Understanding Diversity and Distribution of Tiger Beetles and Their Conservation Through Community Participation Along the Ramganga River Uttarakhand, India

The Rufford Foundation

Progress Report:

Understanding Diversity and Distribution of Tiger Beetles and Their Conservation Through Community Participation Along the Ramganga River Uttarakhand, India

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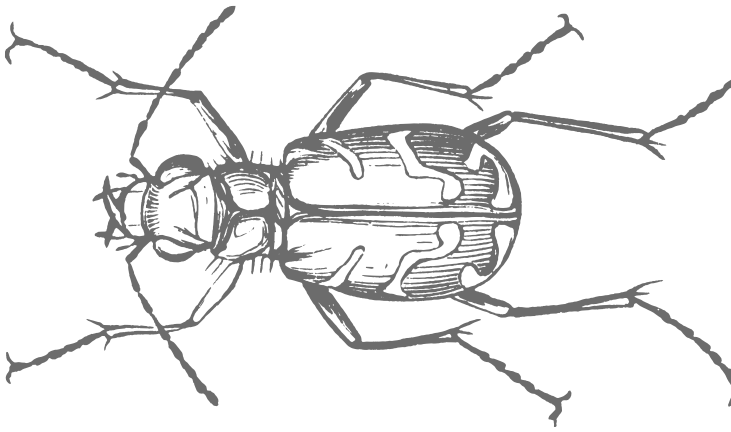
1. Background of the project:

Tiger beetles are charismatic beetles that belong to the most popular and well-studied family, Cicindelidae (Order: Coleoptera). They are well-known predatory insects often referred to as the "tigers of the insect world" due to their aggressive hunting techniques and incredible agility. With powerful mandibles they prey on ants, flies and other small invertebrates and making them natural pest controllers in many ecosystems. They are found in all habitats except Antarctica, the Arctic North, and some isolated oceanic islands like Hawaii in the mid-Pacific Ocean and the Maldives in the mid-Indian Ocean (Pearson et al. 2020). The world is home to about 2,900 species of tiger beetle (Pearson & Wiesner 2023). They are used as bioindicators for determining biodiversity of both regional and global areas; as a result, they have become a very important global flagship group for beetle and insect conservation. Their presence reflects the ecological health of an area. India hosts the second largest diversity of tiger beetles with 247 species, which include 127 endemic species (Pearson & Wiesner 2023). Despite their ecological importance, in India many regions remain poorly explored especially riverine landscape where human disturbance is more. Many people especially in rural areas are unaware of their existence or mistakenly identify them as harmful to crops. Educating local communities specially students and farmers about these beetles is a crucial step toward biodiversity conservation.

The Ramganga River is an important tributary of the Ganga River, which has its source in the Himalayan mountains and flows through the alluvial region of the Ganges. It serves as a habitat for many animals in this riverway, including conservation-dependent animals such as golden mahseer, gharial, lesser flamingo and otters (Gupta et al. 2014, Gupta et al. 2020, Gangaiamaran et ai. 2021, Vashistha 2022). Several species of benthic macroinvertebrates and insects have also been reported from this river (IITs 2012, Nautiyal et al. 2014, Nautiyal and Mishra 2022), but the diversity and ecology of tiger beetles have not been previously reported. As an important bioindicator and ecosystem service provider of the riverine landscape, it is important to understand the diversity of tiger beetles in the Ramganga River and aware local stakeholders about the importance of these key bioindicator species. Thus, keeping this in mind I have aimed to the following objectives:



1.1.Objectives of the study

- To initiate awareness about tiger beetle through community outreach and awareness programs in the study landscape.
- To assess the diversity and distribution of tiger beetle in riparian habitats of Ramganga river.
- To understand the associations between species and their respective habitats.

2. Progress during period (January 2025 – June 2025):

2.1.Objective 1: To initiate awareness about tiger beetle through community outreach and awareness programs in the study landscape

I have categorized three different stakeholder groups: farmers, Students and local communities. Awareness outreach programs with all three stakeholders has been conducted:

2.1.1.Farmers Outreach Programs:

The first objective of the project is to initiate an awareness program. To achieve this, I have conducted awareness sessions and community outreach activities in various schools and among farming communities. During this we have conducted this awareness session in five villages situated near riparian habitat and engaging 120 farmers (Fig. 1).

Fig. 1: Community outreach and awareness session conducted with local farmers.

As part of these efforts, I asked participants whether they were familiar with tiger beetles and conducted a short questionnaire specifically for farmers. Also, I provided hands-on training on how to create field conditions that support the presence of tiger beetles. During the questionnaire, I have asked some basic following question: (showing tiger beetle picture and ask)

Q1. What is this and have you seen this in your field?

