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Traditional ecological knowledge on stingless bees in two Ashaninka communities in the central rainforest of Peru

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ABSTRACT

This article explores the Traditional Ecological Knowledge (TEK) on the management of stingless bees and the cultural use of honey among the Ashaninka communities of Marontoari and Pichiquia in the central Amazon Rainforest of Peru. From March 2019 to November 2022, semi-structured interviews were conducted with seven families dedicated to raising stingless bees. The communities' knowledge includes harvesting honey, particularly from species such as neronto or pitsi (*Melipona eburnea*), and shinkenka (*Tetragonisca angustula*), emphasizing practices that protect tree integrity and align with seasonal cycles. The honey, primarily used in traditional medicine, is valued for treating respiratory ailments, reflecting a deep interconnection between cultural practices and ecological stewardship. Additionally, the Ashaninka identify over 14 plant species utilized by bees to construct their nests, demonstrating a sophisticated understanding of local biodiversity. This ethnological report is the first to document these ancestral practices within Ashaninka culture, offering critical insights into their conservation efforts. By integrating TEK with elements of cultural narrative, this study underscores the importance of incorporating indigenous knowledge into sustainable resource management strategies in the Amazon, advocating for a holistic approach to biodiversity conservation that honors both ecological and cultural dimensions.

Keywords: Meliponines; Conservation; Traditional knowledge.

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SIGNIFICANCE STATEMENT

This study provides a novel exploration of the Ashaninka communities' Traditional Ecological Knowledge (TEK) regarding stingless bees in Peru's central Amazon. It documents, for the first time, sustainable beekeeping practices in Marontoari and Pichiquia, focusing on traditional honey extraction and species management. The research highlights the cultural and medicinal significance of stingless bees within Ashaninka society, emphasizing the importance of incorporating TEK into conservation strategies. This work bridges gaps in understanding indigenous beekeeping and contributes significantly to both ethnobiological research and biodiversity conservation.

INTRODUCTION

Indigenous communities have long possessed and utilized intricate knowledge of native stingless bees, or meliponines, particularly within the Amazon Rainforest (Posey 1982; Crane 1999). This Traditional Ecological Knowledge (TEK) reflects a deep understanding of the ecological roles and cultural significance of these species, developed over centuries of close interaction with their environment (Berkes 1993). Prior to European colonization, indigenous groups in the Amazon adeptly managed these bees, not only for honey production but also as integral components of their medicinal practices and spiritual life (Crane 1999; Quezada-Euán et al. 2018; Medrano and Rosso 2010). The introduction of European honeybees (*Apis* sp.) in the late 15th and early 16th centuries for Catholic rituals marked a significant shift, overshadowing the native meliponines, whose populations have since faced decline due to various anthropogenic pressures (Toledo-Hernández et al. 2022; Rasmussen and Delgado 2019; Delgado et al. 2023).

Stingless bees are revered as sacred species in the spiritual and cultural fabric of various Amazonian indigenous groups, including the Kukama-kukamiria, Kayapó, Enawene-Nawe, Kaxinawá, Atikum, Maijuna, Kawaiwete, Ikpeng, Yudja and Kĩsêdjê (Delgado et al. 2023; Posey 1982; Posey 2002; Santos and Antonini 2008; Costa-Neto 1998; Oliveira 2002; Léo Neto 2011; Athayde et al. 2016; Wingfield and Gilmore 2023). For example, the Ikpeng people of Brazil believe certain bees can control natural elements, using sacred songs to ward off thunderstorms, highlighting their deep spiritual connection with these creatures (Athayde et al. 2016). The Kayapó even model their social structures on the cooperative and organized behavior of bees, illustrating how deeply these species influence their societal norms (Posey 2002). Similarly, the Kawaiwete reflect this connection, viewing the arrival of the European honeybee to the Amazon as a metaphor for integrating new members into their community aiming for social harmony (Athayde et al. 2016). Such narratives underscore the intertwined nature of ecological and cultural systems, a theme central to the TEK framework (Berkes 1993).

