advancements. Ideally, solar panels can be best installed in occupied spaces such as parking lots, roofs, and landfills, i.e., utilizing already built up or irreversibly degraded lands to install photovoltaic systems would significantly lower the impact compared to the utilization of undisturbed land (Tawalbeh et al. 2021).

Conclusion

Solar farms are indeed alternatives of energy relative to coal and fossil fuels, but destroying grasslands and natural vegetation for construction of solar farms have more adverse effects than benefits considering the climate crisis. Grasslands are one of the carbon sinks, which helps in sequestration of tonnes of carbon, and destroying the last patches of grasslands will only contribute to increased Green House Gasses, temperature rise and decreased water retention.

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The lowest altitudinal records of Himalayan Serow in India

The Mainland Serow *Capricornis sumatraensis* is a member of the order Cetartiodactyla, belonging to the family Bovidae and the subfamily Caprinae (Phan et al. 2020). The global distribution of Mainland Serow spans 11 countries, including China, southeastern Asia, and the Himalayan range (Phan et al. 2020). There are five known subspecies of *Capricornis sumatraensis*: *maritimus* & *mildneedwardsi* restricted to much of China, Myanmar, & southeastern Asia; *rubidus* restricted to the hilly tracts south of Brahmaputra, southwards from Nagaland into Bangladesh; *sumatraensis* restricted to Indonesia, Malaysia, & Thailand; and *thar* restricted to the Himalayan range (Phan et al. 2020).

Himalayan Serow *Capricornis sumatraensis thar* in VTR. © VTR/WWF-India.

Apart from India, the Himalayan Serow *C.s. thar* is also distributed in Nepal, Bhutan, Bangladesh, China (Tibet), and probably into western Myanmar (Grubb 2005). Its distribution in India is relatively continuous throughout the Himalaya, ranging from Jammu & Kashmir through Nepal and Bhutan to the eastern side of Arunachal Pradesh (Phan et al. 2020). The Himalayan Serow usually inhabits steep, rugged, inaccessible, and densely forested areas of the Himalaya (Aryal 2008; Menon 2014). It also prefers moist and thickly wooded gorges, broadleaved valleys and subalpine scrub situated at 1,500–4,000 m. In addition, it is seen on open cliffs and rocky slopes (Aryal 2008).

The distribution of Himalayan Serow in India and Nepal's Himalaya was previously reported to span a broad elevation range. The upper limit of its altitudinal distribution is documented to be at 3,000–3,500 m (Aryal 2008; Giri et al. 2011). Recent surveys conducted by WWF-India indicate occurrences as low as 500m in sal-dominated *Shorea robusta* habitats in the Uttarakhand Himalayas (Johnsingh & Manjrekar 2015). The species has been observed at its lowest altitude in the northeastern Himalaya

in India, with a recorded altitude of <200 m (Sathyakumar 1994; Duckworth & MacKinnon 2008). However, records below 300 m in the western Himalaya are very rare.

We photo-captured Himalayan Serow (~50 photo-capture) at an elevation ranging between 186 m and 372 m (Average = 273 m) in Valmiki Tiger Reserve (VTR), India during the camera trapping exercises performed between 2013 and 2016–17.

At three instances, the species was photo-captured below 200 m. It was first photo-captured on 19 March 2013, at an elevation of 188 m in the Raghia Range. The capture site was characterized by a slow-moving perennial water stream, with undulating terrain dominated by Sal *Shorea robusta*. The nearest human habitation from the capture site was approximately 4 km away (aerial distance).

Subsequently, it was again photo-captured at altitudes of 195 m and 186 m on 20 November 2016 and 14 December 2016, respectively, in the Gobardhana Range. These locations are part of the Shivalik Hill Chain, known for its rugged terrain within the VTR. Numerous small water streams crisscrossing the habitats flow from north to south. The surrounding vegetation comprises a typical of bhabhar dun sal forest dominated by *Shorea robusta*, *Terminalia elliptica*, *T. bellirica*, and *Lannea coromandalica* in the top canopy. In the middle and understory, species such as *Dillenia pentagyna*, *Miliusa tomentosa*, and *Mallotus philippensis* are prevalent. The ground cover is dominated by *Clerodendrum infortunatum* and *Indigofera tinctoria* (Maurya & Borah 2013).