Digital marketing is a way of promoting and advertising products, services, or brands using digital channels such as websites, social media, email, search engines, and online advertising to reach and engage with a target audience.

Q2. Is this farmer friendly beetle or farmer enemy?

some farmers correctly recognized the tiger beetle, while others misidentified it as a different species. So far, I have surveyed 120 farmers across different locations: 10 farmers correctly identified the beetle, 37 were unable to identify it, and 73 misidentified it as another insect (Fig. 2). When asked the second question, 77 farmers perceived the tiger beetle as a harmful insect, only 6 farmers recognized it as beneficial to agriculture and the remaining respondents were unfamiliar with the species (Fig. 3). This highlighted the urgent need for continued awareness efforts.

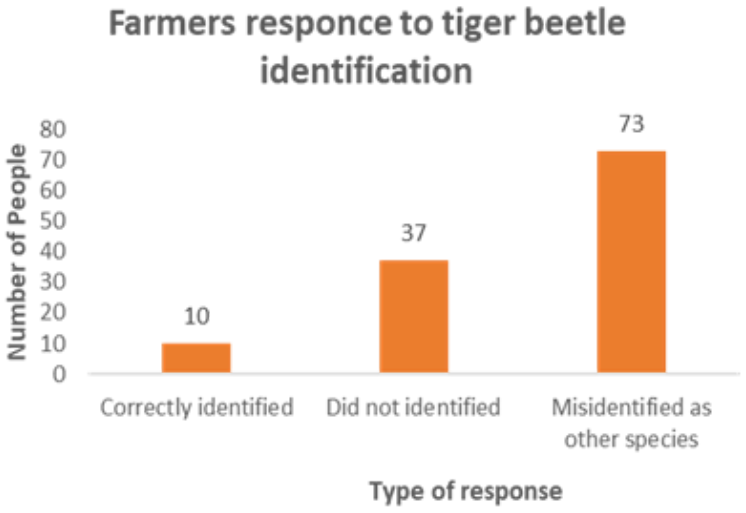


Fig. 2: Farmers response to tiger beetle identification.

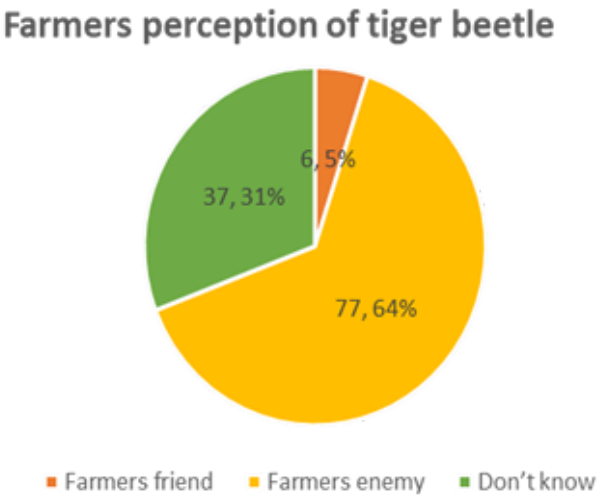


Fig. 3: Farmers perception of tiger beetle.

2.2.School awareness Programs:

Awareness programs have been successfully organized in seven local schools so far, reaching approximately 400 students. Each session included a visual presentation designed to introduce children to tiger beetles, their ecological role and the importance of conserving riverine habitats. The presentations were interactive and aimed at sparking curiosity among students about insects and biodiversity. To reinforce the message, informative pamphlets were distributed to all participants. These pamphlets included simple and engaging content such as dos and don'ts for conserving tiger beetles and protecting their natural habitats written in both Hindi and English language.

As part of the activities a drawing competition was also conducted, where students were asked to draw tiger beetles based on the images and examples shared during the presentation. The competition encouraged creative engagement and helped students visualize and remember the species. The best drawings were selected and the winners were awarded small prizes including chocolates and specially designed caps printed with an image of a tiger beetle and the Rufford Foundation logo as a token of appreciation and encouragement. (Fig. 4).

Fig. 4: Students from different schools participating in the awareness outreach program.

2.3.Public Awareness and communication platforms:

To extend this awareness a digital page titled "Tigers of Tiny Creatures" was launched on Instagram which aimed at extending awareness beyond the immediate community and this page shares field updates (Fig. 5). As part of the project, a two-month internship opportunity (May and June) was provided to three students – Ms. Arya, Mr. Akshat, and Ms. Vagisha. During the internship, they received extensive hands-on training in various field methods including insect sampling techniques, and identification of tiger beetle in the field (Fig. 6). I also had the opportunity to be featured on Baat Pahado Ki, an inspiring community radio show on 91.2FM. This platform provided an opportunity to connect with the local Pahadi communities in their own language and cultural context. Through the program, key messages about the ecological role of tiger beetles and the importance of conserving riverine habitats were communicated effectively. It helps science travel beyond papers into the ears and hearts of our Pahadi communities (Fig. 7).