Stingless bees thrive in tropical or subtropical regions globally, with approximately 500 species known worldwide, 70% of which are found in the Americas (Michener 2007; Vit 2015). In Peru alone, around 175 species are found within the Amazon Rainforest (Delgado et al. 2023). Previous research has extensively documented the management of stingless bees and their use as a source of food and medicine in Peru (Rasmussen and Castillo-Carrillo 2003; Castillo-Carrillo et al. 2016; Elizalde Vilela et al. 2016; Perichon 2013). For instance, the Kukama-Kukamiria ethnic group breeds 17 species of stingless bees, highly valued for their honey's medicinal, nutritional, and cultural uses (Delgado et al. 2023). Despite this rich history of documentation, the relationship of other indigenous groups in the Peruvian Amazon, such as the Ashaninka, remains underexplored, leaving a significant gap in our understanding of their TEK.

The Ashaninka territory spans the high and low zones of the eastern tropical forest in Peru, primarily in the departments of Junín, Ucayali, Pasco, Cusco, Huánuco, and Ayacucho (Ministry of Culture 2014). The Ashaninka language, part of the Arawak linguistic family, is the fourth most spoken in Peru (Ministry of Culture 2022). The Ashaninkas primarily engage in hunting, fishing and cultivating native crops (Ministry of Culture 2014). Their staple crop, kaniri "yucca" (*Manihot esculenta*), forms the basis of their daily diet. From kaniri, they prepare masato (pearentsi), a socializing beverage made from fermented, cooked, crushed, and chewed yucca (Fabián 2013). Additionally, they cultivate a variety of crops including koricha "sweet potato" (*Ipomoea batatas*), shinki "corn" (Zea mays), parenti "banana" (Musa × paradisiaca), inki "peanuts" (*Arachis hypogaea*), tsitoiki "palo bean" (*Cajanus cajan*), maona "sachapapa" (Dioscorea trifida), mapocha "papaya" (*Carica papaya*), tibana "pineapple" (*Ananas comosus*), and tsanaro (*Colocasia esculenta*). They also raise poultry like tyapa (chicken) and ducks (pantyo) to a lesser extent. Over the past decade, the Peruvian government has promoted the cultivation of kemito "cocoa" (*Theobroma cacao*), cajé "coffee" (*Coffea arabica*), and trout (*Oncorhynchus mykissm*) for self-consumption. Despite the recognized connections between the Ashaninka and their natural environment, detailed insights into their relationship with stingless bees and the ancestral wisdom passed through generations are scarce (Ministry of Culture 2022; Kujawska et al. 2023). This gap is particularly concerning in the face of escalating threats to the Amazon and its indigenous custodians, making the documentation and preservation of TEK a critical act of both cultural and ecological conservation (Lovejoy and Nobre 2019; Toledo 2001; Maffi 2005).

This study aims to bridge this gap by documenting the TEK of stingless bees within two Ashaninka communities — Marontoari and Pichiquia. It not only captures the practical aspects of sustainable beekeeping and honey extraction but also delves into the cultural and spiritual dimensions of these practices. By integrating TEK with elements of folkloric narrative, as suggested by Toledo (2001), we provide a holistic view of how the Ashaninka's ecological knowledge is interwoven with their cultural identity and

spiritual beliefs.

Ultimately, this research contributes to the broader discourse on the role of indigenous knowledge in biodiversity conservation. It advocates for the incorporation of TEK into modern conservation strategies, aligning with the interdisciplinary biocultural heritage approach that recognizes the importance of preserving both the ecological and cultural integrity of the Amazon Rainforest (Gadgil et al. 1993). By recording and honoring this traditional knowledge, our efforts are geared toward informing conservation policies that are both effective and respectful of the Ashaninka's biocultural heritage, ensuring the sustainability of these living traditions for future generations.

MATERIAL AND METHODS

Location

The study was conducted in two indigenous communities of the Ashaninka ethnic group (Figure 1): Marontoari and Pichiquia. Marontoari, consisting of 12 families, is located at coordinates 636935-8620461 in the district of Pichari, province of La Convención, department of Cuzco. It sits at an altitude of 1230-2600 meters above sea level, with temperatures ranging from 10-26 °C. Pichiquia, with 19 families, is located at coordinates 597043-8735228 in the district of Rio Tambo, province of Satipo, department of Junín, and has an altitude of 340 to 600 meters above sea level, with temperatures ranging from 18-32 °C. These communities are in the buffer zone of the Ashaninka Communal Reserve and the Otishi National Park and are characterized by rugged terrain, dense tropical jungle vegetation interspersed with conglomerates of grasslands, and a climate with two defined seasons, the dry season with little rainfall and low humidity from April to October, and the rainy season from December to March, characterized by a drastic river growth (Weiss 2005). In both communities, younger people are bilingual and speak Castilian Spanish and Ashaninka, while older adults speak only Ashaninka.

