

Short Communication

From collections to connections: empowering communities through entomological outreach

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Abstract

Following our dung beetle research in Oaxaca, Mexico, we prioritized ethical engagement with Indigenous communities, recognizing the importance of trust and reciprocity in ecological research. After conducting entomological surveys, we facilitated outreach efforts through an intercambio de saberes (knowledge exchange) approach, which included theoretical-practical workshops and entomological display drawers tailored for each community. Community participation enriched our research by incorporating Traditional Ecological Knowledge (TEK) and Local Ecological Knowledge (LEK), offering valuable insights into local biodiversity and ecological interactions. These outreach collections, combined with scientific communication talks, sparked dialogue and strengthened the connections between our team and local communities.

Key words: Entomology, knowledge exchange, outreach collection, Traditional Ecological Knowledge

Introduction

Dung beetles (Scarabaeinae, Geotrupinae, and Aphodiinae), commonly referred to as coprophagous beetles, play a crucial role in ecosystems by recycling nutrients, improving soil health, and controlling parasite populations through dung burial (Nichols and Gardner 2011). These insects are widely distributed but highly sensitive to environmental changes (Halfpter and Favila 1993; Nichols et al. 2007). Despite their ecological importance, the conservation of dung beetles and many other insect groups has not been prioritized (Chowdhury et al. 2023).

To address this gap, we initiated a project focused on ecological and conservation biology. Beginning in 2016, as part of AAJ's postdoctoral research, dung beetle surveys were conducted across various regions of Oaxaca, leading to the description of new species (Kohlmann et al. 2018a; Kohlmann et al. 2018b; Arriaga-Jiménez et al. 2020a, 2020b) and other noteworthy biogeographical stories (Arriaga-Jiménez et al. 2020c). We then expanded our study to assess

complementary communities and build ecological niche models to predict species distributions and potential shifts due to climate change.

A critical component of this research involved gaining access to Indigenous communities, as most of the land in Oaxaca is communally owned. Conducting research in these areas required following a different set of protocols than those applied in federally administered Natural Protected Areas (NPAs). Accessing a community required formal presentations and dialogues with local authorities, ensuring that research was conducted with permission, trust, and respect (da Fonseca-Kruel et al. 2019). Furthermore, we committed ourselves to the delivery of results. In contrast, working in an NPA involves more bureaucratic procedures, which are evaluated by a government agency. These procedures typically include standardized permit applications, institutional affiliations, and adherence to pre-defined research guidelines. While this process can be more predictable and uniform, it often lacks the personal, trust-based relationships that are central to working in Indigenous territories. In community-owned lands, the emphasis is placed on building mutual understanding and long-term engagement, whereas in NPAs, the focus tends to be on regulatory compliance and scientific outputs.

As our team began fieldwork, our interactions with the community deepened, and we became increasingly aware of the depth of local knowledge about the land. One of the first moments that revealed this was during our initial meeting with the *comisariado*, who shared a wealth of natural history knowledge about the biodiversity of the sacred mountain Zempoaltépetl. This knowledge was so extensive that it led us to reflect on what might remain to be discovered or understood. Later, in informal conversations with other community members, we learned how people interpret environmental cues, such as the presence or behavior of specific animals, to determine the best times for planting and growing food. These early encounters and the openness of community members, combined with an ethical approach, led us to integrate Traditional Ecological Knowledge (TEK) and Local Ecological Knowledge (LEK) into our research, rather than merely extracting data. TEK and LEK encompass a profound understanding of ecosystems, species, and natural processes that Indigenous and local communities have developed over generations (Toledo and Alarcón-Chaires 2018). TEK and LEK are closely linked to cosmovisions, traditional practices, and culture through language (Boege 2017). Integrating this knowledge not only facilitated the search for dung beetles but also enriched our scientific communication efforts. In this exchange, our goal was not to educate but to engage in mutual learning through a knowledge-sharing (*intercambio de saberes*) and a co-learning (*co-aprendizaje*) approach (Bastidas et al. 2009; Nieto 2011).

Both models recognize the diversity of human knowledge and promote an enriching exchange between different cultures, actors, and knowledge systems, based on critical and reflective dialogue. These kinds of approaches not only enhance public understanding of science but also contribute to more inclusive and collaborative scientific practice, which are key to the social appropriation of knowledge and the empowerment of communities (Leff 2006; Atuesta-Venegas et al. 2016; Delgado and Rist 2016).

