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Exploring biocultural diversity in urban ecosystems: an ethnobiological perspective

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ABSTRACT

Urban ecosystems differ from non-urban ones in the strong and rapid biocultural dynamics generated by the interactions between people from different cultures, at large spatial and temporal scales and very fast rates. This opinion piece explores the concept of urban ethnobiology as a critical field of research that investigates the complex and dynamic biocultural systems that exist in urban environments. We argue that interactions between humans and other life forms in urban ecosystems are influenced by a characteristic set of social, cultural, and political factors that are linked to urban environments, such as infrastructure development, population density, and governance structures. We emphasize the need for an interdisciplinary approach that brings together experts from different fields to study the inherent complexity of these systems. By examining the sociocultural dynamics that shape the way urban biodiversity is perceived, used, and managed, we can gain deeper insights into the different dimensions of socio-cultural biodiversity in urban areas.

Keywords: Biocultural heritage, Ethnobotany, Ethnozoology, Urban Ethnobiology.

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INTRODUCTION

Urban areas are becoming increasingly important in understanding how humans interact with their environment. Urban ethnobiology is a field of research that explores the relationships between people in urban social-ecological systems (see Emery and Hurley 2016; Pieroni and Vandebroek 2007). This approach is not new in ethnobiology, but only recently have we come to understand that urban social-ecological systems deserve special attention in an increasingly globalized world (Ladio and Molares 2014a; Ladio and Albuquerque 2016).

Currently, the growth of large cities is one of the problems that today's society has to address. Today, the world's population is more than three times that of the mid-20th century. There are estimates of exponential growth in the coming decades. In the 1900s, only 10% of the world's population lived in urban areas (Grimm et al. 2008). Today, the world's population has surpassed 8 billion, and should reach 9.8 billion by 2050 (World Population Prospects 2022). Furthermore, the population living in urban areas is expected to increase from 55 to 68% by 2050 (United Nations 2018). Urbanization is driven by natural urban population growth, migration to cities, and the growth of urban areas absorbing places that were originally rural. One can question if urbanization is a desirable objective in and of itself, considering that during the COVID-19 pandemic reverse migration occurred from cities to the countryside, since the latter was thought to be safer and provide more food security.

Urban spaces offer an intellectual and practical challenge for humanity to become more harmonious with nature and to better adapt our living patterns to these new anthropogenic environments. Living in an urban area is very recent in human history. The vast majority of the human population that has existed throughout history has been rural. Since 2015, more than half of the human population has become urban (United Nations 2019). Given this fact, the climate crisis, food insecurity, and water and food shortages, are some of the challenges that the growing urban population of the planet will have to face. Urban planning and the design of efficient public policies are therefore some of the *sine qua non* conditions for our adaptation as a species to these new environments. Urban ethnobiology therefore has a leading role to play in this process.

Urban ethnobiology, which includes urban ethnobotany and urban ethnozoology, is a field of research that studies human-nature relationships in multicultural urban contexts (Pieroni and Vandebroek 2007; Ladio and Albuquerque 2016; Puentes 2016; Alves et al. 2019). Note that the earliest studies of urban ethnobiology emerged in 2003 and, to date (April 2023), comprise 87 publications listed in Google Scholar. Urban botanical knowledge is a complex system that varies according to the pluricultural context and internal biocultural variation diversity of cities (Hurrell 2014). Each city has its own dynamic environment that favors the circulation and consumption of knowledge and plants through formal and informal circuits. Traditions are reproduced, innovations developed, and practices from diverse cultural contexts rooted in different philosophical positions are shared (Hurrell 2014; Acosta et al. 2021).

In this opinion article, we point out several important issues that are relevant to understanding social-ecological systems in cities while providing theoretical and methodological reflections. In an increasingly globalized context, where different cultures and societies can quickly connect, understanding how these dynamics play out in urban ecosystems is essential not only for preserving existing biocultural complexity but also for understanding the forces that generate and/or maintain that complexity. We are using here for convenience the term Local and Traditional Knowledge (LTK), being aware that urban ecosystems are highly complex and diverse, and that none of these individual terms fully accommodates this complexity.

WHY WE NEED MORE URBAN ETHNOBIOLOGY RESEARCH

Urban ethnobiology research is crucial for exploring patterns of Local and Traditional Knowledge (LTK) in urban and diaspora communities and understanding how these may vary from rural communities. It also provides insights into the articulation of urban LTK with external (society at large) and internal (community) concerns and perspectives, including mainstream (biomedical) healthcare and global versus traditional food systems and religions. At the same time, multicultural urban contexts also provide opportunities for understanding how LTK patterns are influenced by contemporary modes of transmission (audiovisual and social media), addressing questions such as: Who are the knowledge holders and end users; has their sociodemographic profile changed in urban environments? and, has urban LTK itself changed by emerging global transmission networks?