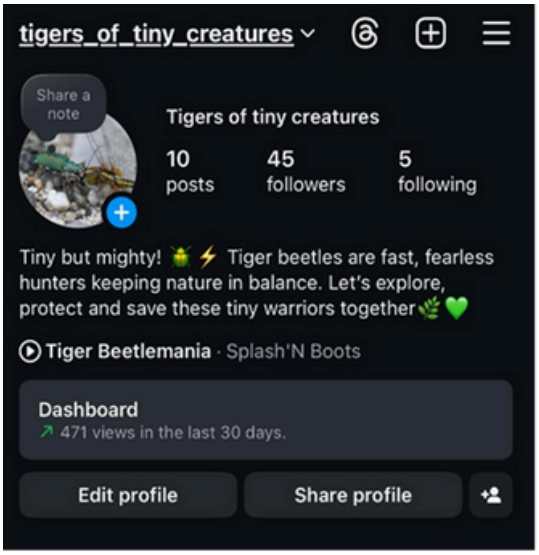


Fig. 5: Instagram page "Tigers of tiny creatures.

Fig. 6: Implementation of Field Sampling Techniques by Interns During Training.

Fig. 7: Awareness through community radio show – Baat Pahado Ki (talk of mountains) on 91.2FM.

Other than that, I have also participated as a specialist with other specialist from Asia in the tiger beetle conservation consultation meeting on "Tiger Beetle research and conservation in the Asian region" on 15th June 2025. The consultation focused on strategies for the long-term conservation of tiger beetles across broader landscapes and facilitated knowledge exchange among regional specialists (Fig. 8). I also, delivered a presentation on the ecological importance of tiger beetle during the World Environment Day 2025 celebration (Fig. 9).

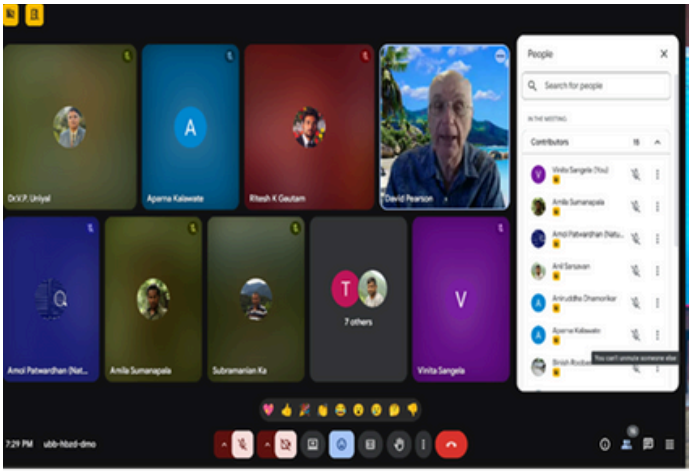


Fig. 8: *Online meeting on Tiger Beetle research and conservation in the Asian region on 15th June 2025.*

Fig. 9: *Tiger beetle presentation on World Environment Day.*

In addition to these events, a few newspaper articles have also been published highlighting the awareness program initiative in schools. Also, local people on social media platforms have played a significant role in promoting the initiative and spreading its message to a wider community, thereby enhancing public engagement and outreach (Fig. 10)

जागरुकता शिविर में शोधार्थी विनीता, बोनाफाइड स्कूल स्टाफ एवं विद्यार्थी।

सामुदायिक वितरण व संरक्षण कार्यशाला संपन्न

चौखुटिया (अल्मोड़ा), अमृत विचार: वाइल्ड लाइफ इंस्टीट्यूट ऑफ इंडिया की शोधार्थी कुमारी विनीता संगेला द्वारा स्थानीय बोनाफाइड पब्लिक हाईस्कूल में सामुदायिक वितरण और संरक्षण के लिए जागरुकता कार्यक्रम का आयोजन किया गया। रिफर्ड फाउंडेशन से अनुदान प्राप्त शोधार्थी विनीता रामगंगा नदी और उसके किनारे बाघ भृंग टाइगर बीटल की विविधता और वितरण पर शोध कर रही हैं। बोनाफाइड पब्लिक हाईस्कूल में आयोजित इस कार्यशाला में बच्चों को इसके संदर्भ में विस्तार से जानकारी दी गयी। विनीता ने बताया कि वह लगभग चार वर्ष से इस अभियान में जुड़कर काम कर रही है साथ ही रामगंगा के लिए सामुदायिक भागीदारी हेतु भी समाज को विशेष रूप से बच्चों के माध्यम से लगातार जागरूक करने प्रयास कर रही है। कार्यशाला में बच्चों के साथ ही राधा लोहनी, स्कूल की निदेशक मधु कांडपाल, नीलम बडूनी, हयात सिंह राक्त, दान सिंह बोरा, शुचिता और कला ने सहयोग किया।