The Himalayan Serow is legally protected as a Schedule-I species under the Indian Wildlife (Protection) Act 1972, and is also classified as 'Vulnerable' on the IUCN Red List of Threatened Species (Phan et al. 2020). Accurate knowledge of a species' geographical distribution and altitudinal range is crucial for preparing effective conservation strategies. Species with wider variation in altitudinal range may better exploit available resources. Obtaining current altitudinal records of the Himalayan Serow from VTR can contribute to improving our understanding of its distribution pattern across its range. This study significantly expands our understanding of its altitudinal distribution, marking the lowest recorded altitudinal instances of the species in its range. The documented occurrences at altitudes as low as 186–195 m in the VTR underscores the adaptability of the Himalayan Serow. Notably, most records of Serow were restricted to the central part of VTR which is part of the Shivalik hill chain, this highlights the ecological significance of this region and urges further study to comprehend inter and intraspecific interactions among herbivores.

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Kaiser-i-Hind sighted at Darjeeling Hill of West Bengal, India

Kaiser-i-Hind *Teinopalpus imperialis* photographed at Tiger Hill in Darjeeling District of West Bengal, India. © Asim Giri.

This note represents the first published photographic record of the elusive Kaiser-i-Hind *Teinopalpus imperialis* from Darjeeling District of West Bengal, India.

Teinopalpus imperialis (Hope, 1843) is a very beautiful rich green coloured swallowtail butterfly. This rare and elusive butterfly has three subspecies: *T.i. imperialis* (Hope 1843), found in Assam, Manipur, Meghalaya; *T.i. himalaicus* (Rothschild 1898), found in Arunachal Pradesh Sikkim, West Bengal; *T.i. imperatrix* (de Nicéville 1899) found in northern Myanmar southwards to Ataran River (Varshney & Smetacek 2015), southern China, Vietnam and Laos (Inayoshi 2012) from middle to higher altitudes (1,800–3,000 m) in the wooded mountains (Soibam 2016).

This beautiful butterfly was photographed at 26.9970 N, 88.2767 E while I was watching birds with a group on a jungle trail towards Tiger Hill on 07 August 2022. The area was dominated by Malingo bamboos along with Pine (*Pinus*), Oak (*Quercus*) and thorny bushes. It was a pleasant, clear morning and the time was around 0900 h. Suddenly, I saw a very interesting butterfly flying around over us with other butterflies. Then I tracked it for about half an hour. When it had settled down on a bamboo twig (facing

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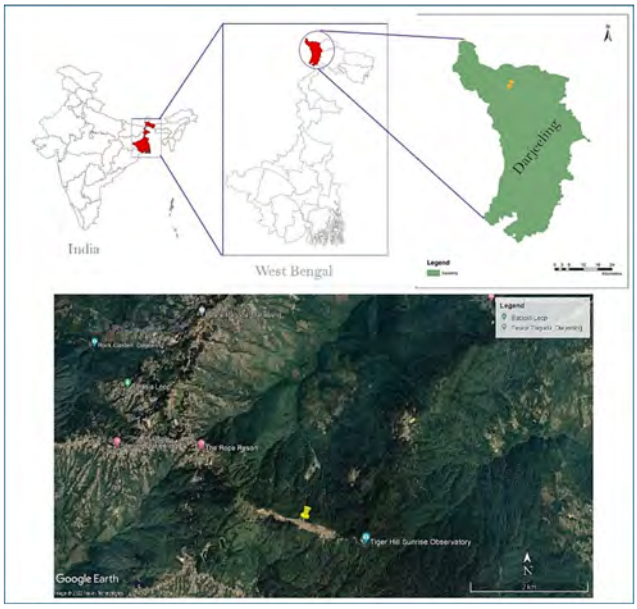

Location where Kaiser-i-Hind *Teinopalpus imperialis* was photographed at Tiger Hill in Darjeeling District of West Bengal, India. Google Earth.

northeast), I was able to take a few photographs using my Nikon Coolpix B700. This butterfly was easily identified from the unique identifying keys and plates (Evans 1932; Kehimkar 2008; Wynter-Blyth 2009). I encountered this butterfly twice on that same day. The first one was observed about 300 m behind this photographed one. So, it is quite possible that there could be two butterflies present on that day.

There are also few recent records of this species from Darjeeling, either without photographs or publication (Mnauky 2008; Rai 2022). Its global population is 'Near Threatened' according to IUCN Red List (Dixon 1996). It is also a protected species under the Indian Wildlife (Protection) Act (1972), Schedule-II and now, it is the state butterfly of Arunachal Pradesh (The Hindu 2021).