For example, a study of adaptive processes in response to COVID-19 among urban and rural Mapuche communities (Zank et al. 2022) identified the use of various virtual communication media (VCM). This shows how strategies between urban and rural communities converge and how the lines between rural and urban areas are becoming increasingly blurred. This paper, thus, does not want to position rural and urban

areas as opposed to each other. In the study by Zank et al. (2022), these strategies included virtual communication products (e.g., Facebook, web pages, virtual radios) created collectively by Mapuches. These VCMs were used to communicate values, concepts, and actions to cope with the pandemic. Self-managed virtual radios were created, and messages were sent announcing an opportunity to strengthen spirituality and Mapuche kimün (ancestral wisdom). Our results have shown that VCM have played an important role as a cultural catalyst for resilience during the period of mandatory isolation, revitalizing the validity of local knowledge associated with each territory and its communities, especially among young people. This mode of oblique transmission through VCM should be studied in more detail to understand the dynamics of local knowledge in cities. A second example is the accelerated and amplified exchange through social media channels, including Facebook, YouTube, and WhatsApp, of LTK by community members in large cities and rural areas across the world related to the (repurposed) use of previously known and new herbal remedies for preventing and treating COVID-19 symptoms (Pieroni et al. 2020). During a time when public health services around the world were overwhelmed and/or collapsed, communities took it upon themselves to develop improved strategies for sharing LTK among their extended networks of families and friends. One exciting avenue for future studies is to document to what extent this sharing has influenced their LTK systems to overlap or merge with those of other communities and/or the biomedical system.

In addition, cities are important hubs of urban (and online) markets that sell animals and wild-harvested plants used as medicines, foods, and for spiritual well-being (see Alves and Rosa 2007). Those plants and animals are obtained in (and exported from) rural areas, raising questions about their conservation status and the sustainability of the rural–urban (and transnational) supply chain. Therefore, the dynamics of urban ethnobiology offer a timely and much-needed window into research that is directly relevant to the health and well-being of diverse urban and diaspora communities, and the preservation of their biocultural heritage.

Finally, in places such as Mexico City, the fourth largest city in the world, a phenomenon known as the "Indigenization of cities"is taking place (Toledo 2015). This consists of a significant demographic rebound of the Indigenous population in the cities. Today, there is a greater indigenous population in Mexico City than there was in ancient Tenochtitlan (approximately half a million inhabitants today, Toledo 2015), which in itself is an interesting phenomenon. Likewise, in Brazil, according to the 2010 Census, the (absolute) numbers of indigenous people in large cities are also surprising, such as 11,918 Indigenous people in São Paulo, 7,560 in Salvador, 6,764 in Rio de Janeiro, 6,072 in Boa Vista and 5,941 in Brasília. In recent years, these numbers have even increased. Moreover, the New York Metropolitan Area is recognized as the most linguistically diverse urban center in the world according to the Endangered Language Alliance (ELA). As of mid-2021, ELA has mapped just over 700 languages in New York City, and some of these are endangered heritage languages spoken only by individuals or small groups, which in some cases are the sole survivors of these languages in the world (Perlin et al. 2021). This makes cities an ideal place for ethnobiology research.

However, despite its immediate relevance, urban ethnobiology studies have been slow to proliferate. One reason may be that knowledge based on traditions is sometimes erroneously perceived by community outsiders and non-ethnobiologists as "static"or even absent in urban environments. Moreover, some ethnobiologists seem to prefer to conduct research in rural environments, perhaps because they are seen as more urgent and/or more interesting to study. Research studies also tend to divorce the spiritual underpinnings of LTK from its material values, which hampers ethnobiology research in urban environments (Vandebroek and Moerman 2015; Ladio 2020). Finally, there remains a reliance on the scientific validation of LTK, rather than on upholding and celebrating LTK as an independent cultural knowledge system that operates at the same level and in parallel with scientific knowledge. This divide will likely become more pronounced in urban centers where technological solutions tend to be hailed as “progress” and cultural traditions perceived as a barrier to acculturation. To address such challenges, it is crucial to amplify urban ethnobiology research on a global scale across different countries, regions, and continents. This approach can help support previous findings that urban LTK is dynamic and relevant in a globalized world, that it is "glocal"(localized as well as global), and that it continues to address the needs of people who engage in rural–urban and/or transnational mobility (Vandebroek 2023).

