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Abbreviations
PAR: Participatory Action Research; TEK: Traditional Ecological Knowledge; ICH: Intangible Cultural Heritage; DCC: Declining Colony Conditions / Drivers of Colony Collapse; UACJ: Universidad Autónoma de Ciudad Juárez

Case report

Traditional Beekeeping After Africanization in Puerto Del Aire, Nuevo León: A Bio-Cultural Case Report

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Abstract

Traditional family beekeeping constitutes a critical component of ethnobiological and intangible cultural heritage in the semi-arid regions of Mexico. However, socio-ecological shifts and biological invasions threaten the continuity of this ancestral practice. This report examines the erosion and adaptation of traditional beekeeping practices within the "Puerto del Aire" ejido, a rural community located in the Chihuahuan Desert system of southern Nuevo León, Mexico. Spanning a observation window from 2019 to 2024, this study utilizes an ethnographic case study design integrated into a broader participatory action research framework. Data were collected via household surveys, direct observations, environmental transects, and eight deep biographical interviews with community elders (aged 45 to 96 years). The findings illustrate a severe decline in localized apicultural knowledge and colony survival. This loss is primarily driven by environmental stressors, shifting socio-economic dynamics, and the historical invasion of the Africanized honey bee (Apis mellifera scutellata). Despite severe knowledge erosion, contemporary efforts highlight community-led adaptation strategies designed to manage new socio-ecological and behavioral traits of regional bee populations. The intersection of biological pressures and cultural erosion poses a critical threat to regional biodiversity and intangible heritage. Preserving family-scale apiculture requires targeted participatory conservation strategies that bridge traditional ecological knowledge with modern apiary management under changing climate regimes.

Introduction

The objective of this case report is to document the evolutionary trajectories, decline, and adaptation strategies of traditional family beekeeping within a rural community in Mexico's arid northeast. Adopting a participatory action research (PAR) design and an ethnographic case study methodology, this paper frames the phenomenon through the dual lenses of ethnobiological heritage and Intangible Cultural Heritage (ICH). The theoretical conceptualization of ICH positions tradition as an intergenerationally transmitted, collectively owned matrix of knowledge, customs, and material practices that define societal identity [1]. Crucially, this intangible matrix relies on a material foundation: a "humanized nature" where the environment acts as a socio-ecological legacy and symbol of community survival [1,2,3]. Consequently, environmental sustainability and cultural heritage are mutually constitutive dimensions [4]. Within ethnobiological heritage, this culture-nature nexus manifests through domestic and economic reproduction strategies embedded within family units [4], such as artisanal, small-scale apiculture.

Apis mellifera plays an indispensable role in maintaining regional ecological equilibrium, driving symbiotic interactions that facilitate the pollination of approximately 75% of global flowering plant species [6,7]. In the rural ejidos of the northeastern Mexican semi-arid zone-where economic survival hinges on subsistence rain-fed maize agriculture and extensive goat pastoralism-backyard family beekeeping historically served as a critical economic buffer and nutritional resource. While global arid and semi-arid zones exhibit high bee species diversity-with the US-Mexico borderlands hosting the world's most extensive apifauna [8]-the exact parameters of these populations in Mexico's adjacent arid pockets remain under-documented due to a lack of baseline systematic registries [7]. Following the introduction of European A. mellifera lineages to Mexico in the 16th century [8], countrywide honey production scaled exponentially between 1950 and 1980, making Mexico the world's second-largest honey exporter by 1977 [9,10]. This trajectory was severely disrupted by the introduction and rapid expansion of the Africanized honey bee (*Apis mellifera scutellata*) in 1986, alongside compounding anthropogenic and environmental stressors [11,12,13]. Globally, these drivers contribute to an estimated annual bee mortality rate of 30% [9], climbing higher across Europe and North America [14]. Regionally, [11] reported an estimated mean colony loss rate of 33.4% across the highlands and northern territories of Mexico, a loss driven by adverse weather anomalies, pests, pathogens, chemical insecticides, and management complexities arising directly from africanization.