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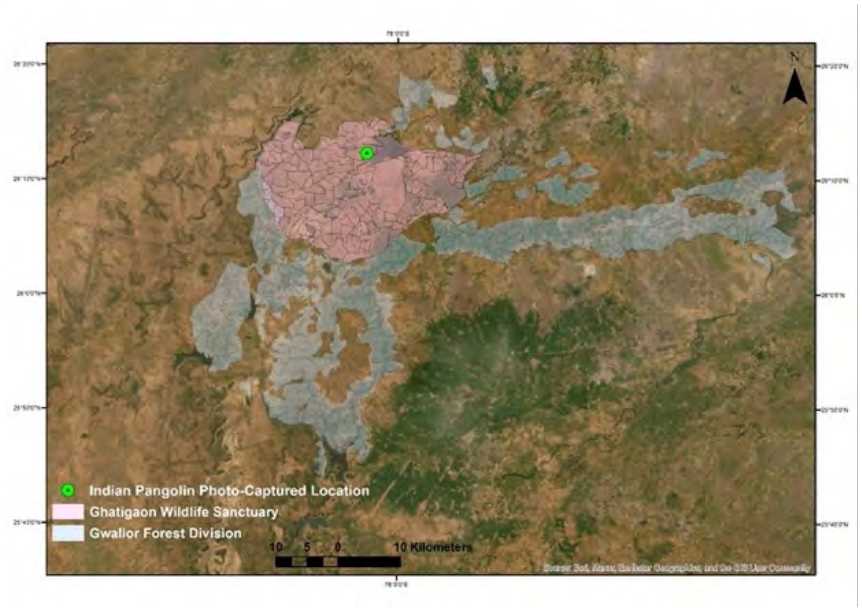
Photographic evidence of Indian Pangolin from Gwalior Forest Division, Madhya Pradesh, India

The Indian Pangolin *Manis crassicaudata* otherwise known as the Thick–tailed Pangolin, is an average-sized insectivore manid native to southern Asia (Mahmood et al. 2020). Pangolins comprise eight living species globally, with two found in India: The Indian Pangolin and the Chinese Pangolin *Manis pentadactyla* (Kumar et al. 2016). Despite its significance, little research has been conducted on Indian Pangolins. The species is classified as Endangered on the IUCN Red List of Threatened Species throughout its distribution ranges (Mahmood et al. 2020). However, specific studies conducted locally suggest the Indian Pangolin is Endangered in Nepal (Jnawali et al. 2011), Vulnerable in Pakistan (Sheikh & Molur 2005), and Near Threatened in Sri Lanka. Its population is rapidly declining due to illegal hunting and poaching for its meat, scales, and other products (Mahmood et al. 2020). Legal protection is provided for the Indian Pangolin under Schedule I of the Indian Wildlife (Protection) Act 1972, as well as in Appendix I of CITES, which prohibits international trade in the species (CITES 2017).

Photo capture of Indian Pangolin from GFD. © Devavrat Pawar.



Map of Gwalior Forest Division highlighting the area where the Indian Pangolin was photo captured.

The species is widely distributed across parts of eastern Pakistan, and the Indian subcontinent and extends south to Nepal,

Habitat of Gwalior Forest Division. © Udayan Rao Pawar.

Sri Lanka, and Bangladesh (Srinivasulu & Srinivasulu 2012). In India, these elusive mammals can be found from the Himalayan foothills to the south of the country, excluding the far north and northeast (Tikader 1983). Due to the pangolins' adaptive nature, the species inhabits a wide range of diverse habitats, including natural forests, timber plantations, grasslands, plains, hilly areas, and agricultural lands near human settlements (ZSI 2002). The opportunistic mammal feasts primarily on insects and termites, using its olfactory senses to trace and its elongated saliva-coated sticky tongue to draw in the prey (Mahmood et al. 2020). The nocturnal species naps during the daytime, curling up itself into the burrows excavated using their sharp claws (Mahmood et al. 2020). Historical anecdotal accounts have mentioned the presence of Indian Pangolins in the region. Incidents of illegal wildlife trade related to pangolins have also been recorded from the Gwalior region. On May 2016, in Gwalior, Madhya Pradesh, three poachers were apprehended with several kilograms of rare Pangolin

body parts (Wildlife SOS 2016). While previous literature indicates the presence of Pangolins in Gwalior (Saxena 1986), this camera-trap image of the Pangolin is, to the best of our knowledge, the first documented photograph within the region. The results presented in this report could provide significant supporting data indicating the existence of Indian pangolins within the Gwalior Forest Division.