बोनाफाइड स्कूल में कार्यशाला हुई

सामुदायिक वितरण और संरक्षण पर व्याख्यान दिया

चौखुटिया (अल्मोड़ा)। वाइल्डलाइफ इंस्टीट्यूट ऑफ इंडिया की शोधार्थी विनीता संगेला ने क्षेत्र के अलग-अलग स्कूलों में सामुदायिक वितरण और संरक्षण विषय पर व्याख्यान दिया। उन्होंने कहा कि रामगंगा के लिए सामुदायिक भागीदारी बेहद जरूरी है।

नई पीढ़ी को भी इससे सीख लेनी चाहिए। वहां पर राधा लोहनी, मधु कांडपाल, नीलम बडूनी, हयात सिंह रावत, दान सिंह बोरा, शुचिता, कला मौजूद रहे। संवाद

Pushkar Kandpal

वाइल्ड लाइफ इंस्टीट्यूट ऑफ इंडिया की शोधार्थी कुमारी विनीता संगेला ने बच्चों के साथ साझा किए रामगंगा नदी किनारे बाघ भृंग टाईगर बीटल की विविधता और वितरण पर किये जा रहे शोध के अनुभव।

Fig. 10: Newspaper articles and social media promotion for school awareness programmes by local peoples.

3.Objective 2: To assess the diversity and distribution of tiger beetle in riparian habitats of Ramganga river and Objective 3: To understand the associations between species and their respective habitats.

So far lower Ramganga stretch has been surveyed and analysed the dataset.

3.1.Materials and methods:

We conducted the study in the Ramganga River, a major tributary of the Ganga River. Geographically, this 642 km km long river having catchment area of about 23,758 km^2 flows through two separate regions namely Himalayan mountainous terrain which is covered by forest in the state of Uttarakhand and Gangetic alluvial plain which is mainly covered by agricultural lands in the state of Uttar Pradesh (Bhattacharjee et al. 2022, Khan et al. 2022). An interval of ~ 50 km along the Ramganga River from Biharipur Ahatmali, Uttar Pradesh to Khamdoopur, Uttar Pradesh (at the confluence of Ganga and Ramganga River) has been covered so far (Fig. 11). At each site, depending on accessibility, we collected tiger beetles between 10:00 –15:00 from five type of habitats namely grassland, gravel and rocks, mud, sand and shrub using a standard insect net (Dangalle et al. 2012). We preserved the collected specimens in 96% ethanol and identified with the help of literature (Fowler 1912, Pearson et al. 2020).

