Afrotropical Stingless Bees Illustrate a Persistent Cultural Blind Spot in Research, Policy and Conservation

Nicolas J Vereecken *, Madeleine Héger, Marcelin Aganze Mweze, Aina Razakamiaramanana, Rebecca Karanja, Nkoba Kiatoko, Pierre Noiset

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Article

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Nicolas J. Vereecken [1,2,*], Madeleine Héger [1,2], Marcelin Aganze Mweze [1,2,3,4], Aina Razakamiaramanana [1,2,5], Rebecca H. N. Karanja [3], Kiatoko Nkoba [4] and Pierre Noiset [1,6]

[1] Agroecology Lab, Université libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50 CP 264/02, B-1050 Brussels, Belgium

[2] Evolutionary Biology & Ecology, Université libre de Bruxelles (ULB), Av. FD Roosevelt 50 CP 160/12, B-1050 Brussels, Belgium

[3] Department of Plant Sciences Kenyatta University, Nairobi, Kenya

[4] International Centre of Insect Physiology and Ecology (icipe), Duduville Campus, Off Thika Road, Kasarani PO Box 30772-00100, Nairobi, Kenya

[5] Ecole Doctorale Gestion des Ressources Naturelles et Développement (ED GRND), Universite d'Antananarivo Ankatso, 101, Antananarivo BP 175, Madagascar

[6] Cellular and Organismic Networks, Faculty of Biology, Ludwig-Maximilians-Universität München, Großhaderner Str. 2-4, 82152 Planegg-Martinsried, Germany

* Correspondence: nicolas.vereecken@ulb.be

Abstract

Managed and wild bees contribute not only to ecological functions and agricultural productivity, but also to a wide range of cultural ecosystem services (CES) structuring human livelihoods and that remain largely overlooked in pollinator research, policy and conservation. This article examines the multifaceted CES provided by wild bees, with particular attention to the spiritual, medicinal, and traditional knowledge-based dimensions associated with Afrotropical stingless bees. We argue that systematic recognition and documentation of these cultural roles are critical to advancing more inclusive and effective conservation frameworks. Drawing on examples from sub-Saharan Africa, we demonstrate how CES simultaneously support biodiversity objectives and strengthen community resilience, and we propose future research and policy directions aimed at embedding these cultural values more comprehensively within conservation strategies.

Keywords: Meliponini; ecosystem services; biodiversity conservation

Socio-Cultural Dimensions as a Blind Spot in Pollinator Conservation

Across the globe, wild bee assemblages are undergoing profound transformations due to human activities. While some species, often habitat specialists or those with narrow ecological niches, are reported to experience range contractions and declines [1–4]. Others, particularly generalist species adapted to intensively human-modified landscapes, seem to persist or even expand their distribution even in the face of global changes [4–7]. Pollinator decline is far from being a uniform phenomenon, and it is indeed better viewed as a complex and mosaic process involving both biodiversity loss and more subtle community restructuring to varying degrees in time and space driven by land-use change, pesticide exposure, urbanization, and climate change [8–10]. These dynamics are often accompanied by the erosion of functional and phylogenetic diversity [11–13], as well as the homogenization of bee faunas across regions (e.g. [14]), with cascading consequences for plant–pollinator interactions and ecosystem functioning [15–17].

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In response, pollinator conservation agendas have primarily focused on the ecological (or biophysical) contributions of bees, especially in relation to crop pollination and food security [18–20]. Yet amidst this emphasis on instrumental values, several dimensions remain critically overlooked at the interface of bee-human ecosystems (see e.g. [21]), among which their non-material cultural significance to human livelihoods [22]. This striking imbalance in how we approach bees and their relationship with the environment as well as society is what the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has described as a broader "values crisis" [23]. Indeed, decades of research show that dominant conservation frameworks prioritized a narrow subset of nature's values, at the expense of relational, spiritual, and identity-based connections to nature [24,25]. However, many Indigenous and local contexts challenge purely utilitarian worldviews and also call for more inclusive conservation approaches [26,27].

Many managed and wild bees, particularly eusocial species like stingless bees (Apidae: Meliponini), are embedded in traditional ecological knowledge systems, spiritual practices, and local worldviews, including in the Afrotropical region which have received less attention so far than on other continents [28,29]. Their hive products, nesting behavior, and ecological presence carry symbolic, ritual, and medicinal importance that transcends the logic of provisioning services and resource extraction, and research in sub-Saharan Africa is increasingly uncovering and documenting the socio-cultural roles of these bees [21,30–32].