Study Area and Photo Capture Event

The photograph of the Indian Pangolin was captured during a camera trap survey conducted opportunistically by the Gwalior Forester's Society. Two camera traps were strategically placed in the forest for one month (March 2023). The placement site for the cameras was chosen strategically, considering the results of prior sign surveys, to optimize the probability of capturing the diverse wildlife in the area.

The Gwalior Forest Division (GFD) encompasses a land area of around 2,150 km^2 along the Agra-Mumbai Road and is located at an elevation ranging from 132–443 m. The GFD serves as a significant wildlife corridor facilitating the movement of various animals, including tigers *Panthera tigris*, leopards *Panthera pardus*, Sloth Bears *Melursus ursinus*, and more. It is interconnected with Kuno National Park and Madhav National Park, enhancing ecological connectivity and facilitating the conservation of these species (Pawar et al. 2022). The northern and southern dry deciduous forests region is dominated by tree species like Dhau *Anogeissus pendula*, Salaiya *Boswellia serrata*, and Palash *Butea monosperma*.

The camera trap was positioned in a mixed forest where *Anogeissus pendula* is the dominant species. One Indian Pangolin was photo captured in one out of the two camera traps during the study period. The camera traps captured various mammalian species. These include the Striped Hyena *Hyaena hyaena*, Indian Jackal *Canis aureus*, Wild Boar *Sus scrofa cristatus*, Chital *Axis axis*, Blue Bull *Boselaphus tragocamelus*, Four-horned Antelope *Tetracerus quadricornis*, Indian Hare *Lepus nigricollis*, Ruddy Mongoose *Herpestes smithii*, and Indian Crested Porcupine *Hystrix indica*.

This study serves as the first photographic evidence of the Indian Pangolin in GFD, MP. Recent advancements in camera trapping techniques have provided valuable insights into the distribution and presence of shy and endangered species, including the Indian Pangolin. However, research on this species remains limited, and comprehensive studies are necessary to develop effective conservation plans and strategies across its entire range, including the GFD. The Indian Pangolin is highly threatened by poaching due to the growing demand in the trade market (Mahmood et al. 2020). It is crucial to take proactive measures to combat hunting and disrupt the trade supply chain associated with this species.

Currently, the population size of Indian Pangolins is unknown in the GFD region, emphasizing the need for further research to better understand their distribution, population dynamics, and the threats they face. The first photographic record of pangolins in a specific area highlights the importance of intensive camera trapping surveys to assess their distribution and obtain reliable density estimates.

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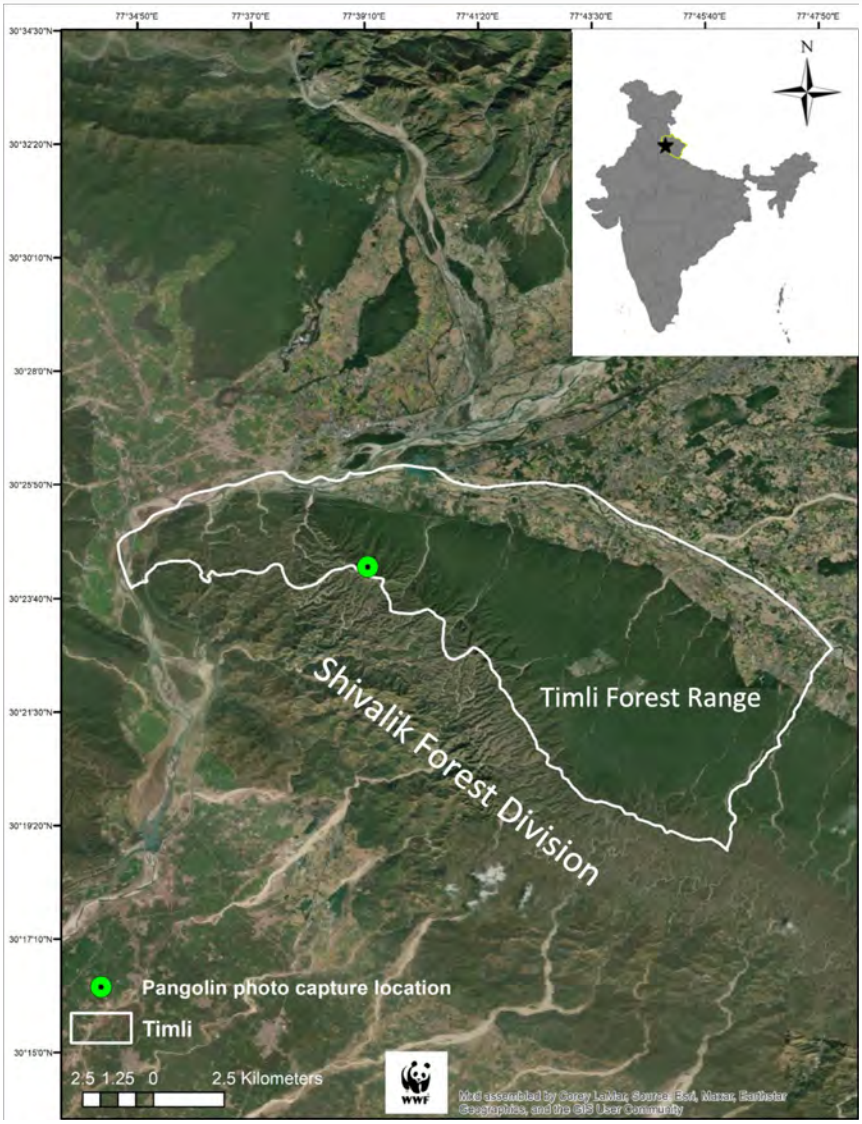
Photographic evidence of the Indian Pangolin in Timli Range, Soil Conservation Forest Division, Uttarakhand