The pandemic has revealed the socio-environmental fragility of urban life, the lack of food and health autonomy, and individuals who do not know how to grow their own food and medicine. In addition, the spatial organization of a city perpetuates health challenges due to the low number of green spaces, the small distance between dwellings, crowded living conditions, and overcrowded public transport, for example (Ladio 2020).

URBAN ETHNOBIOLOGY AND THE CHALLENGE OF RESILIENT CITIES

Green areas within cities are crucial spaces for all citizens, particularly children and the sick and elderly. Their importance has been self-evident throughout the COVID pandemic. The World Health Organization recommends 9 m^2/inhabitant, but many large Latin American and Caribbean cities lack sufficient green spaces. Achieving citizen appropriation and the comanagement of public areas that are often wasted can transform them into areas of food production for all, pollination gardens, scenarios for artistic expression, sports, recreational areas, etc. The health benefits include the faster recuperation of sick people closer to green areas (Ulrich 1984). While local appropriation and co-management are required and viable, there is often a lack of citizen interest associated with the notion that responsibility for such areas lies exclusively with the municipal government. One important case, however, occurred in Rotterdam, where the locals were involved in the design and upkeep of the green space (Urban Green blue grids 2022). However, citizen movements and motivation, as well as a transdisciplinary approach that includes ethnobiology, can help to address this challenge. Communicators and artists have led a transdisciplinary effort in Pachuca, Mexico, involving local inhabitants, biologists, and municipal authorities (Briseño Tellez and Pulido Silva 2022). Pachuca only presents 1.7 m2/habitant of green areas with more than 500,000 inhabitants in its metropolitan area. A very small green area was intervened on to construct artistic scenarios, a pollination garden, and a "Galería del Barrio,"where the local history of Pachuca's first barrio is conserved and recounted by local inhabitants.

URBAN MARKETS IN THE SPOTLIGHT

Urban markets that commercialize animals and medicinal plants are spaces that promote agrobiodiversity and wild plant use, but they also have multiple other functions in cities (Ladio et al. 2013; Fa et al. 2019). In addition to economic and social purposes, it is important to mention the conservation of knowledge and its transfer to other people, both consumers and sellers (McMillen et al. 2012). Fairs are places where knowledge is updated and/or reinvented (Sõukand et al. 2020). Markets are dynamic systems that are subject to change both by the people who are part of them and by contextual socio-cultural and environmental factors.

Due to numerous factors, but mainly agroecological, vegan and vegetarian movements, urban horticultural markets are becoming important places for urban food sovereignty and plant-based foods. An ethnobotanical approach of all the species and local foods commercialized in these places is a task needed to evaluate and monitor the access and preferences of these natural products to urban dwellers.

In addition, hybridization is a key concept to study in urban markets, considering a process of cultural adaptation when structures, practices and knowledge from different cultural heritages are combined. This process is dynamic and flexible; patterns and mechanisms can be identified and observed in space and time (Ladio and Albuquerque 2016; Ladio and Acosta 2019). In this sense, research conducted in S.C. de Bariloche City, with a local fair of familiar farmers, has shown that 186 species are commercialized, including 315 local foods made from these plants in different forms (Longo Blason et al. 2022). Most of the species traded in Bariloche are exotic, showing processes of cultural hybridization in local horticulture, which are also revealed in local foods. The composition of these foods reflects traditions but also innovations. Most of these foods belong to family recipes that include all these foreign species in their components. These processes derive from the long processes of assimilation and cultural imposition that have taken place in the region since European colonization and immigration and from the gradual action of state agencies that have favored the cultivation of exotic plants of global importance, mainly in greenhouses (Ladio and Molares 2014b).

Urban markets are therefore a space of resistance against the rapid processes of agricultural and food homogenization for several reasons. The market connects urban dwellers and farmers, the latter inextricably linked to their territories of production (urban, suburban or rural). Consequently, the market symbolically brings these spaces and experiences to center stage. This is why the market has great potential in the recomposition of regional biocultural memory (Longo Blason et al. 2022).

URBAN PARKS AS NOVEL CULTURAL LANDSCAPES

Cities are often described as new ecosystems or "novel ecosystems". This is because no analogous natural ecosystems existed prior to human settlement (Hobbs et al. 2006). These urban ecosystems consist of microenvironments and biological ensembles (such as urban parks and gardens). Unlike natural remnant ecosystems, urban ecosystems are constructed and designed by local people (Grimm et al. 2000). Urban vegetation is unique in that it is made up of new as-

semblages of native and exotic tree species that are influenced by the biophysical conditions of the site and by human factors, such as management or planting preferences (Betancourt et al. 2017). In addition, there has been evidence that socioeconomic factors are important determinants of urban plant richness patterns (Avolio et al. 2015). For example, the income of property owners is positively correlated with plant richness - a relationship that has been defined as the "luxury effect"(Hope et al. 2003).