Here, we argue that cultural ecosystem services (CES) deserve far greater attention in pollinator research and conservation, with the relatively little-known Afrotropical stingless bees providing an insightful example. First, we define CES and outline how they apply specifically to bees, illustrated by stingless bee knowledge systems, symbolic traditions, and emerging practices like bee tourism/meliponitourism. Second, we examine why CES remain critically underrepresented in pollinator studies and conservation frameworks, despite their central role in shaping human–nature relationships. Finally, we propose concrete ways to better integrate CES into pollinator conservation, highlighting opportunities for biocultural approaches that combine biodiversity protection with the recognition of cultural heritage and identity. Through this perspective, we call for a broader, more inclusive vision of pollinator conservation that recognises not only ecological and economic values, but also the diverse cultural, emotional, and everyday connections that people experience with bees.

Understanding Cultural Ecosystem Services (CES) in Relation to Bees

Cultural Ecosystem Services (CES) are one of the four major categories of ecosystem services defined in the Millennium Ecosystem Assessment (2005), representing the non-material benefits that people derive from ecosystems and their surrounding environment [33]. These services encompass a broad range of human–nature interactions, including spiritual, symbolic, aesthetic, educational, recreational, and identity-based connections.

The underrepresentation of CES in ecosystems services research and conservation policy seems partly due to conceptual ambiguity: as noted by Daniel et al. (2012), the boundaries between services, benefits, values, and human activities are indeed often blurred [34]. Authors further highlight the tendency in the literature to conflate values with services, hampering clear assessments [35,36]. Yet, despite these challenges, CES are increasingly recognized as vital components of biocultural diversity, shaping people's emotional, ethical, and identity-based ties to the environment [37–39].

To illustrate the diversity of CES, we drew examples from the context of Afrotropical stingless bees and meliponiculture, as this group seems particularly well suited to show how CES manifest through at least four broad domains (adapted from [39,40]) (Figure 1):

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Figure 1. Wild bees contribute to a wide range of cultural ecosystem services (CES) that are essential to the well-being, identity, and resilience of human societies. These services can be grouped into four main categories illustrated here with different examples focused on Afrotropical stingless bees (Apidae: Meliponini). **Top left.** *Symbolic and spiritual values*: a colony of *Hypotrigona* sp. established in an empty coconut shell hung at the main (entrance) door of traditional houses in Pemba Island (Zanzibar, Tanzania) carries symbolic and sacred meanings linked to spiritual protection; **Top right.** *Knowledge systems and education*: *icipe* scientist (*right*) training a local stingless beekeeper (*left*) in Unguja (Zanzibar, Tanzania) on honey harvesting, colony division and hive management among other aspects of knowledge integrated into formal and informal environmental education; **Bottom left.** *Inspirational and recreational values*: ecotourism such as meliponitourism in Ghana (International Stingless Bee Center) and Tanzania (BEEtopia) invite visitors to engage in the aesthetic, sensory and emotional experience of observing stingless bees and tasting their honey, inspiring artistic expression, biodiversity photography and other activities in the process; **Bottom right.** *Sense of place and social cohesion*: stingless beekeepers in Kakamega Forest (Kenya) and Unguja (Zanzibar, Tanzania) engage in activities that foster strong place-based identities, reinforce cultural landscapes as well as cultural heritage, while supporting social cohesion and inter-generational transmission of knowledge through shared practices, orally transmitted knowledge and traditions, and collective management of bee resources. All photos by NJ Vereecken.

- *Symbolic and spiritual values*, including bees in myths, taboos, rituals, or healing traditions remain the least documented among the cultural ecosystem services. Yet, recent ethnographic studies suggest deep symbolic and spiritual embedding of bees in cosmologies, healing practices, and belief systems [32,41–43];
- *Knowledge systems and education*, where traditional ecological knowledge is transmitted *via* stingless bee tracking, honey collection techniques, or habitat recognition. These structured knowledge transfers often involve intergenerational and experiential learning which

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contributed to transmit and preserve biocultural knowledge [44,45], including complex ecological or cultural knowledge (e.g. bee ecology, taxonomy, tracking techniques, or habitat indicators), with important links to poverty alleviation [46], and associated impacts on cultural identity and environmental protection. In addition to ecological or cultural knowledge, formal and informal educational programs and the general public are increasingly recognizing the importance of bees, despite the fact that most people interviewed so far are apparently still unable to discern bees from non-bees (e.g. [47–49]). Nevertheless, recent studies also show that general knowledge about bee biology, behavior (including nesting sites and foraging ecology) and diversity is associated with stronger pro-pollinator attitudes and environmental concern among the public [50]. The audience typically targeted by these activities are community members, students, or practitioners (but not tourists; see below). Although more studies are required on this specific dimension of CES, practitioners estimate that the relationship with learners is usually longer-lasting;