Species identification

Bee and plant species were initially identified through interviews with local informants who possess extensive traditional ecological knowledge. Following this, we conducted field examinations of the tree trunks used for beekeeping, identifying plant species based on their morphological characteristics *in situ*. Bee species were identified by observing their morphological features and the distinctive architecture of their hive entrances, which are characteristic of different stingless bee species in the Amazon. To enhance the accuracy of identification, these morphological observations were further evaluated using taxonomic keys specific to the region's stingless bees.

Community consent

Prior to data collection, ethical considerations were meticulously addressed. Meetings were held in each community to obtain informed consent from local authorities and participants, adhering to ethical guidelines for research with indigenous communities. This process ensured respect for cultural norms and autonomy.

Semi-structured interviews

Data were collected through semi-structured interviews conducted in March 2019 and November 2022 by the first author. The selection process of informants from diverse backgrounds in terms of age, gender, and beekeeping experience was based on an intentional non-probabilistic sampling technique known as snowball sampling (Sadler et al. 2010), which is particularly effective in accessing hard-to-reach populations and gaining trust within close-knit communities (Biernacki and Waldorf 1981). The methods for semi-structured interviews were based on previous experience gathering traditional knowledge regarding stingless bees from indigenous Kukama-Kukamiria and non-indigenous river dwellers in the Peruvian Amazon (Delgado et al. 2023).

The interviews were conducted in both Castilian Spanish and Ashaninka, depending on the preference of the participant, to ensure clarity and cultural sensitivity (Bernard 2006). Interviews were recorded with previous consent. In Marontoari, out of the 12 families present, four families (33.3%) engaged in raising native stingless bees. In Pichiquia, out of the 19 families present, three families (15.7%) practiced meliponiculture. Given the small number of beekeeping families in these communities, it was both feasible and necessary to interview all participants to ensure comprehensive data collection. We interviewed the lead beekeeper in each of these seven families, representing 100% of the beekeeping families. This complete sampling led to the saturation point, where no new information or themes emerged as all the available beekeeping families were included (Bernard 2006). The interviewees consisted of four individuals from the Marontoari community and three from the Pichiquia community, including three women and four men, ranging in age from 38 and 61 years.

The survey consisted of eight key questions, each carefully designed and reviewed in collaboration with community members to ensure cultural sensitivity

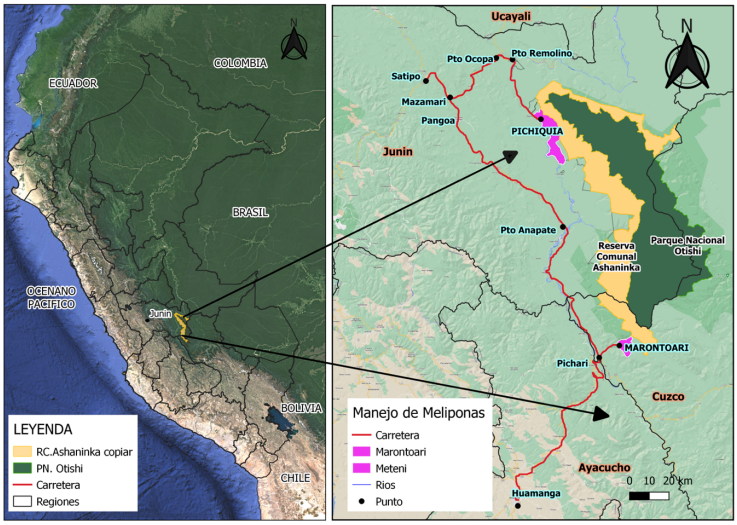

Figure 1. Map showing the areas of study in the Cuzco and Junín departments.