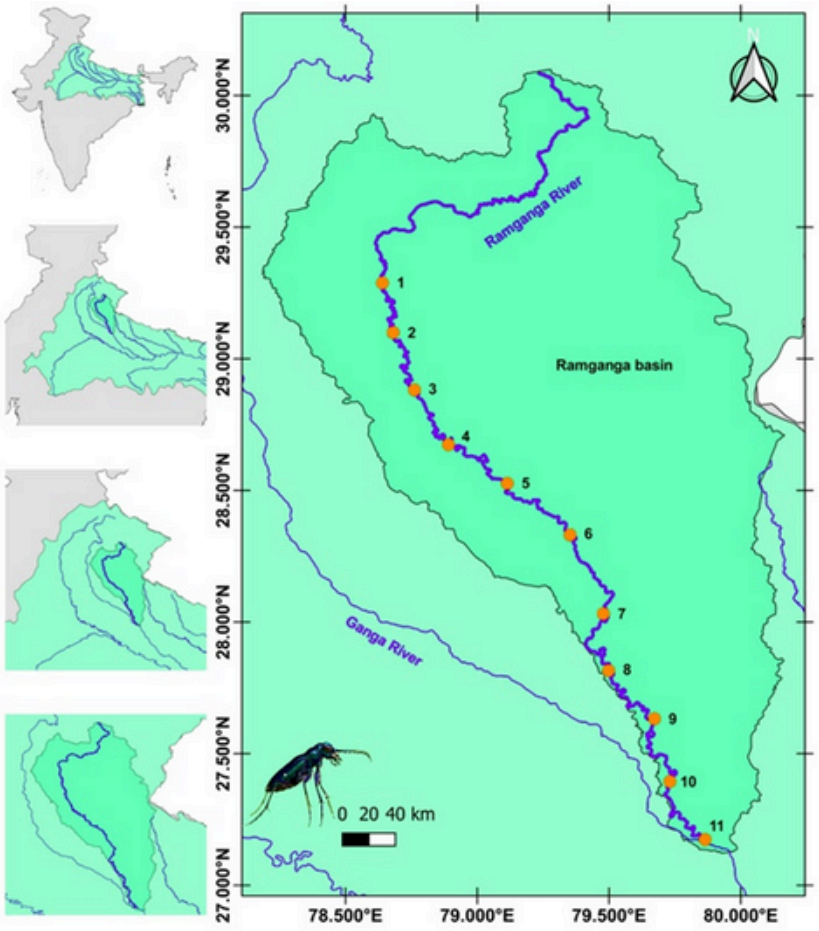


Fig. 11. Location of 11 study sites in the Ramganga River.

3.2.Analysis of the dataset:

For the analysis, I have used summed species data (i.e., pooled over all seasons for all year) for each sampling site. For all statistical analyses, I have used tiger beetle presence-absence data as they provide a natural basis for understanding relationships between multiple indicators of biodiversity at large geographic scales, lend themselves to the study of mobile species communities, and are worthy of describing ecological patterns (Arita et al. 2008, Dorazio et al. 2011, Dai et al. 2018, De et al. 2023).

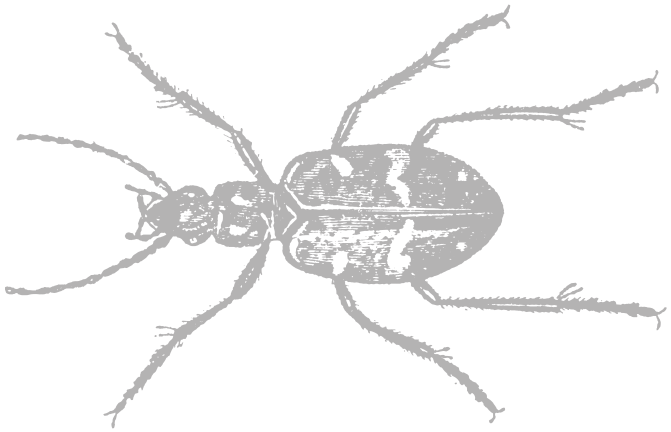
I have calculated sample-based rarefaction curves (Gotelli & Colwell, 2001) to assess whether the sampling effort was sufficient to be representative of the tiger beetle diversity of the study area. To do this, I have calculated the second-order Chao estimator (Chao2) (Colwell and Coddington 1994) and the first-order Jackknife estimator (Jackknife1) (Burnham and Overton 1978) using the 'BAT' package (Cardoso et al. 2022). I have used Chao2 and Jackknife1 estimators because they are non-parametric, can use rare species frequencies for calculation, provide lower bound estimates for small sample fractions, can reduce bias, are more accurate and less sensitive to sample coverage, non-uniformity in species distributions and variability in capture probability, and are therefore reliable for studying invertebrate species richness (Smith and Pontius 2006, Hortal et al. 2006, Chao et al. 2009, Brito et al. 2021, Chiu 2023).

To find out whether the species composition of different habitats is similar or not, I have performed the nonparametric analysis of similarity (ANOSIM) test (Clarke 1993) and the nonparametric permutational multivariate analysis of variance (PERMANOVA) (Anderson 2001) in the 'vegan' package (Oksanen et al. 2019). To facilitate interpretation of the results from ANOSIM and PERMANOVA, I have performed nonmetric multidimensional scaling (NMDS) based on tiger beetles' composition.

To identify bioindicator tiger beetles of specific habitats, I have calculated the indicator value index (IndVal) (Dufrêne and Legendre 1997) in the 'labdsv' package (Roberts 2023). This index can assess a species' predictive value as an indicator of specific habitat which is beneficial for ecosystem conservation and management (Legendre 2013).

The Market Basket Analysis (MBA) is a data mining technique used to identify relationships between product groups, items, or categories (Aguinis et al. 2012). In ecology, it is used to identify associations between species and their respective habitats by analysing the data set to identify the species that are commonly found together in common habitats (Leote et al. 2020). I have performed the MBA with apriori algorithm (Agrawal et al. 1993) in the 'rule' package (Hahsler et al. 2005, 2011, 2023) to find out whether there is a connection between species and their respective habitats in the study area. I have used the 'apriori algorithm' because it offers a good performance gain in data mining (Chee et al. 2018, Xie et al. 2019). I have kept the minimum support value at 0.038 and the confidence level at 0.95 to generate significant associations. I have used the lift value as a measure of the association between species and habitat. If the lift value is greater than 1.0, the association is considered positive, and if the lift value is less than 1.0, the association is considered negative (Leote et al. 2020).