Establishing strong relationships with local communities became fundamental to our work (Arriaga-Jiménez et al. 2018, 2022). As we expanded our research, we prioritized trust-building by using our findings and entomological collections as tools for engagement.

Methods

During our fieldwork, standardized dung beetle collections were conducted in different mountain regions of Oaxaca, including San Pablo Etla, Santa María Tlahuitoltepec, San José del Pacífico, San Esteban Río Hondo, San Esteban Atatlahuca, Huajuapán de León, and San Luis Amatlán. During our interactions with local community members (e.g., local authorities and the families we stayed with), we asked for the local name given to dung beetles.

All collected specimens were brought back to the lab at the Instituto de Ecología A.C. (INECOL), Xalapa, Veracruz, Mexico, where they were pinned and identified to the species level. Once the curation process was complete, we carefully selected representative specimens of each species from each site to create an outreach collection (OC). The remaining specimens were deposited at the Entomological Collection at Instituto de Ecología, A.C., Veracruz, Mexico (IEXA); the Canadian Museum of Nature, Ottawa, Canada (CMNC); the Coleção de Entomologia of the Universidade Federal de Mato Grosso, Cuiabá, Brazil (CEMT); and the Colección de Coleoptera, Universidad Autónoma del Estado de Hidalgo, Mexico (CC-UAEH). Like any scientific collection, OC specimens were labeled with detailed location data, dates, and other important information. However, the outreach/educational display drawers included additional contextual information, such as local names, and were arranged to engage the communities (Fig. 1A, B).

