

Perspective

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

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Abstract

This perspective paper examines the multifaceted cultural ecosystem services (CESs) provided by wild bees with particular attention to the spiritual, medicinal, and traditional knowledge-based dimensions associated with Afrotropical stingless bees. We integrate these insights within a biocultural framework, highlighting their relational values and arguing that the systematic omission of these cultural roles in pollinator research, policy and conservation constitutes a form of epistemic injustice. We also argue that the systematic recognition and documentation of these cultural roles are critical to advancing more inclusive and effective conservation frameworks. Based on a synthesis of field observations, photo-documentation, and literature review, we propose future research and policy directions aimed at embedding these cultural values more comprehensively within biocultural conservation strategies.

Keywords: Meliponini; ecosystem services; biodiversity conservation



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1. Introduction

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].

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]), including 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]. Here, we argue that this oversight has been exacerbated by a reliance on first-generation CES concepts [24]. Therefore, we integrate the concept of cultural ecosystem services (CESs) with the emerging paradigm of relational values [24,25], linking them to biocultural diversity [26,27] and framing their systematic discrimination and marginalization in ecosystem services research as a form of epistemic injustice [28–30]. Likewise, many Indigenous and local contexts challenge purely utilitarian worldviews and also call for more inclusive conservation approaches [28,29], which include links between linguistic, cultural and biological diversity [31].

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 across the mosaic of socio-cultural and environmental contexts in the Afrotropical region, which have received less attention so far than on other continents [32,33]. Stingless bee 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 [21,34–36].

Here, we argue that CESs deserve far greater attention in pollinator research and conservation with the relatively little-known Afrotropical stingless bees providing an insightful example. This perspective paper is structured as follows: we first detail the approach used to gather our field and literature examples and conceptualize the main figure. Second, we define CESs and outline how they apply specifically to bees, illustrated by stingless bee knowledge systems, symbolic traditions, and emerging practices like bee tourism/meliponitourism (combining meliponiculture and tourism). Third, we examine why CESs 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 CESs into pollinator conservation, highlighting opportunities for biocultural approaches that combine biodiversity protection with the recognition of cultural heritage and identity [37].

Through this perspective, we call for a broader, more inclusive vision of pollinator conservation that recognizes not only ecological and economic values but also the diverse cultural, emotional, and everyday connections that people experience with bees.

2. Approach and Conceptual Framework

The evidence base for this perspective paper draws upon three sources. First, there is the extensive field experience and photographic documentation of Afrotropical stingless bees used by the authors, namely in Kenya, Tanzania, Democratic Republic of Congo and Madagascar. Second, we rely on a non-systematic literature synthesis focusing on known CESs associated with Afrotropical stingless bees, particularly as part of ongoing research on the non-food uses of stingless bee honeys with published (see e.g., [34]) and unpublished

records. And third, we present a brief bibliometric overview to empirically illustrate the geographical “cultural blind spot” in pollinator cultural ecosystem services (CESs) research.

The conceptual framework for assessing CESs generally relies on the established classification systems developed by The Economics of Ecosystems and Biodiversity (TEEB) [38] and the Common International Classification of Ecosystem Services (CICES) [35]. While TEEB classifies CESs under a broad “non-material benefits” category, including spiritual, aesthetic, and educational values, the CICES offers a more detailed hierarchical structure, classifying CESs into three main divisions: Recreation and Intellectual Interactions (e.g., tourism, formal education), Spiritual, Symbolic and Other Interactions (e.g., religious ceremonies, traditional knowledge, artistic inspiration), and Characteristic Features of Ecosystems (e.g., sense of place, heritage) [39]. Our approach integrates these existing, widely used top-down frameworks but refines them by explicitly connecting the CICES categories to the specific, relational values (such as identity and social cohesion) observed in Afrotropical stingless bee–human interactions. This allows us to ground the theoretical classification in local biocultural realities.

3. The Cultural Ecosystem Services of Afrotropical Stingless Bees (Apidae, Meliponini)

Building upon the approach outlined above, this section presents the empirical evidence supporting the existence of a systematic cultural blind spot in pollinator conservation research with a focus on the Afrotropical region. We first provide quantitative substantiation of this geographical bias through a brief bibliometric overview, which is followed by detailed examples of the specific cultural, symbolic, and identity-based contributions of stingless bees that remain critically undervalued in global conservation discourse.