I have performed all statistical analysis in the R language and environment for statistical computing (R Core Team 2022).



3.3.Results:

I have reported presence of 17 species of tiger beetles under eight genera in the study area. Among these species I have found two species exclusively from muddy habitat, seven species exclusively from sandy habitat and eight species from multiple habitats like grassland, gravel and rocks and shrub (Fig. 12).

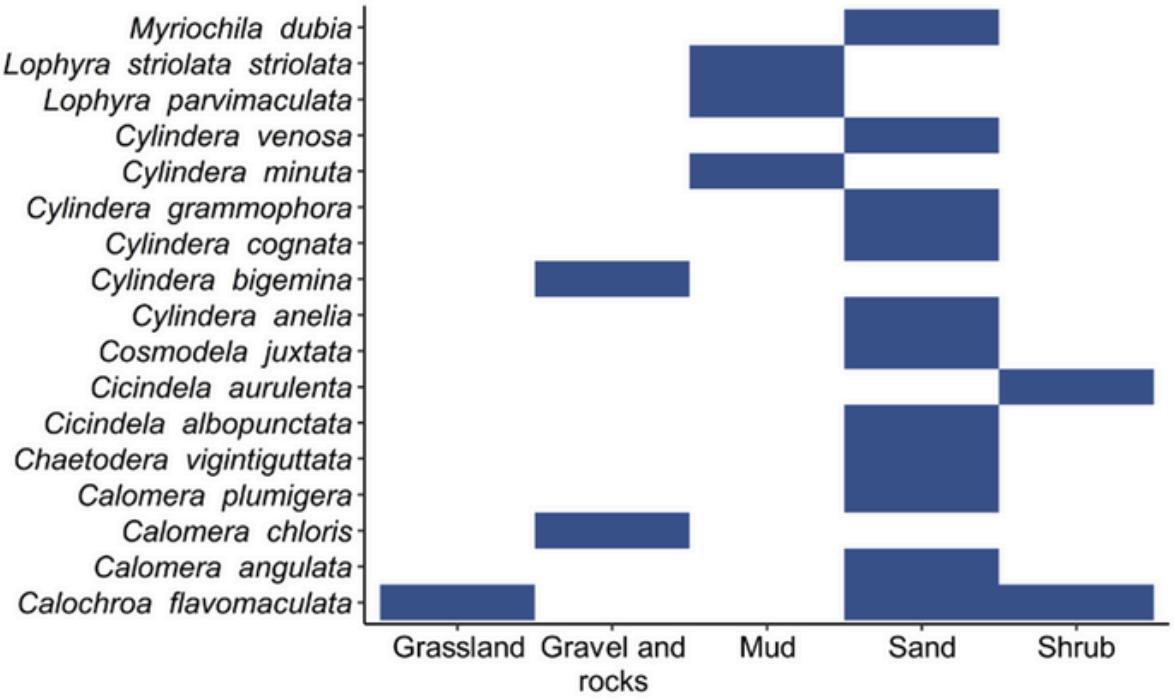


Fig. 12. Distribution of 17 species of tiger beetles in 5 habitat types.

Rarefaction curves and species richness estimators are reported in Fig. 13. The sample-based rarefaction curve of observed species richness based on the sampling data and the implemented non-parametric species richness estimators (Chao2 and Jackknife1) reached the asymptote for a species richness of 17, thus suggesting that the recorded species richness is likely representative of the tiger beetle diversity occurring in the study area.