India hosts two pangolin species: the Indian Pangolin *Manis crassicaudata*, classified as 'Endangered' on the IUCN Red List (Mahmood et al. 2019), and the Chinese Pangolin *Manis pentadactyla*, ranked as 'Critically Endangered' (Challender et al. 2019). The Indian Pangolin's known distribution spans southern Asia, excluding the Himalaya, from eastern Pakistan across much of the Indian subcontinent. The range of the Indian Pangolin extends throughout India from northern India (Roberts & Vielliard 1971) to certain regions of the northern Western Ghats and northern Eastern Ghats (Aditya et al. 2021). The species sighting has also been indicated in both coastal and mountainous forested areas of Odisha (Mishra & Panda 2012). With an altitude range of 0–2,000 m, it thrives in tropical, sub-tropical, dry-mixed evergreen, sub-mountain, and riverine forests (Roberts 1977). Adult Indian Pangolins weigh 8–16 kg and measure up to 148 cm, with their tail constituting around 39–54 % of their body length (Mahmood et al. 2019). Their specialized diet comprises insects, mainly ants and termites, which they capture with their adhesive tongues (Karawaita et al. 2020).

Camera trap image of the Indian Pangolin from Timli Forest Range, Uttarakhand. © WWF-India.

It faces threats across its range due to widespread hunting, poaching, and trade for its skin, scales, and meat (Mahmood et al. 2012; Perera & Karawita 2020). Its derivatives are highly sought after, making it the world's most trafficked wild animal (Shepherd 2009). In India alone, nearly 6,000 pangolins were poached between 2009 and 2017 (Challender 2020). Recognizing its rapid decline, the Indian Pangolin is listed under Schedule I of the Indian Wildlife (Protection) Act 1972, which prohibits hunting and emphasizes on conservation. It is also included in CITES Appendix I, banning



Location where the Indian Pangolin was photo captured in Timli Forest Range.

commercial international trade (CITES 2017). Despite these protections, illegal trade persists.

This report highlights the presence of the Indian Pangolin in the Shivalik Bhabhar tract in Western Uttarakhand, India. Limited studies have explored the pangolin's distribution, habitat use, and ecology in this area. Our findings suggest a potentially larger geographic range than previously understood, providing valuable evidence for the extent of Indian Pangolins in the region. This discovery points to a broader distribution than previously recognized and contributes significant evidence to the species' range in the area.

Study Area

Timli Range is found within the Soil Conservation Forest Division, Kalsi. It shares its boundary with Barkala Range of Shivalik Forest Division in the south, Malhan Range of the Dehradun Forest Division in the east and Kalesar National Park of Haryana in the west, which is connected to Timli Range via the Yamuna River. The terrain is undulating (elevation ranging 300–1,000 m) and has diverse habitats including sal forests (dominated by *Shorea robusta*), mixed forests (dominated by *Mallotus philippensis*), and Himalayan forests (characterized by *Pinus roxburghii*). There are steep hills, deep valleys, and several rocky streams (raus). While the northern part of Timli Range is hilly, comprising of steep slopes which characterise the typical Shivalik Range, the southern part of this range has extensive sal forest patches, which are regularly frequented by elephants. Being a junction of sorts, the area is exposed to over 200 species of birds and many invertebrate species (WWF India unpub.). This range also serves as a crucial wildlife corridor for tigers, elephants, leopards and other animals and facilitates their movement

Habitat of Timli Forest Range, Uttarakhand. © Devavrat Pawar.

between Rajaji Tiger Reserve, Uttarkahand, Shivalik Forest Division, Uttar Pradesh, to Kalesar National Park, Haryana & Simbalwara Wildlife Sanctuary, Himachal Pradesh.