3.1. Quantifying the Afrotropical Cultural Blind Spot: A Brief Bibliometric Illustration

The central argument of this perspective paper rests on the hypothesis that a cultural blind spot exists, wherein CESs provided by Afrotropical pollinators (and bees in particular) are systematically overlooked in academic literature, conservation policy, and funding. To provide empirical substantiation for this geographical bias, we conducted a brief bibliometric assessment of recent literature focusing on cultural ecosystem services across major global regions.

We performed a comparative search of scholarly databases on Scopus for the period 1997–2025, using combined keywords (TITLE-ABS-KEY ((bee* OR apis OR meliponini) AND (“cultural ecosystem service*” OR “ecosystem service*” AND cultural))), confirming a stark disparity. When ranked by country of author affiliation, no Afrotropical country features in the top 10 list of publishing nations (where the 10th-ranked country, India, registers nearly 150 papers). The publications are heavily concentrated in the northern hemisphere (Europe, North America) and established research regions of Asia (Figure 1). Within the Afrotropical region itself, the limited coverage is heavily dominated by South Africa, further highlighting the widespread neglect across the rest of the continent (Figure 1).

These patterns should arguably be regarded as a relatively conservative estimate of the Afrotropical cultural blind spot. Scopus and other conventional knowledge hubs are not global or language-neutral mirrors of scholarship (well over 90% of Scopus records are in English): they have been shown to under-index outlets from Africa, Latin America and parts of Asia, and they strongly privilege English-language journals, which likely reduces counts for local and Indigenous knowledge studies that are often published in regional platforms and other languages (see e.g., [40]). Consequently, our figures likely undercount culturally embedded work on pollinators, particularly studies on stingless bees that are produced outside the dominant Anglophone circuits. Even under these

conservative conditions, the disparity is stark: Afrotropical countries are absent from the global top 10, and production within the region is highly node-centered (e.g., South Africa), corroborating the hypothesis that CESs associated with Afrotropical pollinators are systematically overlooked in academic literature and, by extension, in the policy and funding arenas that draw on them. To mitigate these biases in future syntheses, we recommend triangulating Scopus-based searches with regional indices and repositories, non-English queries, and gray-literature/community-co-produced sources. Yet, even with such adjustments, the present evidence already substantiates a material cultural blind spot that warrants targeted investment and inclusion in research, conservation planning and valuation frameworks for Afrotropical stingless bees.