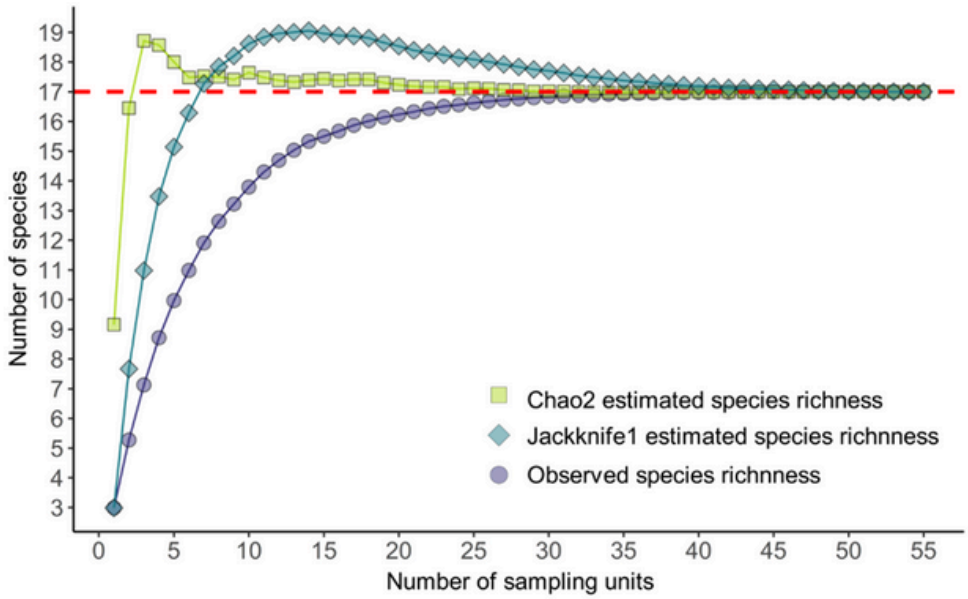


Fig. 13. Species accumulation curves for tiger beetles in Gangetic riparian zone at increasing sample size. The sampling effort yielded all the estimated species (17 species).

By non-parametric ANOSIM test I have found that there were significant differences exist between tiger beetle communities in different habitats (ANOSIM statistic R = 0.667, p = 0.001). By non-parametric PERMANOVA test I have found that there were significant differences exist between tiger beetle communities in different habitats (ADONIS, F = 19.087, R2 = 0.604, p = 0.001). I have found that two species (Calomera chloris and Cylindera bigemina) can be used as indicator of gravel and rocks habitat, three species (Cylindera minuta, Lophyra striolata striolata and L. parvimaculata) can be used as indicator of muddy habitat, ten species (Calomera angulata, Calomera plumigera, Chaetodera vigintiguttata, Cicindela albopunctata, Cosmodela juxtata, Cylindera anelia, Cylindera cognata, Cylindera grammophora, Cylindera venosa and Myriochila dubia) can be used as indicator of sandy habitat and one species (Cicindela aurulenta) can be used as indicator of shrub (Table 1). I have not found any species as indicator of grassland habitat.

Table 1: List of indicator species of tiger beetles for different habitats

Species	Habitat	Indicator Value Index (IndVal)	p value
Calomera chloris	Gravel and rocks	0.416	0.002
Cylindera bigemina	Gravel and rocks	0.298	0.02
Cylindera minuta	Mud	0.669	0.001
Lophyra striolata	Mud	0.636	0.001
Lophyra parvimaculata	Mud	0.273	0.036
Cylindera venosa	Sand	0.636	0.001
Calomera angulata	Sand	0.545	0.001
Chaetodera vigintiguttata	Sand	0.545	0.001
Cosmodela juxtata	Sand	0.545	0.001
Cylindera anelia	Sand	0.545	0.001
Cylindera cognata	Sand	0.545	0.001
Calomera plumigera	Sand	0.364	0.003
Myriochila dubia	Sand	0.364	0.003
Cicindela albopunctata	Sand	0.343	0.007
Cylindera grammophora	Sand	0.343	0.004
Cicindela aurulenta	Shrub	0.388	0.005

By non-parametric ANOSIM test I have found that there were significant differences exist between tiger beetle communities in different habitats (ANOSIM statistic R = 0.667, p = 0.001). By non-parametric PERMANOVA test I have found that there were significant differences exist between tiger beetle communities in different habitats (ADONIS, F = 19.087, R2 = 0.604, p = 0.001). I have found that two species (Calomera chloris and Cylindera bigemina) can be used as indicator of gravel and rocks habitat, three species (Cylindera minuta, Lophyra striolata striolata and L. parvimaculata) can be used as indicator of muddy habitat, ten species (Calomera angulata, Calomera plumigera, Chaetodera vigintiguttata, Cicindela albopunctata, Cosmodela juxtata, Cylindera anelia, Cylindera cognata, Cylindera grammophora, Cylindera venosa and Myriochila dubia) can be used as indicator of sandy habitat and one species (Cicindela aurulenta) can be used as indicator of shrub (Table 1). I have not found any species as indicator of grassland habitat.

Table 1: List of indicator species of tiger beetles for different habitats

Species	Associated habitat	Lift
Lophyra striolata striolata	Mud	6.5
Lophyra parvimaculata	Mud	6.5
Cylindera venosa	Sand	2
Calomera angulata	Sand	2
Chaetodera vigintiguttata	Sand	2
Cosmodela juxtata	Sand	2
Cylindera anelia	Sand	2
Cylindera cognata	Sand	2
Calomera plumigera	Sand	2

3.4.Discussion:

Quantifying biodiversity is important to understanding how it is shaped in space and time, and this is all the more important in a context of ongoing global change and biodiversity loss (Laini et al. 2023). The conservation of insect biodiversity is one of the most important global tasks of conservation science and a major challenge for present and future generations (León-Cortés et al. 2023). Understanding the diversity of river insects is fundamental to river monitoring, conservation and restoration (Wang et al. 2023). The tiger beetles live in the transition area between terrestrial and aquatic ecosystems and can use both dry and wet habitats (Bobrek 2022). Thus, these species are among the few candidates that can be used for conservation monitoring in both terrestrial and aquatic ecosystems. Pearson and Wiesner (2022) argued that future conservation of biodiversity depends on the level of knowledge about some well-studied taxa, such as tiger beetles, and these could be used as model organisms to identify conservation priority areas.