- *Inspirational and recreational values*, as bees increasingly inspire eco-tourism (e.g. "apitourism" or "meliponitourism", introducing visitors and travelers to bees and the honey they produce), artistic representations, biodiversity photography, and sensory experiences anchored in "slow tourism" and contributing to the local tourism-associated value chain (see e.g. [51–56]). Emotional responses toward bees (ranging from admiration to aversion) also mediate human engagement and are shaped by both direct experience and knowledge, as highlighted in psychological studies [50] and references therein. Here, the primary purpose is largely experiential and recreational in intent, and visitors (mostly tourists) engage with stingless bee farms (meliponaria) not primarily to be formally educated, but to enjoy the sensory, aesthetic, and cultural experience such as tasting honey, observing bees, taking photos, enjoying nature, and participating in slow/local tourism practices. In essence, these activities are similar to visiting a vineyard. The information transmitted during meliponitourism is usually informal, experiential, or introductory. Some level of learning takes place during these visits, but learning is not the main goal, nor is it delivered through structured pedagogical frameworks as would be expected in more education-focused activities (see above).
- *Sense of place, cultural heritage, and social cohesion* represent important dimensions through which bees contribute to emotional attachment to landscapes, place-based identities, and communal practices [57]. Meliponiculture often becomes a family or community activity, reinforcing socio-cultural bonds across generations through gatherings during times of honey harvesting, colony management and meliponaries construction. Stingless bees also contribute to more intimately associating the local environment to highly praised non-timber forest products such as stingless bee honey. Such attachments are not the hallmark of forest habitats or forest margins, but they can also be observed in urban or peri-urban contexts (e.g. through (peri-)urban beekeeping initiatives) where individuals report valuing bees as part of their local environment, reinforcing biocultural connections [50], although these dimensions remains hitherto underexplored and ill-documented for stingless bees in the Afrotropics.

Beyond these conceptual categories, it is important to note that formal instruments such as geographical indications (GI) and honey quality standards can be regarded as important yet poorly activated institutional levers for the recognition of CES in the case of Afrotropical stingless bees. By linking local knowledge, specific landscapes, but also distinctive meliponiculture practices and product properties, GIs could actively contribute to cultural valorization, preservation of Traditional Ecological Knowledge and biocultural conservation; as such, GIs have the potential to embed honey

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within a collective history and cultural landscape, thereby reinforcing identity and community cohesion.

Toward a Better Integration of CES in Afrotropical Stingless Bee Research and Conservation

Despite a growing recognition of their importance, Cultural Ecosystem Services (CES) associated with stingless bees remain largely overlooked in contemporary research. Here we propose a non-exhaustive set of key factors that may account for this underrepresentation:

1. Difficulty in Categorization and Quantification

Any researcher who previously engaged in CES characterisation will argue that the diversity, the spatio-temporal patterns and the associated drivers of CES are inherently complex, intangible, and context-specific. The partitioning of CES associated with Afrotropical stingless bees proposed above echoes the recent literature on the topic, but some of these boundaries blur in practice: for example, meliponitourism can serve as a bridge between recreation and education, while the ritual use of stingless bee honey in healing ceremonies may simultaneously reflect symbolic, spiritual, and medicinal knowledge systems transmitted through oral tradition and practices.

The lack of clear boundaries between services, values, and benefits [34,35] has long made Cultural Ecosystem Services (CES) difficult to categorize, standardize, or quantify across sociocultural and ecological settings [58]. This stands in contrast with provisioning and regulating services such as crop pollination, which can more readily be modeled, mapped, and monetized using ecological and economic metrics [59,60]. The non-material, intangible and context-dependent nature of CES illustrated in Figure 1 poses challenges for their integration into conventional conservation planning. However, recent developments offer promising pathways. Emerging frameworks (Héger et al., in preparation) propose novel, hierarchical classification systems specifically tailored to non-food uses of stingless bee honey, grounded in ethnographic evidence and traditional ecological knowledge (TEK). These approaches would allow not only to document CES more rigorously, but also to render them more visible and actionable in policy, education, and decision-making. By combining creative and innovative qualitative and semi-quantitative methods (including participatory mapping, local typologies, and spatial modeling) these tools will likely help bridge disciplinary divides while supporting more inclusive and culturally sensitive conservation strategies. Their application across the Afrotropics and other regions of the world could help reposition CES as essential, rather than marginal, components of biocultural resilience, using a wider range of bee species, genera and tribes that more intimately interact with human societies.

A promising avenue lies in exploring how the legal and economic recognition of unique bee products, for example through geographical indications or quality standards structured to protect collective rights which are currently being developed for stingless bee honeys in the Afrotropical region, can contribute to making CES more visible and actionable. Such legal instruments do not only serve to structure value chains or secure market access but they also contribute to safeguard intangible heritage, recognize traditional know-how, and strengthen cultural identities associated with bees and their products.