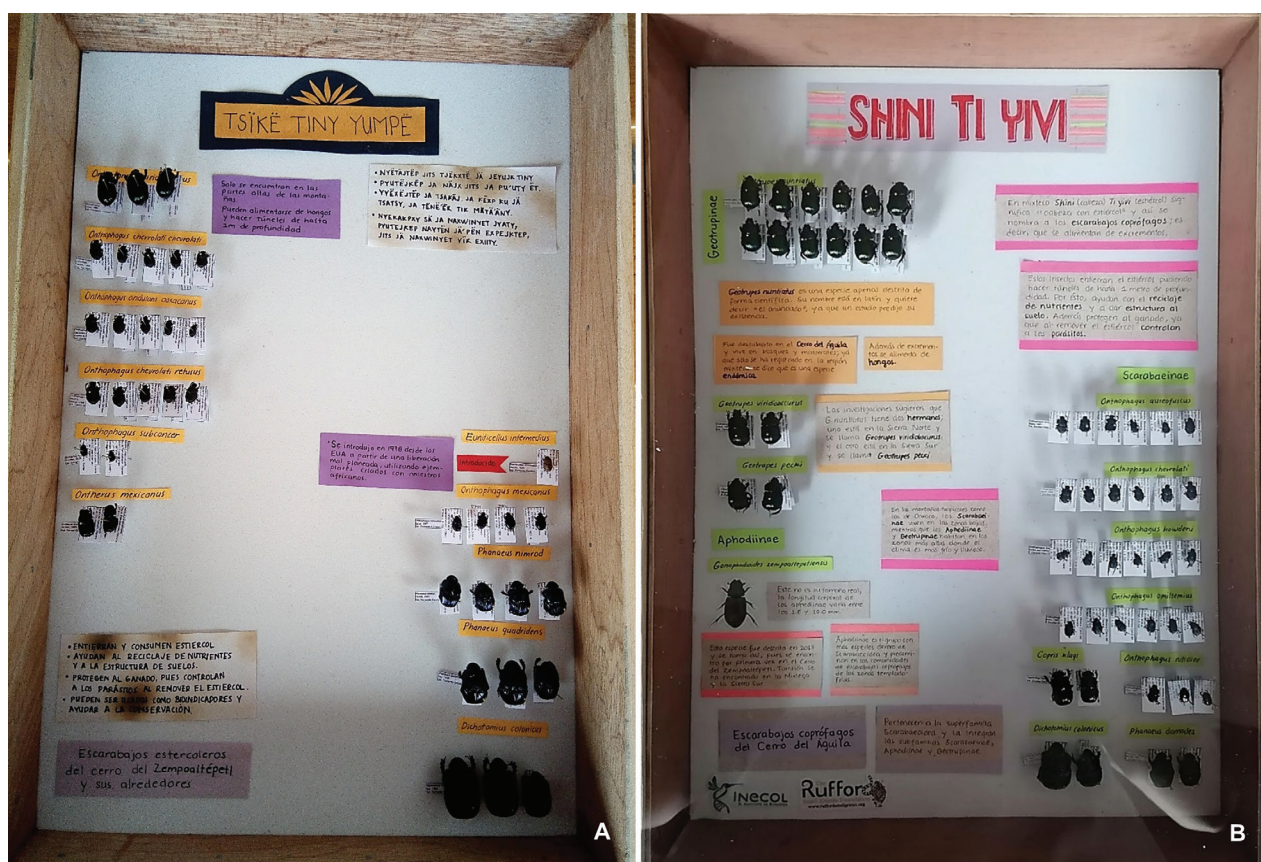


Figure 1. Example of outreach drawers featuring dung beetles, including local names in A. Ayuujk (Mixe) and B. Tu'un Savi (Mixtec), along with their scientific names. We use technical terms only when necessary and provide basic explanations of their biology, ecology, taxonomy, and diversity. We highlight information on endemic species and those recently discovered by science. Text interpretations in Ayuujk (A) by Lucelli Pérez Díaz and Citlalli Pérez Díaz.

Due to their practical nature and collective construction, most of the outreach work was carried out through workshops (Nieto 2011). We used various tools, but OCs were the main implement (Fig. 2). During the workshops, three OCs were incorporated. The first OC included specimens of the most recognizable insect orders and families (e.g., Lepidoptera [butterflies and moths], Apidae [bees], Odonata [dragonflies and damselflies], Mantodea [mantises], and Scarabaeidae [scarab beetles]). The second and third collections comprised dung beetle specimens focusing on state and local diversity, respectively. In addition to OC, workshops included digital graphic materials (Fig. 3) and informal scientific communication talks in which we shared information about these insects and engaged attendees by asking them questions about local knowledge, such as common names, habitat, diet, and seasonal patterns (phenology). Subsequently, we complemented the participants' knowledge by sharing some interesting data, such as explanations about reproductive biology, the ecosystem services they provide, taxonomy, collection methods, and curation. Finally, we developed printed materials, including infographics featuring newly described species and a series of six posters explaining dung beetle ecology (Suppl. material 1).



Figure 2. Examples of interactions with elementary school students using entomological outreach collections after workshop sessions in the communities of Tlaxiaco (A–C) and Huajuapán de León (D, E).



Figure 3. Digital materials and presentations provided to elementary schools during the scientific communication talks/workshops in **A.** San Esteban Atlatlahuca and **B.** Tlaxiaco.

Community engagement and knowledge exchange

Building respect and trust within each one of the communities is essential, as it not only validates our work but also ensures our safety, and that of future researchers, while fostering a welcoming environment in the region. Our approach varied with each community; in some cases, we were fortunate to connect with a local community member, which was invaluable, as they were familiar with the local language and customs and helped us navigate and build rapport. In other cases, we had to start from scratch, seeking permission and gradually establishing relationships through consistent engagement and mutual respect.

Sharing knowledge with the community, rather than merely extracting information, allowed for meaningful exchanges and provided deeper insights into their TEK and LEK (Arriaga-Jiménez et al. 2018), particularly regarding dung beetles and the names and uses of other local insects.

The process of documenting local names in each community followed the steps outlined by Fonseca-Kruel et al. (2019) and began with an explanation of dung beetle feeding behavior to community members. This behavioral association proved essential, as relying solely on verbal morphological descriptions or pinned specimens often led to misidentifications. All local knowledge and names were documented in the field during direct conversations with community members. Notes were taken in written form, primarily in a field journal, and we consistently invited community members to verify spellings and, when possible, to provide interpretations or translations into Spanish to ensure accurate representation and cultural understanding. We always worked in collaboration with members from each community to ensure Indigenous names and descriptions were recorded respectfully and accurately. This approach was essential not only for the integrity of the data but also for reinforcing community ownership of the project. Although the data are currently handwritten and partially compiled in basic digital formats, we aim to process, digitize, and organize them with the goal of developing a shared, accessible database as part of the social and cultural outcomes of this research. This future resource will serve both the communities involved and the broader scientific community interested in biocultural knowledge systems.

The comparative exercise using pinned specimens from our outreach collection (OC) provided an opportunity for both participants and researchers to explore and discuss the identification of insects and dung beetles through

the lenses of both ethno-taxonomy and scientific taxonomy. These OC materials served as conversation starters and allowed people to physically interact with and examine the specimens, helping to clarify which species were locally known or unknown. This activity encouraged a two-way exchange of knowledge, where participants shared their traditional or community-based classifications and understandings of these insects, while we introduced the corresponding scientific names and classification systems. We learned that ethno-taxonomy relies heavily on prominent morphological characteristics.