In a study conducted in 30 urban parks in the city of Bariloche, S.C., we found that the diversity of owners and management types can contribute significantly to the diversity of vegetation management styles, thereby influencing the structure, composition, and distribution of plant communities in the urban landscape (Betancourt et al. 2017). Management can be top-down, such as that imposed by urban planning guidelines, conservation obligations, or owners' associations, or it can be bottom-up, such as that carried out by local people hired to manage the space, local groups of friends, or local residents and garden owners (Kendal et al. 2012). This potentially raises some questions: Will this vary across different regions of the world? Are there differences in how mega-cities and small cities approach this issue? Is there a stronger top-down power dynamic in mega-cities compared to smaller cities?

In Bariloche, we found that urban parks contain a total of 160 woody species. Most of them are exotic (72%) and show complex hybridization processes. A multinomial logistic analysis showed that parks managed by local neighborhoods had a higher (13-times) tolerance of native species compared to those managed by the municipality (top-down administration). We have shown that urban parks are cultural landscapes that reflect different cosmovisions and drivers typical of multicultural contexts. Our results have shown the projection in these parks of conceptions and values of the hegemonic cultures that dominate the market, with species mainly originating from the Northern Hemisphere. The preferences of the first Swiss, German, and Austrian immigrants are strongly expressed in the city's parks, reproducing the idea of "Argentine Switzerland"of landscape domestication (Betancourt et al. 2017). The total richness values found here indirectly show a series of actions over time, since the city's foundation 121 years ago, that have shaped the urban vegetation and favored certain plants over others. Based on a Eurocentric view that what is most beautiful and valuable comes from this region, native biocultural diversity has been underestimated and undervalued (Rozzi et al. 2003). However, different values and actions are placed on the parks by local residents and neighborhood councils that are now committed to native plant conservation.

In this sense, the "new ecosystems"in cities bring opportunities for the formation of new greenways. Interesting studies have focused on the green areas created after deindustrialization processes, connecting previously underprivileged neighborhoods, due to their proximity to large industries, to the city (e.g., von Haaren and Reich 2006; Zepp 2018; Kowarik 2019).

Another line of studies has related military legacies in cities, seeking to understand transformation processes, the intersection of urban planning with cultural heritage, and different values and knowledge between societies over the years (Bruce and Creighton 2006). Fortified areas, such as the "Berlin Wall", were a complex fortified border system that for 28 years was related to the traumatic legacy of the postWorld War II political situation in Europe, when Germany was divided into West Germany (capitalist) and Oriental (Communist) (Kowarik 2019). However, after the fall of the Berlin Wall in 1989, the "Green Belt Berlin" was established, a successful example of the establishment of urban greenways, due to the link of ecological, cultural, and social approaches, as well as integrating the history and legacy in the area (with parts of the wall integrated into nature) (Kowarik 2019). Several ancient fortifications have been integrated into green systems due to their cultural value and to provide "new"habitats for species, such as Óbidos and other Portuguese cities (dos Santos 2017).

UNIVERSITY CAMPUSES AND URBAN ETHNOBIOLOGY

University campuses in urban areas with a large acreage of green space also represent spaces of significant biocultural diversity where people from diverse communities (Indigenous and non-Indigenous descent, Afrodescendants, farming communities, people from rural and urban communities, and international migrants and non-migrants) come together and reside along with diverse communities of plants and animals that are native to the campus, were introduced (since colonial or postcolonial times), and are managed (and/or forcefully controlled) by campus administrators. These spaces have been overlooked thus far as sites for ethnobiology research, in spite of their potential to address innovative research questions about plant blindness, patterns of biocultural heritage and colonial power imbalances. For example, a common tree planted in the Caribbean and across Central and South America is almond/almendro (*Terminalia catappa* L.), which has edible fruits and is used as a shade tree, and dune stabilizer, among other uses. Growing on campus, these and other species offer im-

portant opportunities for students to conduct ethnobotany surveys and reflect on important questions, such as: Who on campus knows about the uses of this tree? Who still eats the fruit? What ecosystem and cultural services can this species provide? Where does it originate from? When, how, and by whom was it introduced in the country and why? What social justice lessons can we learn from this tree? Oftentimes, important opportunities for teaching and research are right at our fingertips instead of a half-day drive away in a remote rural area. Given the economic challenges that disproportionately affect the Global South and its universities, ethnobiologists should look at their own urban institutions as places to conduct *in situ* research and provide outreach to national and regional general audiences and governments.