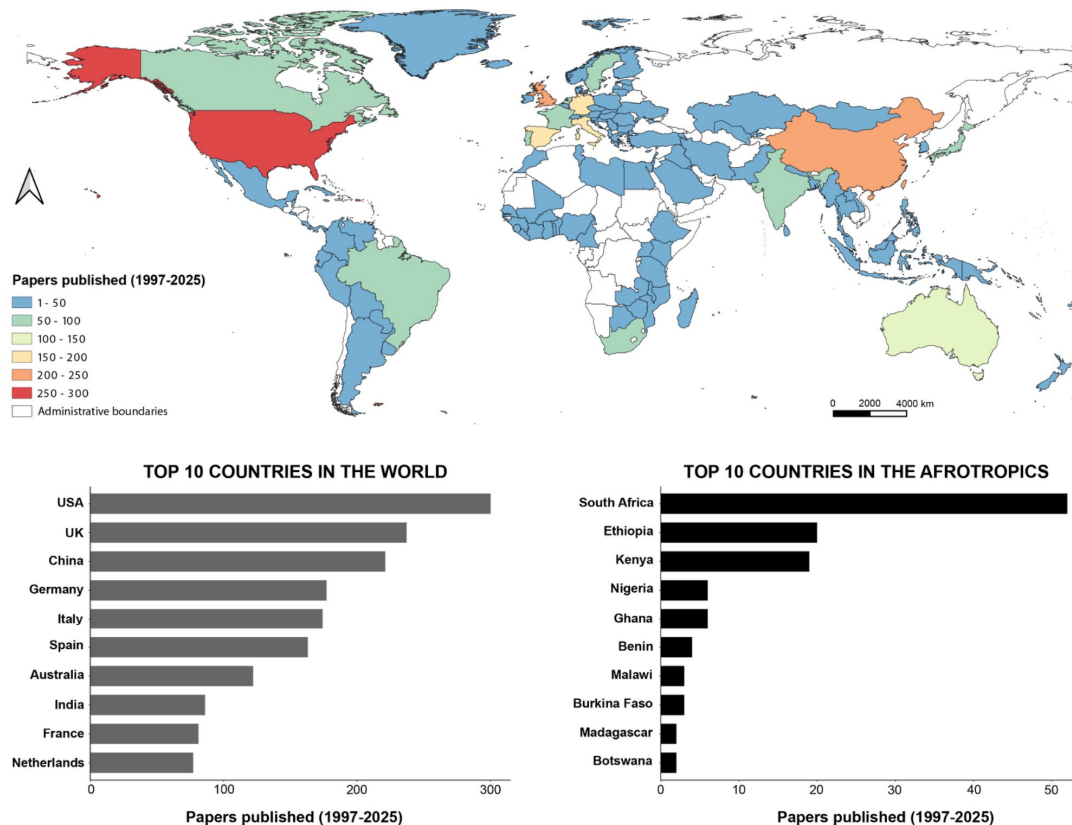


Figure 1. Global distribution and leader countries of the cultural ecosystem services literature on bees (1997–2025). **Top panel:** Choropleth world map showing the number of publications retrieved in Scopus for TITLE-ABS-KEY ((bee OR apis OR meliponini) AND (“cultural ecosystem service” OR (“ecosystem service*” AND cultural))) over 1997–2025, aggregated by country/territory and colored according to the number of records. Administrative boundaries are displayed for reference. The map highlights a strong concentration of publications in a small set of countries with particularly high totals in North America, Western Europe, China and India, and far lower counts across much of Latin America (except Brazil), Eastern Europe, the Middle East and large parts of Africa, our target region. **Bottom panels:** Horizontal bar charts summarizing the top 10 countries worldwide (*bottom left*; gray bars) and the top 10 countries within the Afrotropical region (*bottom right*; black bars). The global top 10 countries is dominated by high-income research hubs (e.g., USA, UK, China, Germany, Italy, Spain, Australia, India, France, The Netherlands), whereas the Afrotropical top 10 countries is led by a smaller group of regional hubs (e.g., South Africa, Ethiopia, Kenya, Nigeria, Ghana), followed by countries with emerging but comparatively modest outputs (e.g., Benin, Malawi, Burkina Faso, Madagascar, Botswana). Together, these panels emphasize the contrast between the global distribution of research capacity and the more uneven, node-centered production of CES-related bee research in the Afrotropical region.

3.2. Defining the Spectrum of CESs Associated with Afrotropical Stingless Bees

Cultural ecosystem services (CESs) 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 [41]. These services encompass a broad range of human–nature interactions, including spiritual, symbolic, aesthetic, educational, recreational, and identity-based connections. Contemporary research recognizes this original concept as the first generation of CESs research [25], which has since evolved through the integration of concepts like relational values [24,42] and biocultural approaches [37] to fully capture the complexity of human–nature relationships.

The underrepresentation of CESs 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 [43]. The authors further highlight the tendency in the literature to conflate values with services, hampering clear assessments [44,45]. Yet, despite these challenges, CESs are increasingly recognized as vital components of biocultural diversity, shaping people's emotional, ethical, and identity-based ties to the environment [25,46,47].

To illustrate the diversity of CESs, we drew examples from the context of Afrotropical stingless bees and meliponiculture, as this group seems particularly well suited to show how CESs manifest through at least four broad domains (adapted from [42,48]). These examples are categorized and illustrated in Figure 2.

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 [34,49–51].

Knowledge systems and education includes the transmission of traditional ecological knowledge via stingless bee tracking, honey collection techniques, or habitat recognition. These structured knowledge transfers often involve intergenerational and experiential learning which contributed to transmit and preserve biocultural knowledge [52,53] including complex ecological or cultural knowledge (e.g., bee ecology, taxonomy, tracking techniques, or habitat indicators), with important links to poverty alleviation [54], 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., [55–57]). 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 [58]. The audience typically targeted by these activities includes community members, students, or practitioners (but not tourists; see below). Although more studies are required on this specific dimension of CESs, practitioners estimate that the relationship with learners is usually longer lasting.