From these exchanges we learned, for example, that beetles with horns are often named *toritos* (i.e., little bulls); this group can include species from Dynastidae, Melolonthidae, and Scarabaeidae. More specifically, in Tu'un Savi (Mixtec) and Ayuujk (Mixe) languages, dung beetles are known as *timirru shini ti yivi* and *tsëkë ti'ny yumpë*, respectively. In both cases, the name refers to the action of pushing or carrying a ball of dung with the head. However, any beetle that feeds on dung can be named in this way. In contrast, in Didze (Zapotec), we did not find a specific term for dung beetles, but we did encounter the word *mingut*, which is used generically to refer to members of Scarabaeoidea.

For these communities, dung beetles are commonly associated with the rainy season and forested areas. People also know about their burial behavior, but other aspects of their life cycle, such as tunnel construction and larval stages, were less known. As far as we know, and based on our research, dung beetles do not hold sacred or any other cultural significance. This might be because dung beetles are not a resource that can be used or managed, unlike fungi, which are used for different purposes and hold sacred value for Mixtec peoples (Santiago et al. 2016), or *Agave* spp., which hold cultural significance and are managed by many Oaxacan and Mexican communities (Torres-García et al. 2019).

Considering the knowledge of the communities, outreach activities facilitated by our team introduced the ecological role of dung beetles and the importance of biodiversity through interactive discussions and knowledge exchange sessions, primarily working with elementary and middle school students (Figs 2, 3). Participants also learned about scientific classification, collections, and curation methods. In a very basic way, we explained each concept and its utility. From this perspective, participants gained awareness of a broader range of species, particularly those that, due to their coloration, size, or shape, might be included in other beetle families (e.g., Dynastidae) or species that are not as eye-catching (e.g., Aphodiidae).

At the end of each event, we provided each community with a reference collection for the local library, along with posters, brochures, and other educational materials, ensuring that the knowledge remained accessible for future learning (Fig. 4). In addition to these engagements, we facilitated hands-on workshops where participants practiced specimen preparation and species identification, particularly with undergraduate students (Fig. 5), and we also participated in local events or assemblies in some communities (Fig. 6).

Outcomes and challenges

The research process not only deepened our understanding of local biodiversity but also facilitated a meaningful exchange of knowledge. From the outset, we encouraged local participation, inviting community members, including



Figure 4. Outreach drawers and printed materials donated to libraries and communities in A, B. Santa María Tlahuitoltepec; C. San Pablo Etla; D. San Esteban Atlatlahuca; E. Huajuapán de León; and F, G. Tlaxiaco.

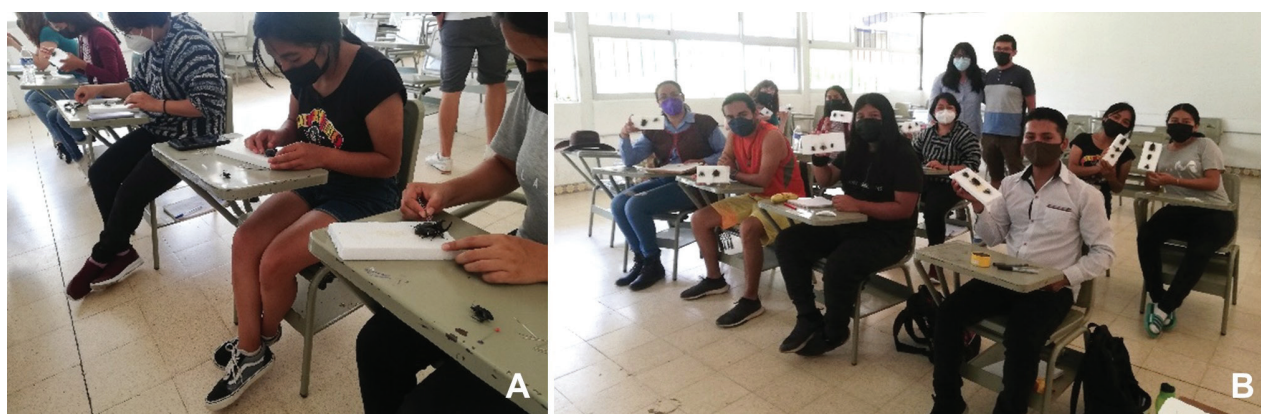


Figure 5. Hands-on workshop for college students at Instituto Tecnológico de los Valles de Oaxaca.