To better understand the diversity and distribution of the mammalian fauna in the Timli Range of Soil Conservation Forest Division, Kalsi, a rigorous and continuous camera trap survey was conducted between February and March 2022. Around 150 camera traps were deployed for 25 days throughout the range, with pairs of cameras placed in each 2 km^2 grid cell to maximize coverage, providing comprehensive coverage of the study area.

The pangolin was photo captured at a single-camera trap location at 2300 h on 3 March 2022, at an elevation of 808 m. The terrain where the pangolin was photo captured, was rugged and undulating. The dominating vegetation cover at the location consisted of Sal *Shorea robusta*, Rhoini *Mallotus philippensis* and Kadu *Clerodendron*.

This record of the Indian Pangolin is the first documented evidence from the Soil

Conservation Forest Division, Kalsi. However, it isn't the initial record within the Shivalik-Bhabar region. Previous sightings exist in Rajaji Tiger Reserve, Uttarakhand (WWF-India unpub.). Additionally, Singh et al. (2023) recently photographed the Indian Pangolin in the neighbouring Colonel Sher Jung National Park in Himachal Pradesh. These findings emphasize the continuous presence of the Indian Pangolin in the Shivalik-Bhabar region, extending beyond protected areas. Advancements in camera trapping techniques have enhanced our understanding of these elusive, endangered species' distribution and presence. Due to limited studies (Mahmood et al. 2019), comprehensive data on the Indian pangolin remains scarce. In-depth research in their habitats is essential for grasping ecology, behaviour, and addressing threats like poaching, habitat fragmentation, and linear infrastructure (road accidents and obstruction to connectivity). Such insights are pivotal for designing effective interventions, and supporting survival across its range, including the Shivalik Hills. Given the unknown population size, continued research on the distribution and population dynamics of the Indian Pangolin is imperative. This knowledge will contribute to forming robust conservation strategies, ensuring survival beyond protected areas.

An Indian Pangolin road kill, near Rajaji Tiger Reserve. © I.P. Bopanna.

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Distribution of Rusty-bellied Shortwing in Assam with a recent record from Lakhimpur District

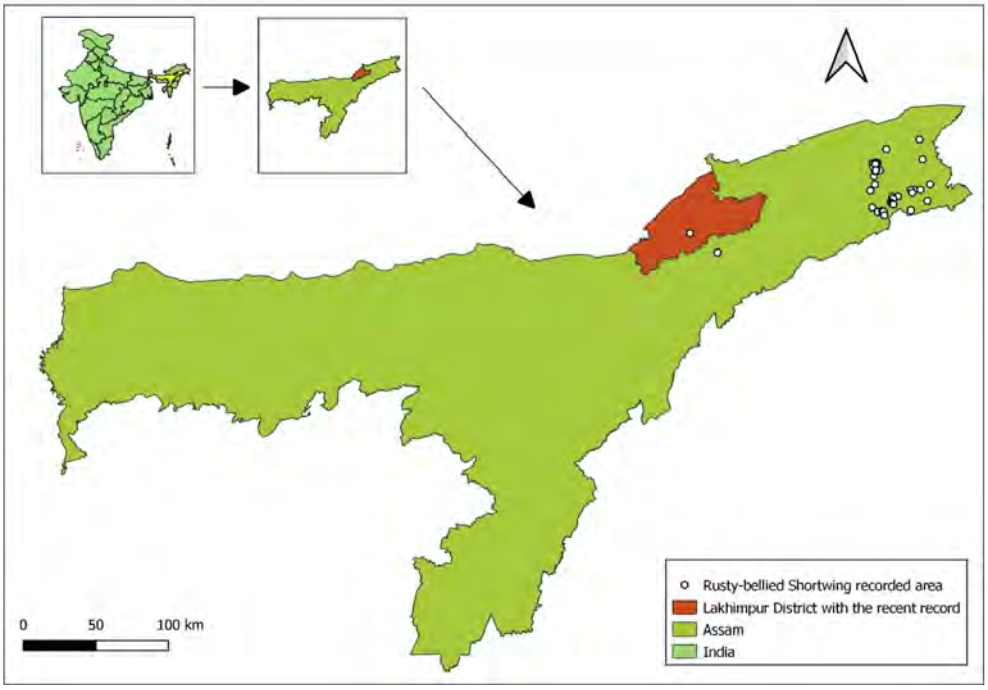
Assam, being a unit of two zoogeographic sub-regions, the Indian and the Indo-Chinese, is immensely rich in avifaunal diversity with more than 800 species (Choudhury 2000) and holds 55 Important Bird Areas (Rahmani et al. 2016).