and relevance. These questions were crafted to be open-ended with the goal of unraveling the layers of meaning in Ashaninka beekeeping folkore and values. Open-ended questions are particularly effective in ethnographic research because they allow respondents to express their knowledge and experiences in their own words, providing deeper insights into the cultural and ecological dimensions being studied (Spradley 1979). This approach enabled a nuanced understanding of both the ecological and cultural dimensions of meliponiculture. The questions included were: 1) What type of bees (species) do you collect honey from? 2) What type of trees (species) do bees use to make their nests? 3) How do you collect honey? 4) How much honey do you collect and how often? 5) At what time of day do you collect honey? 6) What type (species) of bee do you breed? 7) What problems arise in the beekeeping facility? 8) What diseases do you treat with honey?

RESULTS AND DISCUSSION

Types of Bees Used Locally

We recorded a total of four different species of native stingless bees in three genera that are raised or harvested for honey in the Ashaninka communities. The species kept or harvested include: *Melipona eburnea*, locally known as "neronto" or "pitsi", used by 100% of informants for honey harvesting; *Tetragonisca angustula*, traditionally known as "shinkenka", used by 85.7% of informants including four beekeepers from Marontoari and two from Pichiquia; *M. grandis*, known as "earato", raised by two beekeepers from Pichiquia representing 28.6% of all informants; and *Trigona amazonensis*, locally called "eri", raised by one informant from Pichiquia totaling 14.2%.

The diversity of stingless bee species used for honey harvesting by the Ashaninka communities mirror findings from a previous study on the indigenous Kukama-kukamiria and non-indigenous river dwellers of Loreto in Peru (Delgado et al. 2023). In that study, interviews with 17 families across 21 communities reported the same four species, along with three additional species. This variation in the number of species used may be attributed to the larger sample size of communities and families interviewed, suggesting that further expansion of our research could provide deeper insights into the Ashaninka's sustainable use of stingless bees.

These records underscore the importance of stingless bee biodiversity in local meliponicultural practices, suggesting that a decline in bee abundance and species diversity could have significant negative repercussions on traditional practices and cultural knowledge (Klein et al. 2007). Maintaining high species diversity is crucial for sustaining both ecological balance and the variety of resources communities rely on (Gadgil et al. 1993). This is particularly relevant for the Ashaninka, whose use of multiple bee species ensures access to a broad range of honey types, each serving distinct purposes.

Other species whose scientific name could not be validated, but whose honey is considered harmful to health, and thus not of interest for honey harvesting, include pantamakori, shetanti, eriki, tsiteriki, penti, amotoro, tsiticanairiki, batsetori, ajikitsi. The informants stated that the honey from these species causes dizziness, headache, nausea, and weakness. According to Rojas (2003), the Ashaninkas have generated the taxon nerontoki for the African honeybee *Apis mellifera*, known as the most efficient producer of

Figure 2. Management of stingless bees in the Ashaninka communities of Marontoari and Pichiquia: a) Raising of *Tetragonisca angustula* bees in the "chonkorina" fruit of *Cucurbita moschata*, b) An Ashaninka child opening a bee nest to collect honey and retrieve the colony without cutting down the tree, c) Transfer of the colony from a tree to a rational hive, d) A rational hive placed next to a tree to facilitate the entry of all flying bees into the hive, next to tree ashes used to control pests, e) Rational hives with bees placed inside agroforestry systems, f) An Ashaninka woman collecting honey and consuming larvae and honey of *T. angustula*, g) An Ashaninka woman holding honey and honey pots recently harvested, h) An Ashaninka girl enjoying recently harvested honey, i) An alternative method of raising *T. angustula* bees in cooking pots, i) An Ashaninka child enjoying honey collected in the cooking pot.

honey. However, the informants reported that they refuse to *breed A. mellifera* due to the painful stings it causes. This reluctancy to raise the stinging honeybee was also detected in the Kukama-kukamiria ethnic group where interviewees reported not keeping them and only using "their honey when a tree is cut for purposes other than honey extraction" (Delgado et al. 2023).