Inspirational and recreational values are also relevant, as bees increasingly inspire ecotourism (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., [59–64]). 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 [58] 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).



Figure 2. Wild bees contribute to a wide range of cultural ecosystem services (CESs) 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) invites 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 the intergenerational transmission of knowledge through shared practices, orally transmitted knowledge and traditions, and collective management of bee resources. All photos by NJ Vereecken.

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 [65]. 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 [58], although these dimensions remain hitherto underexplored and ill documented for stingless bees in the Afrotropical region.

Note on category overlap. The CESs illustrated in Figure 2 are conceptual but also partly permeable and overlapping categories. Across the mosaic of socio-cultural and environmental contexts of the Afrotropical region, they are indeed expected to be often co-produced and intertwined. For stingless bees, a single practice such as collective honey harvesting can simultaneously carry spiritual/symbolic significance (ritual offerings), strengthen identity and heritage (clan traditions, initiation knowledge), enable intellectual/representational values (intergenerational and experiential TEK transmission, school visits, research), and support physical/experiential benefits (eco-cultural tourism, community festivals). Likewise, aesthetic and inspirational values (songs, crafts using wax, visual motifs) often emerge from the same places and practices that sustain sense of place and social cohesion. Our coding (TEEB/CICES v5.1) assigns each observation to the closest final service for comparability, but we recognize that many observations legitimately span categories.

Beyond these conceptual categories, it is important to note that formal instruments such as geographical indications (GIs) and honey quality standards can be regarded as important yet poorly activated institutional levers for the recognition of CESs in the case of Afrotropical stingless bees. By linking local knowledge, specific landscapes, and distinctive meliponiculture practices and product properties, GIs could actively contribute to cultural valorization as well as the preservation of traditional ecological knowledge and biocultural conservation [66,67]; as such, GIs have the potential to embed honey within a collective history and cultural landscape, thereby reinforcing identity and community cohesion.

4. Toward a Better Integration of CESs in Afrotropical Stingless Bee Research and Conservation

Despite a growing recognition of their importance, cultural ecosystem services (CESs) 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:

4.1. Difficulty in Categorization and Quantification

Any researcher who previously engaged in CESs characterization will argue that the diversity, the spatio-temporal patterns and the associated drivers of CESs are inherently complex, intangible, and context-specific. The partitioning of CESs 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 [43–45] has long made cultural ecosystem services (CESs) difficult to categorize, standardize, or quantify

across socio-cultural and ecological settings [42]. 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 [68,69]. The non-material, intangible and context-dependent nature of CESs illustrated in Figure 2 poses challenges for their integration into conventional conservation planning. However, recent developments offer promising pathways. Emerging frameworks (Héger et al., in preparation [70]) propose novel, hierarchical classification systems specifically tailored to non-food uses of stingless bee honey, which are grounded in ethnographic evidence and traditional ecological knowledge (TEK). These approaches would allow not only to document CESs 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 Afrotropical and other regions of the world could help reposition CESs 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 CESs more visible and actionable. Such legal instruments not only serve to structure value chains or secure market access, they also contribute to safeguard intangible heritage, recognize traditional know-how, and strengthen cultural identities associated with bees and their products.

4.2. *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 to the concept of cultural ecosystem services (CESs) 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 [71]. Similarly, some of the categories we highlighted above (Figure 2) related to “spiritual value,” “cultural identity,” or “heritage” are rarely accommodated within standard conservation assessments or ecosystem service valuation frameworks (e.g., [72]). 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 ([73] and references therein), and they still seem to fail to capture deeper affective, symbolic, or historical dimensions of CESs (see e.g., the review by McElwee et al. 2022 on CESs in the Global South [74]).

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 programs, 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 Afrotropical region, ignoring CESs may not only perpetuate epistemic injustice (i.e., a gap in our collective tools for interpretation; hermeneutical injustice as defined in [30]) 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 CESs. 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.

5. Conclusions and Perspectives

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

To advance the meaningful integration of CESs 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 CESs with local actors while enhancing both the legitimacy and applicability of findings, (iii) *leveraging CESs for education, communication, and environmental engagement, including the 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 CESs into policy and conservation frameworks* to better recognize the cultural significance of bees, to justify the protection of habitats beyond their agricultural utility, to promote biocultural landscape conservation, and support policies that legitimize 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 CESs has 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.

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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