The Rusty-bellied Shortwing *Brachypteryx hyperythra* is a restricted range species found in eastern Himalaya in extreme northern West Bengal, Sikkim (possibly adjacent western Bhutan), Assam, Arunachal Pradesh, extreme northern Myanmar, and southern China (Xizang & Yunnan) (Collar 2020).

In Assam, the distribution of Rusty-bellied Shortwing is mostly concentrated in the eastern part of Assam, i.e., records of Rusty-bellied Shortwing are mostly from different areas of the three districts of upper Assam, Tinsukia, Dibrugarh and Majuli (eBird 2023). Recently, the Rusty-bellied Shortwing was recorded from the Kuhiabari (27.102 N, 94.109 E) area of the Lakhimpur District, 17 km from the north Lakhimpur town on 16 December 2023 and was photographed on 17 December 2023. After analysing the records of the species in the eBird basic dataset, we consider this record from Lakhimpur District as the western most record of the species from Assam.

Rusty-bellied Shortwing. © Jugal Borah.

The Rusty-bellied Shortwing is 10–15cm in size, male has a short white supercilium and black lores, blue upperparts including wings and tail and rufous-orange underparts. Female has olive brown upperparts, paler rufous-orange underparts with whitish centre to belly and lacks the white supercilium. Terrestrial habits, orange chin, undertail coverts, shorter tail, and longer legs help separate from the Snowy-browed Flycatcher (Grimmett et al. 2016). The recorded individual was identified by noting the short white supercilium and rufous-orange underparts along with pinkish-black long legs. The individual was also giving response to the song playing for confirmation of the species.



Distribution of Rusty-bellied Shortwing in Assam with the recent record from Lakhimpur District.

The species is listed as 'Near Threatened' on the IUCN Red List with criteria C2a(i) and population trend is decreasing (BirdLife International 2018) because of forest clearance and degradation probably mainly through logging, small-scale fuelwood collection, conversion to tea plantations, shifting agriculture and livestock grazing (Collar 2020).

Lakhimpur District is located in the northeast corner of the state and lies on the north bank of river Brahmaputra and covers an area of 2,277 km^2. Lakhimpur District witnessed several changes in terms of land use and land cover which has negative impacts on its environment. There have been remarkable changes in terms of area of forest land from 1998 to 2020. As in 1998, forest land covered 845.45 km^2 (37.12%) which decreased to 393.93 km^2 (17.30%) in 2020. The forest area has declined by 19.82% over the period which may be due to increasing population pressure as well as for various developmental activities (Singh & Bhattacharjee 2021).

Occurrence of the species in the Kuhiabari area of Lakhimpur District, Assam indicates that the area has suitable habitat for the species. Since the species is 'Near Threatened', therefore necessary action to conserve the habitat and awareness among local people about the species and habitat is utmost important in order for long-term conservation of the species.

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Observations on brood parasitic behavior of Jacobin Cuckoo fledgling at AMU campus, Uttar Pradesh

The avian brood parasites depend totally on the hosts to raise their young. They lay eggs directly into the nest of their hosts and leave parental care duties to the foster parents (Payne 1977; Ridley & Thompson 2012). It is rather a rare breeding strategy, a total of 100 species of brood parasites exist, accounting for nearly 1% of all the avian species (Davies 2000). Over 200 host species in various habitats, from reedbeds to mountainous areas, are known to be exploited across their range, indicating strong relationships with many passerine species occurring in various habitats (Yun & Lee 2022).

Adult Jungle Babbler.

Adult Jacobin Cuckoo.

Jungle Babbler fledgling.

Jacobin Cuckoo fledgling.

Adult Jungle Babbler feeding the fledglings.