Uses of Bees and their Products

Informants stated that they collect honey from these four species primarily due to the high volumes produced, the potent medicinal properties and the ease of collection from nature. All interviewees reported that they use the harvested honey to treat various illnesses while they consume pollen and larvae as food. All informants indicated that propolis is used as wax to make candles and to prepare arrows for hunting and fishing. This broad range of uses for stingless bee propolis has also been reported in the Enawene-Nawe people in Brazil (Santos and Antonini 2008) where the propolis is used in hand-crafting and traditional medicine.

We recorded a total of 12 illnesses that are treated with stingless bee honey . The honey is primarily attributed to treating respiratory tract diseases including the flu, bronchitis, cough, sore throat, and asthma. However, informants reported also using the native honey to treat tuberculosis, conjunctivitis, hemorrhages, muscle aches, diarrhea, burns, wounds, and even to improve children's intelligence. Some of the respiratory tract diseases treated with stingless bee honey coincide with those reported by the Kukama-kukamiria culture in Peru (Delgado et al. 2023) and the Enawene-Nawe community in Brazil (Santos and Antonini 2008). Wound healing properties were also reported by the inhabitants of the province of Oro in Ecuador (Vit et al. 2015).

Recent physicochemical analyses of *M. eburnea* and *T. angustula* honey in Peru provide scientific evidence on the biochemical and healing properties of stingless bee honey (Delgado and Espinoza 2023). The study reported the tentative identification of small molecules with anti-inflammatory, antioxidant, antimicrobial and antiviral activity such as naringenin chalcone, fraxin, hyperoside, and lutein in honey, also previously detected in other medicinal honey around the world (Delgado and Espinoza 2023) including Ecuadorian stingless bee honey (Guerrini et al 2009).

In Ashaninka traditional medicine, honey is used pure or mixed with plants cooked or macerated in sugarcane alcohol as previously observed in other parts of the Peruvian Amazon (Rasmussen and Castillo 2003). The plants most used in this combination are maticoshi "matico" (*Piper aduncum*), irariki "blood of the dragon" (*Croton lechleri*), kapiari "ayahuasca" (*Banisteropsis caspi*), samentotsa "cat's claw" (Uncaria tomentosa), metaki "clavo huasca" (*Tynnanthus panurensis*), metakinisoki "chichuhuasi" (*Maytenus maciocaspa*), potsoti "achiote" (*Bixa orellana*), sanancoshi "sanango" (*Bruntessia grandi*), shinti "balsa wood" (*Ochroma pyramidali*), jiribati "quina quina" (*Pouteria torta*).

It was also noted that in the Ashaninka world, stingless bee honey is not typically recommended for school-aged children due to beliefs that it induces laziness. This notion underscores the role of myths and legends in shaping and maintaining traditional ecological knowledge, as indicated by Dudgeon and Berkes (2003).

Pest Management and Sustainable Practices

The informants identified several pests that pose challenges to beekeeping, such as the "black fly or vinegar fly" (*Pseudohypocera kerteszi*) (Diptera: Phoridae), the ant "sitaracuy" (*Eciton buchelly*) (Hymenoptera: Formicidae), and cockroaches (*Periplaneta* sp.). To control these pests, they use ashes from trees, spreading them at the base of the platforms where the hives are placed. This method reflects an intimate understanding of and respect for their natural environment (Gadgil et al. 1993). Notably, the main pests found in the meliponaries are consistent with those reported in other meliponaries throughout the Peruvian Amazon (Delgado et al. 2020), indicating common challenges and possibly shared solutions across regions.

Methods of Harvesting Bees and their Products

Honey is extracted from various sources in the wild. For example, Ashaninka people harvest the nests of stingless bees found underground, built inside the nests of "comejin" termites (Insect: Isoptera). More predominantly, they also scout for wild beehives located in the cavities of logs. According to the informants, the bees construct their nests on 21 plant species, with the primary species being "marometiki" (*Brosimum alicastrum*) at an 85.7% frequency of citation of informants, "pochotariki" (*Tetragastris altissima*) at a 57.1% frequency, "inchakitso" (*Aniba gigantiflora*), and "manitiki" (*Pseudolmedia laevis*) with 42.8% occurrence (Table 1). To harvest forest honey, 100% of informants reported that they make a cut in the tree resembling a window at the nest's height, extract the honey, and then seal the cut with a lid made of wood and clay. They use

Table 1. Diversity of plant species used by stingless bees as nesting habitats in the communities of Marontoari and Pichiquia as mentioned by informants and verified by authors following morphological analyses of the plant species.