Our study area is in the humid subtropical climate zone (Kppen-Geiger climate classification: Beck et al. 2018), which is characterized by high average annual temperatures and high humidity. Areas with such climatic conditions and sandy habitats like wide river bed provide excellent conditions for housing a large variety of tiger beetles (Jaskuła and Płóciennik 2020). This diversity was reflected in this study as I have found 17 species (6.88% of all Indian species) of tiger beetles in the study area. This result confirms the important role of the Ramganga River in maintaining rich biodiversity, as has been noted for many other groups of organisms.

The dietary spectrum of the tiger beetle is very broad and includes arthropods of various groups such as Lepidoptera, Orthoptera, Hymenoptera, Coleoptera, Diptera, arachnids and crustaceans as well as plants and dead organisms (Pearson and Vogler 2001, Jaskula 2013, Pearson et al. 2015, Wang et al. 2023). This varied diet ensures that tiger beetles can survive in different habitats. In this study, I have found eight tiger beetle species from multiple habitats. Within the same habitat, the tiger beetle population can coexist and escape competition for resources through niche partitioning (Brosius and Higley 2013). It is a process whereby natural selection drives competing species into different resource-use patterns or niches (Vacher et al. 2016, Jaskuła and Płóciennik 2020). In this study, I have found seven tiger beetle species from sandy habitats only and two tiger beetle species from muddy habitats only.

Among the six species of tiger beetles identified by Bhargav et al. (2008) in their study as indicators of riverine habitat or river associated habitats from the Shivalik landscape of north-west India, I have re-identified five (Calomera angulata, Calomera chloris, Chaetodera vigintiguttata, Cylindera bigemina and Cylindera venosa) of them as indicators of different habitat within riverine riparian ecosystem. I did not find Calochroa flavomaculata as indicator of any specific habitat and this observation is consistence with the finding of Acciavatti and Pearson (1989) and Jaskula (2011).

PC: Vinita Sangela

The lateral dimension of river lateral dimension supports high biodiversity in river ecosystems and provides an abundance of goods and services for human needs but the over-exploitation of these resources has had a negative impact on river system functions (Modi et al. 2022). In the Ramganga River, human activities over the past few decades have altered bank land-use patterns and the river is threatened by pollution (Khan et al. 2019, Sarah et al. 2019, Bhattacharjee et al. 2022). With urban development, sand was extracted from river and coastal areas around the world at an ever faster rate, most of which are illegal and contrary to local opinion and law, leading to riverbed alteration and bank erosion, resulting in loss of ecosystem services (Pandey et al. 2022, Rangel-Buitrago et al. 2023).The Ramganga River is also not free from this problem as sand quarrying continues at various points along the river course (Daityari and Khan 2017, Alexander Speed et al. 2019, Nautiyal and Mishra 2022). An important result of this work is, I observed that most tiger beetles are strongly associated with sandy habitats and riparian vegetation in riverbeds and riverbanks. Therefore, the destruction of natural sand habitats and riparian vegetation may be detrimental to the tiger beetles of the Ramganga River.

PC: Vinita Sangela

4.Observed Challenges:

Organizing awareness programs among school students and farming communities came with several on-ground challenges. One of the major hurdles was the limited prior knowledge of insects, especially tiger beetles. Many participants were unfamiliar with the species, and in rural areas, tiger beetles were often mistaken for harmful pests. This made it difficult to immediately capture the interest of the audience, requiring extra time and creative methods to explain their ecological importance. Among farmers, there was noticeable scepticism about the relevance of conserving an insect species. As their focus is largely on practical agricultural outcomes, the indirect ecological benefits of tiger beetles had to be carefully framed and explained in terms of long-term sustainability. However, once the farmers understood how tiger beetles contribute to natural pest control and overall field health, their perception gradually shifted, and many expressed interests in supporting their conservation. Despite these challenges, adaptive strategies and continued engagement helped in gradually building awareness and interest among both school children and local farming communities.

5.Future Plan:

Conduct the field sampling after monsoon to the remaining upper Ramganga sites.

Awareness outreach program in remaining areas.

Data analysis, interpretation and final report will be compiled.

6.Glimpse of Field activities:

7.References:

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