Case Presentation

Socio-Ecological and study site context

The study was localized within a rural ejido in the municipality of Doctor Arroyo, Nuevo León, positioned inside the *Ixtlera* region of the Chihuahuan Desert. This geographic coordinate borders the states of San Luis Potosí, Zacatecas, and Tamaulipas. The ecosystem is characterized by a BSh (semi-arid) climate, exhibiting a low mean annual precipitation of 350 mm and vegetation dominated by xerophytic scrubland. The community comprises a demography of fewer than 500 inhabitants residing in traditional adobe structures. The domestic economy is organized around subsistence rain-

fed agriculture and rustic goat husbandry, operating under high indices of regional marginalization, poverty, and youth emigration [15]. Historically, from the late 19th-century hacienda era through the late 1990s, rustic family-managed apiculture was a ubiquitous socio-economic staple across southern Nuevo León [16]. Puerto del Aire is one of the ten tributary ejidos of the Sierra Azul, located between the states of Nuevo León and San Luis Potosí.

Methodological framework and data collection

Beginning in 2019, a multidisciplinary cohort of researchers initiated the Multidisciplinary Participatory Action Research Project for a Comprehensive Well-being Model in the "Puerto del Aire" *Ixtlera* Area. Fieldwork blocks were executed symmetrically across different seasons during the first longitudinal phase (2019-2024). To analyze the erosion of ethnobiological heritage, the study paired qualitative ethnographic inquiries with targeted quantitative data streams. The field methodology integrated:

a) Community-wide household surveys.
b) Direct observational field notes.
c) Botanical and environmental transects.
d) Primary documentary and historical archive analysis.
e) In-depth, semi-structured ethnographic and biographical interviews [17, 18,19].

The core primary datasets utilized for this case report were derived from eight deep biographical interviews conducted between 2019 and 2024. The informant cohort comprised female and male community members aged between 45 and 96 years. These individuals represent the final generation of keepers holding direct lineages to ancestral, pre-africanization apicultural knowledge. The thematic matrices analyzed from these transcripts focused on local apiary taxonomy, historic colony yields, behavioral shifts post-1986, and the domestic transmission pathways of beekeeping knowledge. The individual subject served as the baseline unit of analysis for the descriptive categorization of bio-cultural loss and emergent socio-ecological adaptation strategies.

Results

Typologies of traditional apiculture and ethnotaxonomy

The ethnographic data revealed two distinct structural configurations of traditional family apiculture within the semi-arid *Ixtlera* region of the Chihuahuan Desert: wild "hive harvesting" (*recolección o "capa" de colmenas silvestres*) and domestic apiary production utilizing bútanos. While wild hive harvesting persists under severe socio-ecological precarity, domestic bútano-based production is completely extinct within the studied ejidos. Historical Traditional Ecological Knowledge (TEK) encompassed a sophisticated ethnotaxonomical framework regarding the behavioral traits, nesting habits, foraging diets, and life cycles of coexisting avifauna and insect species. Informant accounts (Don MAP) identified several distinct ethnotaxa:

A. **Guariches:** Described as diminutive, yellow, highly social wild bees resembling ants; ecologically correlated with wild social wasps of the genus *Polybia*.
B. **Jicotes:** Characterized as large, yellow, highly aggressive hymenopterans demonstrating high stinging persistence without autotomy (lack of venom apparatus retention). These correspond phenotypically to Bombus steindachneri or larger social Vespidae.
C. **Tánganos:** Identified as large, dark flying insects, which align with the biological characteristics of Apis mellifera drones or specific Mimetic Diptera.

Wild hive harvesting and intergenerational knowledge erosion

The extractive craft of wild hive harvesting historically targeted feral colonies nesting in natural cavities. Prior to regional environmental shifts, the local "moscos" (docile *feral A. mellifera* lineages) exhibited low defensive behavior, requiring minimal smoke management during honey extraction.

TEK matrices held by elder handlers included explicit sustainable harvesting guidelines that are unquantified among younger generation pastoralists. These protocols dictate:

a) Retaining baseline structural brood comb within the cavity to ensure colony vitality and continuous honey production.
b) Preserving the structural integrity of the botanical substrate (e.g., Yucca spp. or Prosopis spp.) by avoiding the use of direct fire.
c) Sealing the extraction aperture post-harvest to protect the remaining colony from secondary pests and environmental exposure.