Family	Scientific Name	Ashaninka Name
Burseraceae	*Tetragastris altissima*	Pochotariki o Pochotaroke
Calophyllaceae	*Calophylum brasiliense*	Tsibeniroki
Euphorbiaceae	*Croton lechleri*	Irariki
Fabaceae	*Erythrina velutina*	Sonkare
Fabaceae	*Ormosia coccinea*	Chochovaroki
Fabaceae	*Inga feuilleei*	Intsipaki
Juglandaceae	*Juglans neotropica*	Ketaki
Lauraceae	*Aniba gigantiflora*	Inchakitso
Malvaceae	*Chorisia integrifolia*	Manpeki
Malvaceae	*Heliocarpus americanus*	Shinti
Meliaceae	*Guarea kunthiana*	Koshiritiki
Meliaceae	*Guarea guidonia*	Sheiriki
Moraceae	*Brosimum alicastrum*	Marometiki
Moraceae	*Ficus anthelmintica*	Kiriniroki
Moraceae	*Pseudolmedia laevis*	Manitiki
Moraceae	*Perebea longipendunculata*	Pamaki
Moraceae	*Ficus insipida*	Potoki
Sapindaceae	*Nephelium lappaceum*	Sokopenki
Sapotaceae	*Chrysophyllum oliviforme*	Chonkirivantiki
Sapotaceae	*Pouteria torta*	Jiribati
Urticaceae	*Pourouma cecropiifolia*	Shevantoki

tools like machetes, axes, and, more recently, chainsaws, which have made the process more efficient, precise, and less destructive to the nest and colony. Informants mentioned that this technique of harvesting honey without felling the tree is an Ashaninka sustainable practice aimed at preserving future harvests, in alignment with their cosmovision of living in harmony with nature. This sustainability commitment in traditional beekeeping practices is also observed in Kukamas communities in Peru that make openings in the tree for honey harvesting and then cover the trunk (Rasmussen and Castillo 2003), and in the Quilombola, Guarani and Pankararé that perform colony division to form new hives (Carvalho et al. 2014). These ancient sustainable practices echoe the intricate relationship indigenous communities have with their environment as noted in previous studies (Dudgeon and Berkes 2003; Tengö et al. 2014).

Informants highlighted that honey extraction predominantly occurs in the rainy season (November - April) when plants are in full bloom, and early in the morning when flowers are richest in honey (nectar). The amount of honey harvested varies from 1/2 to 2 kg every 8 to 12 months, depending on the bee species. Three out of the seven informants also noted that they prefer to harvest during the full moon, though not all consider lunar phases significant for this activity.

The main species cultivated by the Ashaninka communities are "neronto" or "pitsi" (*M. eburnea*) and "shinkenka" (*T. angustula*). A similar preference for keeping *M. eburnea* was reported by the Kukama-kukamiria and local dwellers in Loreto, Peru

(Delgado et al. 2023) primarily due to the quantity of honey produced and the availability of the species in the area.

Traditionally, Ashaninka villagers keep stingless bees in sections of tree trunks measuring 70cm to 1.50m, and in fruits of the "chonkorina" plant (*Cucurbita moschata).* To prepare the chonkorina nests, mature fruits are harvested and dried in the sun for five days before the top is cut to extract the flesh, creating an entry and exit for the bees. After drying for approximately three days, the bee nests are placed inside. These nests are then retrieved from the forest and positioned in fruit trees near the dwellings or under the floor or roofs of the houses, illustrating a deep-rooted harmony with their environment.

Cultural and Spiritual Significance of Stingless Bees

In the community of Marontoari, an informant shared unexpected and additional cultural information regarding stingless bees. The participant shared a local story of creation associated to stingless bees that had been transmitted to their family through grandparents many generations ago. According to the folkloric narrative, the Ashaninka cosmovision believes that in the mythical beginning of time there was only darkness and spirits roaming free in the planet. There were no flora, fauna or ecosystems including mountains or rivers. The spirits had human-like characteristics and were categorized as either good or evil. Legend says there was a female human-like spirit that prepared the best “masato” fermented drink that everyone enjoyed fully. When the god of creation, the “Avireri”, rose to turn every spirit into a living or non-living entity, whether that be an animal, a flower, a mountain or river, the god turned the human-like spirit that prepared masato into the stingless bee that now provides them with the best quality and most tasteful honey.