2. Disciplinary Silos and Methodological Constraints

Conventional pollinator research has historically been grounded in the natural sciences, focusing on taxonomic inventories, foraging ecology, plant–pollinator networks, and pollination services in agricultural and semi-natural ecosystems. While this work is essential to understanding ecological functions and biodiversity dynamics, it often remains disconnected from the methods, epistemologies, and insights of the social sciences, humanities, or traditional ecological knowledge systems. As a result, relational, symbolic, or identity-based human–bee interactions that are central

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to the concept of Cultural Ecosystem Services (CES) are frequently underexplored or dismissed as anecdotal, unquantifiable, or outside the formal scope of biodiversity research.

Here we call researchers to break away from this disciplinary compartmentalization that hinders a more holistic understanding of human–pollinator relationships. For instance, ethnographic and participatory approaches that could reveal insiders' perspectives on bees, honey, and landscape management that are rarely integrated into ecological or biodiversity-oriented studies [61]. Similarly, some of the categories we highlighted above (Figure 1) related to "spiritual value," "cultural identity," or "heritage" are rarely accommodated within standard conservation assessments or ecosystem service valuation frameworks (e.g. [62]). To date, when social science components are indeed included, they are often reduced to knowledge–attitude–practice (KAP) surveys or awareness campaigns related to health issues ([63] and references therein), they still seem to fail to capture deeper affective, symbolic, or historical dimensions of CES (see e.g. the review by McElwee et al. 2022 on CES in the Global South [64]).

Furthermore, research funding structures, journal scopes, and institutional training programs often reinforce these silos by privileging narrowly defined scientific outputs and metrics of impact. This limits opportunities for interdisciplinary collaboration through training and research programmes, co-designed studies, and the integration of local knowledge holders as active partners in research and conservation planning. In the context of stingless bees in the Afrotropics, ignoring CES may not only perpetuate epistemic injustice but also result in conservation strategies that fail to resonate with or benefit local communities. Consequently, bridging these divides requires deliberate efforts to foster methodological innovation and knowledge pluralism. Transdisciplinary, agroecological research frameworks, participatory action research, and culturally embedded valuation tools offer promising avenues to document and mobilize CES. This approach would be essential to appreciate bees not only as ecological agents, but also as cultural mediators that can thus broaden the relevance, legitimacy, and impact of pollinator conservation across diverse socio-cultural contexts.

Conclusions and Perspectives

The increasing recognition of CES offers a promising opportunity to reframe pollinator conservation in ways that are more inclusive, relational, and grounded in local realities. Although CES have historically remained peripheral in both research and policy, such omission has become largely untenable, particularly (but not only) in relation to wild bees and stingless bees in the Afrotropics. As the cultural, symbolic, and knowledge-based dimensions of human–bee interactions continue to erode under the pressures of land use change, climate disruption, globalisation and social transformation, the capacity of communities to maintain resilient, meaningful, and sustainable relationships to their environments.

To advance the meaningful integration of CES into bee-related research, outreach, and conservation planning, we propose several key avenues of action: (i) *expanding ethno-entomological and biocultural research*, (ii) *fostering inter- and transdisciplinary approaches* that bridge the natural and social sciences and address the inherent complexity of CES with local actors, while enhancing both the legitimacy and applicability of findings, (iii) *leveraging CES for education, communication, and environmental engagement, including protection of natural resources and pollinators* by mobilizing narratives, photographs, and traditional knowledge through schools, museums, storytelling initiatives, visual media and environmental outreach campaigns, (iv) *integrating CES into policy and conservation frameworks* to better recognise the cultural significance of bees, to justify the protection of habitats beyond their agricultural utility, to promote biocultural landscape conservation, and support policies that legitimise indigenous and local knowledge systems. Finally, (v) *considering economic and cultural valorization instruments*, such as geographical indications or honey quality standards, as integral vectors of CES have a considerable yet currently underexploited potential to reinforce the cultural recognition of bees and their products, while paving the way for biocultural approaches to conservation and sustainable development.

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Bees and Afrotropical stingless bees in particular stand at the intersection between biodiversity, cultural continuity, community well-being, and socio-environmental resilience. They are also ecologically diverse, culturally esteemed, yet increasingly threatened, and as such, they offer a compelling and timely case for expanding the scope of conservation beyond material benefits toward more holistic, inclusive, and locally grounded frameworks. Such an approach is essential to fully appreciate the under-documented and complex relationships that connect humans and bees, and that shape the landscapes targeted for conservation.

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