Figure 6. Scientific communication talks at **A.** First Forum on Geographic and Environmental Identity in the Mixe Region (Primer Foro de Identidad Geográfica y Ambiental en la Región Mixe; Santa María Tlahuitoltepec); **B.** Mixtec Mushroom Fair (Feria de los Hongos Mixtecos; Tlaxiaco); and **C, D.** Community assembly (San Esteban Atatlauca).

children, to join us in the field. This created opportunities for shared learning, as they provided valuable insights on species behavior, phenology, and local names, while we explained aspects of taxonomy and ecological roles.

This collaborative approach fostered trust and strengthened knowledge synergies. Seeing local students involved in research demonstrated that science can be accessible and inspire younger generations to consider careers in ecology and conservation. Public outreach discussions and science communication events evolved into knowledge-sharing workshops, where all participants exchanged information and learned from one another. These events provided students with knowledge not typically covered in school curricula, as noted by some local teachers (B. Flores and F. Bautista, personal communication, October 2023). Additionally, we distributed printed materials detailing the information shared about dung beetle diversity, ecology, and local names to community libraries, where such resources are often scarce.

Species documentation was another key outcome, where community members showed great interest in recording species found in their lands, incorporating



these data into local checklists that remain accessible in community libraries. Maintaining an open line of communication via email and WhatsApp has also proven valuable. Students and teachers sent photos of insects and arachnids for identification, often asking whether certain species are poisonous. High school students have also sought career guidance, inquiring about universities and scholarships, while community members have requested advice on land management, medicinal plants, and pest control. Our team remains committed to supporting these queries, reinforcing our long-term engagement with the communities.

Conclusion

As part of the process for requesting permission to access sampling localities, researchers must acknowledge the cultural and spiritual significance of certain sacred sites. Additionally, as part of the agreements for delivering research results, integrating outreach collections with TEK/LEK has become a valuable tool for fostering trust and mutual understanding. This approach ultimately strengthens community engagement and collaboration, ensuring that scientific research is conducted with respect and reciprocity.

It is important to note that in some cases, communities may deny access to their territories, or local customs and dynamics may make it challenging to schedule activities on specific dates. In such situations, academic researchers must adapt to the community's agenda and strive to reach agreements while recognizing that not all objectives—especially those requiring broad participation—can always be achieved.

Building trustful relationships takes time, which can be particularly challenging given the academic pressures of reporting results, publishing findings, and meeting deadlines. One way to foster these relationships is by maintaining an open and respectful attitude toward the community's culture while demonstrating patience and consistency through regular visits. However, there may be instances where a mutually beneficial agreement cannot be reached. In such cases, researchers must respect the community's decision and never force a connection or attempt to enter the territory without explicit permission.

Ultimately, entomological outreach collections serve as more than just educational tools; they represent a shared space for scientific and cultural exchange, reinforcing the link between research and community engagement. By integrating TEK and LEK into ecological research and respecting the agency of Indigenous communities, outreach collections can help foster meaningful collaborations that lead to more inclusive and respectful strategies. Moving forward, biodiversity and ecological research must continue to embrace these approaches, ensuring that these efforts remain both scientifically rigorous and culturally respectful.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Use of AI

No use of AI was reported.

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Author contributions

Conceptualization: BJCG, AAJ. Data curation: BJCG, FEH. Funding acquisition: AAJ, BJCG. Investigation: BJCG, AAJ, OS, EJCG. Methodology: BJCG. Project administration: BJCG, AAJ, OS, EJCG. Resources: FEH, BJCG. Writing – original draft: BJCG, AAJ. Writing – review and editing: AAJ.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Examples of different infographic material used during workshops

Authors: Brenda J. Cruz-García, Osvaldo Sandoval, Emilio J. Cruz-García, Fernando Escobar-Hernández, Alfonsina Arriaga-Jiménez

Data type: pdf

Explanation note: SF1. Infographic of new species *Geotrupes nuntiatius* (Arriaga-Jiménez and Kohlmann 2020). SF2. Poster; Dung beetles I: Who are they? SF3. Poster; Dung beetles II: Where do they live? SF4. Poster; Dung beetles III: Why are they important? SF5. Poster; Dung beetles IV: Diversity in Oaxaca. SF6. Poster; Dung beetles V: Common names.

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Link: <https://doi.org/10.3897/nhcm.2.147417.suppl1>