This extractive activity has suffered a severe demographic contraction. While historical wild hives were treated as high-value ecological resources, contemporary youth display an overall lack of interest in the practice. Informants consistently identify the historical introduction of the Africanized honey bee (*Apis mellifera scutellata*) as the primary catalyst driving the abandonment of wild hive harvesting among younger generations.

Domestic production in bútanos: material culture and swarm management

Domestic, small-scale family apiculture was historically ubiquitous across the Sierra Azul region before its complete disappearance approximately three decades ago. Households integrated apiaries directly into residential lots (solares) and livestock corrals. The primary production unit utilized *bútanos*-horizontal, elongated hives constructed from the hollowed, dry trunks of indigenous palms (*Yucca carnerosana* or *Yucca filifera*). This architectural design presents a direct structural analogue to the traditional jobones utilized for Melipona beecheii husbandry in the Yucatán Peninsula [9]. Mid-20th-century family units managed up to 100 *bútanos*, operating as structured domestic enterprises that processed honey and manufactured wax candles (ceras). Swarm capture and hiving required specialized behavioral manipulation techniques. Emerging swarms settling on low-lying vegetation (*Prosopis spp.*) were guided into the bútano using physical implements (brooms), secured nocturnally, and integrated into organized apiary rows. To control flying swarms, handlers utilized two primary acoustic and mechanical interventions:

a) Acoustic Disruption: Striking metal implements (e.g., shovels with stones) to generate high-frequency acoustic waves.
b) Mechanical Disruption: Throwing localized soil particulate matter directly at the flying swarm to simulate a rain event, forcing the queen and worker cohort to land on low branches for immediate capture.

These identical ethno-technological interventions are documented in traditional apiculture across northern Spain (Manterola, 2005), suggesting a deep historical lineage of European husbandry techniques adapted to the Mexican semi-arid landscape. Furthermore, specialized handlers (such as Don MAP's mother) possessed advanced tactile skills, identifying the queen bee mid-swarm by acoustic or visual cues, securing her to clothing to anchor the worker cluster, and subsequently transferring the unified colony into the hive box.

Intergenerational learning frameworks

Knowledge transmission within the domestic production unit operated via non-verbal, observational learning frameworks rather than formalized instructions. Younger family members learned complex apiary tasks through close observation ("*watching closely*") and active participation during low-risk procedures. Children fulfilled a dual economic and educational role within the family unit. For instance, they operated small palm-frond smokers to distract colonies during harvest cycles. This participatory dynamic fostered gradual cognitive construction of apicultural trades through shared labor (Palumbo et al., 2022). Consequently, the contemporary breakdown of domestic apiculture has severed these intergenerational transmission lines, resulting in the permanent loss of localized ecological knowledge.

Biological invasion of apis mellifera scutellata and socio-ecological impacts

The introduction of Apis mellifera scutellata to Mexico in 1986, and its subsequent arrival in the northeastern region in 1990, triggered an acute socio-ecological crisis. The exceptional colonizing and reproductive capacity of this invasive phenotype represents one of the fastest documented biological invasions in modern ecological history [11]. Analogous to the displacement of stingless backyard meliponiculture in southern territories [9], Africanization in Puerto del Aire systematically dismantled European A. *mellifera* apiaries through intense interspecific aggression and competitive exclusion. Informants document violent takeovers: "But when my dad first

got sick, the hellish fighting began; they killed each other and were wiped out [...] right there [in the hives] they were beating each other up, and some left honey while others didn't [...] and the boxes, once they were abandoned, lasted for a while but eventually fell apart and rotted." (Don MPG, Historical Informant) The high hyper-defensive traits of Africanized phenotypes directly triggered widespread apiary abandonment. The profound danger posed by these defensive colonies to human populations and livestock made backyard apiculture untenable within residential zones. Informants noted multiple instances of lethal and sub-lethal stinging events involving humans and horses within regional communities (e.g., La Moreña), driving public health interventions and medical emergencies. This biological shift led to a severe social demonization of apiculture. Public fear, coupled with legal anxieties regarding potential fatalities, prompted handlers to actively destroy their own infrastructure by burning active hives. Epidemiological records confirm that during the peak saturation period of Africanization in Mexico (1988-2000), the country averaged 31.5 human fatalities per year, peaking at 50 annual deaths during the critical stabilization window between 1992 and 1994 [11], validating the severe threat landscape recalled by the community members of Puerto del Aire.