Kujawska et al (2023) reported that Peruvian Ashaninka native communities along the Tambo River consider the “eri” stingless bee a “matsi” (sorcerer) and a cultural hero that first provided Ashaninkas with manioc beer (Sosnowska and Kujawska 2014). In the local myth, the “eri” bee is thought to take food leftovers that have been previously chewed or vomited by humans to their nests and produce an illness that maninfests as dizziness and headache. This illness, observed after drinking manioc beer, is counteracted using “erishi,” a carefully prepared juice from crushed leaves.

These stories deeply reflect the Ashaninka cosmovision and spirituality associated with stingless bees. The symbolic value attributed to stingless bees within Ashaninka culture highlights the role of language in conveying complex ecological and spiritual knowledge (Dundes 1965). Alves and Albuquerque (2010) underscore the challenges posed by the terminological fluidity in ethnoscientific studies, which is evident in the multifaceted roles bees play in Ashaninka folklore and spiritual life. A similar broad range of values attributed to stingless bees, including food, medicine, religion and mythology, has been previously reported among ethnic groups in Tropical America (Quezada-Euán et al. 2018;), the Kayapó’s indigenous group in Brazil (Posey 1982) and the ancient Mayan culture (Cappa and Souza 1995). Similar to the way ’ibinishi’ plants are revered for their spiritual connections in the Ashaninka culture (Kujawska et al. 2023), bees are integral to narratives of mysticism and potent biological powers. Their harvesting and consumption of honey reflects not just an ecological understanding but also a cultural choice, influenced by traditional tales and beliefs passed through generations (Posey 1985; Kujawska et al. 2023). Stingless bees play key roles in local myths that illustrate the Ashaninka community’s values, practices and interconnectedness with nature. This bee-culture connectivity provides a basis for biocultural preservation as suggested by Gadgil, Berkes and Folkes (1993) that acknowledged the role of cultural ethnoknowledge in biodiversity conservation, advocating for indigenous wisdom to be integrated into modern conservation strategies to ensure the resilience and sustainability of our ecosystems.

Moving Towards Sustainable Stingless Beekeeping

Five years ago, the National Service of Natural Protected Areas of Peru (SERNANP), the Provincial Municipality of Pichari, and the technical team from the Institute of Amazonian Research of Peru initiated programs to educate local people on raising stingless bees in rational hives, aiming to enhance the sustainability of this traditional practice. In the communities, individuals dedicated to stingless beekeeping typically maintain between 2 to 5 rational hives. These technified hives are comprised of five components: a trash bin, a nest, an upper nest, and two honey pots, representing a significant advancement in beekeeping technology in the area.

To transition from a natural hive to a rational one, a portion of the tree is carefully opened with an axe or chainsaw. The honey pots and egg discs are then relocated to the rational hive. This hive, containing the egg discs, is positioned adjacent to the tree for about 8 hours, facilitating the maximum entry of bees. At night, the hive is moved to its permanent location. Notably, only one of the seven informants reported proficiency in multiplying or dividing bee

colonies, indicating a potential area for further training and education.

These traditional beekeeping practices, alongside the recent transition to more sustainable methods (Delgado et al. 2023), underscore the contemporary relevance and adaptability of the Ashaninka's knowledge. Their practices provide valuable insights for broader biodiversity conservation efforts and ecological education (Dudgeon and Berkes 2003). Preserving and understanding these traditions are crucial for maintaining biodiversity and cultural heritage, offering a model of coexistence and respect for nature that is increasingly pertinent in our changing world (Gadgil et al. 1993). The Ashaninka's profound understanding and practices concerning stingless bees carry significant policy implications regarding biodiversity models and indigenous knowledge (Quezada-Euán et al. 2018). By recognizing and integrating this traditional wisdom, more sensitive and effective environmental conservation and indigenous rights policies can be formulated (Tengö et al. 2014). Adopting collaborative approaches, where indigenous communities are active policy participants, can foster more sustainable and culturally respectful environmental management and development strategies.