Adult Jungle Babbler with both the fledglings.

© Mirza Altaf Baig.

In southern Asian countries, brood parasitism is found in several members of the family Cuculidae and one species of Indicatoridae, i.e., the Yellow-rumped Honeyguide (Ali & Ripley 1981b; Praveen & Lowther 2020). However, there are only a few of these parasites, and their associated hosts' interactions have been studied in detail (Nahid et al. 2016).

Jacobin Cuckoo is a partial migrant species belonging to the family Cuculidae and is found throughout the Indian subcontinent up to an elevation of 2,600 m (Ali & Ripley 1981a). The host species within its range includes the genus *Argya*

mainly in the plains and the *Garrulax* species at the higher elevations (Gaston 1976; Becking 1981; Praveen & Lowther 2020). Bhatt (2019) has documented a Jacobin Cuckoo pair trying to distract an Indian Paradise-Flycatcher at its nest. Their breeding season mainly coincides with the monsoon when most regions of the subcontinent have received a sufficient amount of rain and the caterpillars are abundant (Payne 2005; Praveen & Lowther 2020).

During a visit on 2 August 2021 at the Aligarh Muslim University campus, Aligarh District, Uttar Pradesh (27.912 N; 78.081 E), we sighted a Jacobin Cuckoo fledgling within a flock of Jungle Babblers. As we approached, it flew and perched on the outer canopy of *Senna siamea* tree. The babblers kept foraging on the ground. The parasitic fledgling was observed calling constantly throughout the time. After some time, the flock moved to the same branch the cuckoo fledgling was perched upon. As the babblers approached, it started calling loudly begging for food. A few minutes later, the parasite fledgling moved to the inner canopy of the same tree.

Three days later, we found the same scenario near the previous location. This time the Babbler fledgling was also there as the nestlings of this cuckoo species are non-evictors of host eggs (Payne 2005). The Jacobin Cuckoo fledgling was at a distance from the host fledgling, hiding within the grasses or perching on the outer canopy of a nearby *Ficus benghalensis* tree, but kept changing its position according to the movement of the Babbler fledgling. The adult babblers were observed picking figs from the ground. The cuckoo fledgling was exhibiting a peculiar wing movement while calling for food, similar to that of the host fledgling. As the parent approached the host fledgling, the parasitic fledgling quickly moved there and took a large amount of food from the beak of the foster parent. The babbler fledgling tried to push the cuckoo in order to get the proper amount of food. This happened several times until the cuckoo fledgling flew away. Similar kind of observations of the Common Hawk-Cuckoo and Jungle Babbler pair has been reported from Bhubaneswar, Odisha (Priyadarshini & Satapathy 2021).

Within the same campus, the other brood parasites recorded are Asian Koel and Common Hawk-Cuckoo. The Jungle Babblers that are parasitized by the two widely distributed cuckoos in peninsular India will be the perfect subject for further exploration.

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ZOO'S PRINT

Communicating science for conservation

ZOO'S PRINT Publication Guidelines

We welcome articles from the conservation community of all SAARC countries, including Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka and other tropical countries if relevant to SAARC countries' problems and potential.

Type — Articles of semi-scientific or technical nature. News, notes, announcements of interest to conservation community and personal opinion pieces.

Feature articles — articles of a conjectural nature — opinions, theoretical, subjective.

Case reports: case studies or notes, short factual reports and descriptions.

News and announcements — short items of news or announcements of interest to zoo and wildlife community

Cartoons, puzzles, crossword and stories

Subject matter: Captive breeding, (wild) animal husbandry and management, wildlife management, field notes, conservation biology, population dynamics, population genetics, conservation education and interpretation, wild animal welfare, conservation of flora, natural history and history of zoos. Articles on rare breeds of domestic animals are also considered.

Source: Zoos, breeding facilities, holding facilities, rescue centres, research institutes, wildlife departments, wildlife protected areas, bioparks, conservation centres, botanic gardens, museums, universities, etc. Individuals interested in conservation with information and opinions to share can submit articles ZOOS' PRINT magazine.

Manuscript requirements
Articles should be typed into a Word document with no more than 800 words of text and 10 key References (Tables, Images with copyright information, and Videos are encouraged) and emailed to zp@zooreach.org. Include the names of one or two potential reviewers when submitting a publication.

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E**ditorial details**
Articles will be edited without consultation unless previously requested by the authors in writing. Authors should inform editors if the article has been published or submitted elsewhere for publication.

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