Discussion

Bio-Cultural erosion and the intergenerational knowledge bottleneck

The data from Puerto del Aire demonstrate that while traditional family-scale apiculture has collapsed as a physical practice, the corresponding Traditional Ecological Knowledge (TEK) persists precariously within the living memory of the community's eldest demographic. This repository of knowledge reflects a highly specialized historical and environmental relationship between the human population and the xeric ecosystem of the Chihuahuan Desert. However, this socio-ecological dynamic faces an acute extinction bottleneck. Because the regional arrival of Apis mellifera scutellata in 1990 abruptly invalidated historical low-intervention husbandry methods, the intergenerational transmission of this trade was completely severed. As the final generation of traditional handlers passes away, the loss of this localized ethnotaxonomical and behavioral knowledge represents a permanent erasure of Intangible Cultural Heritage (ICH). This loss directly harms the local community and deprives the broader scientific and technical community of baseline ecological data regarding bee populations in under-studied arid regions.

Structural colony decline in xeric environments

The empirical reality observed in this ejido reflects the broader global and national crisis of pollinator decline, which exhibits particularly severe metrics across xeric and semi-arid ecosystems. The interaction between climate anomalies (low mean annual precipitation of 350 mm), aggressive biological invasions, and the subsequent social demonization of apiculture forms a hostile socio-ecological matrix. This structural vulnerability directly aligns with the regional findings of [12], confirming that the combination of Africanization, habitat degradation, and chemical stressors drives localized colony collapse. In Puerto del Aire, this structural decline did not merely reduce honey yields; it fundamentally reshaped community safety dynamics, legal anxieties, and the overall perception of the species, leading to the deliberate destruction of apiary infrastructure.

Participatory action research and ethno-technological hybridization

In alignment with the core objectives of the Participatory Action Research (PAR) design initiated in 2020, recent field interventions have catalyzed a structural shift in local apiculture. Facilitated by the project's framework, a local family has reinitiated beekeeping activities by adopting modern, non-rustic apicultural technologies, including standard Langstroth wooden hive boxes and specialized protective apparel. Critically, this contemporary introduction does not operate within a cultural vacuum. Instead, it leverages the deep-seated cultural foundation and historical experiences embedded within the community's collective memory of traditional apiculture. This transition represents a dynamic hybridization of ethno-technological knowledge. This transformation reinforces the contemporary heritage paradigm established by [4], illustrating that heritage does not reside inherently in static material objects (such as the extinct *bútanos*) or fixed geographic coordinates. Rather, heritage functions as a fluid network of social relationships, practices, perceptions, and active community-led decision-making frameworks. By adapting modern safety protocols to manage the hyper-defensive traits of regional Africanized swarms, the community actively reinterpret their historical trade to navigate contemporary nthropocene pressures.

Synthesis of gaps and future outlook

The confluence of documented pollinator decline, deep geographic data gaps across northeastern Mexico, and the accelerating extinction of localized knowledge structures presents a challenging outlook for regional apiculture. The family-scale beekeeping that historically insulated the domestic economy of Puerto del Aire was heavily shaped by these compounding structural issues. To prevent the absolute extinction of this biocultural resource, future interventions must prioritize the deployment of protective apicultural infrastructure that actively bridges surviving traditional ecological insights with modern, climate-resilient management strategies.