CONCLUSION

This study highlights the profound TEK of the Ashaninka communities regarding stingless bees, revealing an intricate relationship between cultural practices and ecological stewardship (Berkes 1993; Posey 1999). The Ashaninka's beekeeping, rooted in both practical and spiritual dimensions, reflects a holistic understanding of their environment (Toledo 2001). Through the selective use of bee species such as *M. eburnea* ("neronto" or "pitsi") and *T. angustula* ("shinkenka"), they manage to sustain both cultural and ecological diversity, preserving vital medicinal, nutritional, and economic resources (Gadgil et al. 1993; Alves and Albuquerque 2010). These practices are informed by a nuanced understanding of the ecological and health implications, passed down through generations. Honey from certain bee species is avoided due to its perceived harmful effects, indicating a refined knowledge of species-specific properties.

Ashaninka meliponiculture has evolved over time, adapting to external influences and changing needs. This has led to a range of techniques, from natural care to more structured forms, such as raising bees in chonkorina fruit or using rational hives. The multifaceted use of honey in traditional medicine, treating 12 ailments - including respiratory diseases, skin conditions, and wounds - underscores the community's deep ecological wisdom and highlights a complex pharmacopeia derived from their intimate relationship with bees and local flora. Honey is used in its pure form and in synergy with plant extracts, demonstrating an advanced understanding of its medicinal properties.

The Ashaninka's selective use of specific bee species is deeply embedded in cultural narratives and spiritual beliefs, emphasizing that these practices are not merely functional but carry significant cultural meaning that attribute spiritual significance to these bees (Berkes 1993; Athayde et al. 2016). This spiritual connection underscores how indigenous knowledge systems like those of the Ashaninka blend ecological wisdom with cultural identity (Posey 2002). The sustainable methods employed - such as harvesting honey without cutting trees and using ashes from trees to control pests - demonstrate a deep respect for the environment, aligning with broader biocultural conservation principles (Gadgil et al. 1993).

Furthermore, this research reaffirms the critical importance of maintaining species diversity in local ecosystems, as any decline in bee biodiversity could have profound impacts not only on ecological balance but also on cultural practices (Toledo 2001; Klein et al. 2007). The Ashaninka's use of multiple bee species for different types of honey, each with unique properties, exemplifies how ecological knowledge can contribute to biodiversity conservation strategies. In this context, it becomes clear that preserving indigenous knowledge is essential for sustaining biodiversity, cultural heritage, and ecosystem resilience in the face of environmental changes (Toledo 2001, Berkes 1993).

As the Amazon Rainforest faces the threat of gradual diminishment due to deforestation, climate change, species competition, and destructive human activities, it becomes imperative to conduct further studies and implement policies to safeguard the Ashaninka's rich knowledge (Lovejoy and Nobre 2019; Toledo 2001; Maffi 2005). The products, practices, and traditional knowledge linked to stingless bees must be recognized and protected. Future research should delve deeper into themes such as the role of bees in Ashaninka folklore, their influence on societal structures, and the sustainable practices that govern both beekeeping and community stewardship of bee biodiversity. Such explorations will enrich our understanding of the intricate relationships between Ashaninka knowledge, ecological practices, and cultural resilience. Additionally, comparative studies in other indigenous communities across the Amazon will help build a more comprehensive view of how stingless bees are intertwined with broader Amazonian biodiversity and cultural practices.

By framing the Ashaninka's meliponicultural

practices through the lens of folklore and ethnobiology, this study contributes to a broader understanding of how indigenous communities engage with their environment, shaping sustainable practices that align with both ecological and spiritual values (Berkes 1993; Toledo 2001). This reinforces the need for conservation efforts and policy-making that integrate traditional knowledge systems, ensuring that both biodiversity and cultural heritage are preserved for future generations (Gadgil et al. 1993; Toledo 2001; Maffi 2005).

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DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: RAD, CD
Carried out the experiment: RAD, DCL
Carried out the data analysis: RAD, DCL, RC, CD
Wrote the first draft of the manuscript: RAD, CD
Review and final write of the manuscript: RVE
Supervision: CD, RVE

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