Conclusion

The narrative data gathered from the elder cohort points toward a sharp decline in structural Traditional Ecological Knowledge (TEK) immediately correlating with the regional arrival of A. m. scutellata. The defensive traits and high swarming frequencies of Africanized phenotypes invalidated historical low-intervention husbandry methods. This led to widespread colony abandonment and a subsequent break in intergenerational knowledge transmission lines. However, the 2019-2024 fieldwork cycles also revealed localized resilience frameworks. Current practices showcase an ongoing ethno-technological shift where remaining handlers modify box designs, alter site selection to mitigate stinging hazards, and selectively cross local swarms to balance defensive traits with environmental resilience. This suggests that while traditional heritage is severely eroded, it is adapting into a hybridized system capable of navigating contemporary anthropocene pressures. The case of Puerto del Aire highlights a classic intersection of environmental biological stress and cultural extinction. Traditional family-scale beekeeping is vanishing alongside the older generation. Revitalizing this socio-ecological asset requires active integration of modern veterinary apiculture support structures with surviving traditional ecological frameworks. This approach is essential to safeguard both regional pollinator biodiversity and the intangible cultural wealth of the Chihuahuan Desert.

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Conflict of Interest

We Declare there is not any financial interest, or any conflict of interest.

References

1. Zamora J (2011) Memory, tradition and heritage: The social construction of cultural legacy. Journal of Dialectology and Popular Traditions 66(1): 101-122.
2. Díaz Cabeza M (2010) Intangible cultural heritage as living heritage. Gazette of Anthropology 26(1): Article 14.
3. Martínez A (2018) Living heritage and community dynamics of resilience. Journal of Social Anthropology 27(1): 89-104.
4. Cantar NM, Endere ML, Zulaica ML (2021) Sustainability and intangible cultural heritage: theoretical junctions and practical horizons. International Journal of Heritage Studies 27(4): 380-395.
5. Cano A, Estrada R, Chávez G (2018) Ethnobiological heritage and social reproduction in rural communities of Mexico. Journal of Ethnobiology 16(2): 45-58.
6. Medina Flores CA, et al. (2021) The environmental and economic value of Apis mellifera pollination services in semi-arid Mexico. Agroecology and Sustainable Food Systems 45(5): 680-698.
7. Ramírez Freire L, Quiroz Martínez H (2016) Apifauna of the arid zones of Nuevo León: Diversity and information gaps. Mexican Journal of Biodiversity 87(2): 415-426.
8. Ayala R, Griswold TL, Bullock SH (1998) Wild bees of mexico (Hymenoptera: Apoidea): Aspects of their phytophily, endemism and biogeography. Archives of Zoology 179.

9. Cervantes MA, Román AD, Velázquez JA (2018) Global pollinator decline and economic vulnerabilities in mexican apiculture. Biodiversity and Conservation 27(3): 781-799.

10. Baena Díaz F (2022) Historical dynamics of Mexican apiculture and honey production trends. Journal of Apicultural Research 61(3): 410-422.

11. Guzmán Novoa E, et al. (2011) Africanization, varroa destructor, and africanized bee management in mexico. Annual Review of Entomology 56: 227-245.

12. Macías Macías JO, et al. (2018) Honey bee colony losses in mexico: drivers, rates, and management perspectives. SciELO / Revista Mexicana de Ciencias Pecuarias 9(2): 365-373.

13. Senasica (2020) Technical report on the situation of national beekeeping in the face of Africanization. Mexico City: Ministry of Agriculture and Rural Development.

14. Vargas Valero A, et al. (2021) Comparative analysis of over-wintering colony losses in North America and Europe. Preventive Veterinary Medicine 189: 105-118.

15. Cano A, Estrada R, Chávez G (2024) Socio-environmental transformations and ixtle producers of the Chihuahuan Desert: The case of Puerto del Aire. Social and Regional Studies 32(1): 112-135.

16. Morales G (1955) Economic statistics of southern Nuevo León. Monterrey: State Printing Office.

17. Balcázar FE (2003) Participatory action research (PAR): Conceptual and methodological aspects. Psychology and Society 15(1): 15-35.

18. Cichoski L, Rubin J (2021) Ethnographic methods in multi-disciplinary ecological frameworks. Qualitative Research Journal 21(2): 143-159.

19. Méndez L, et al. (2019) Mixed methodologies applied to the study of biocultural heritage. University Minutes 29: 1-18.