BOTANICAL GARDENS AND URBAN ETHNOBIOLOGY

Botanical Gardens and Zoos play a significant role in the knowledge, conservation with surveys on endangered species (assessment of endangered status) and/or species with socioeconomic potential, different scientific research, public engagement, and education (Mounce et al. 2017; Learmonth et al. 2021; Doodson et al. 2022). Botanical gardens, for example, aim to ensure plant diversity for the well-being of both people and the planet (Miller et al. 2015). Plants of socioeconomic importance are represented and documented in herbariums, DNA and tissue collections, wood collections, biocultural collections, and thousands of species that are maintained in seed banks or cultivated in arboretums (Hudson et al. 2021). However, these resources are often underused even though they have enormous potential in research for sustainable development and the safeguarding of traditional or local knowledge associated with plant and cultural diversity.

Unlike parks, botanical gardens house living plant species in natural conditions and/or biological collections, classified and registered with historical records. In the past decade, botanical gardens have made progress in understanding the impacts of climate change on plants and have adopted tools such as phylogenetic and comparative methods, online specimen data, and herbarium photographs to expand their research both geographically and taxonomically (Primack et al. 2021). These gardens offer great potential for public engagement and mobilization related to global challenges such as climate change, food security, loss of both habitats and traditional knowledge associated with biodiversity. They can also support measures to improve livelihoods and health, targeting green cities with “edible urbanism” (Esperdy 2002), and provide sustainability and resilience in cities (Russo and Cirella 2019).

The botanical gardens and their biological collections are valuable for education in general, particularly elementary education, and support practical classes for undergraduate and graduate courses. In addition, they still play a key role in the physical and mental health of people living in cities (Cheng and Monroe 2012).

There are certain disparities in access to botanical gardens and natural parks, both within and between countries. Within countries, access to these places may be limited by various factors such as geographic location, availability of transportation, and socioeconomic status, including admission fees and parking fees. Across countries, access disparities can be even more pronounced, with some facing political instability and conflicts that can hinder access to these areas or impede their creation and maintenance. However, in recent years, botanical gardens have shown greater efforts towards inclusion and flexible access, especially for teachers, students, representatives of social movements, and leaders of traditional and indigenous communities. These efforts have been made to ensure greater accessibility to these spaces, regardless of their social and economic background.

From the perspective of urban ethnobiology in botanical gardens and the quest to reconnect people with plants and knowledge, it is possible to go beyond studies related to safeguarding cultural practices and values. New bodies of knowledge may emerge through conceptual advances in considering local relationships between people and nature in cities, particularly for the Global South (Stålhammar and Brink 2021). The area of technology integrated with knowledge related to plants, their histories, traditions, and their potential uses has shown potential to be developed. Researchers are, for example, investigating the use of technology to help children form bonds with their local natural environments and how interactive digital systems use contemporary participatory sensing applications for smartphones and tablets using automated visual identification of botanical species (e.g., iNaturalist) (Sultana and Hawken 2023). These apps can facilitate the "exploration"of nature by being mobile learning tools for users to engage through a variety of senses, such as observing shapes, colors, textures, and scents of different species. These tools can motivate children to interact and share their thoughts and feelings about the physical environment.

There are various realities and contexts that need further exploration and development, such as the resilience of botanical knowledge, globalization, and migrations at different scales in urban environments, especially in culturally and/or biologically diverse cities.

Some studies have already been carried out in this

regard, such as those conducted among immigrants from the Dominican Republic residing in New York City (Vandebroek and Balick 2012), which have provided relevant and unexpected contributions and results, including increased knowledge about medicinal and food plants associated with migration. These studies challenge the common perception that knowledge about plants decreases with cultural change, modernization, and globalization among migrant and non-migrant communities worldwide.

Other studies have demonstrated the resilience of botanical knowledge among migrants from the Andean region (of Bolivian and Peruvian descent) residing in the United Kingdom, highlighting the importance of preserving culturally salient species and the positive influence of the presence of cultural diversity, the combination of different types of knowledge and resources, and the dependence on social networks to exchange plant materials (Ceuterick et al. 2011). Another interesting study was conducted in a large Brazilian favela in Rio de Janeiro, which revealed the cultural relationship and cultural biodiversity connected with nature around the sizeable urban forest - the Tijuca Forest, challenging the 'usual' narrative about slums as sites of environmental degradation and risk of disasters (Stålhammar and Brink 2021). However, in the case of Brazilian favelas, other implications such as security and public policies also need to be considered beyond the maintenance of knowledge about plants and interest in conserving plants and knowledge. Therefore, further studies are needed to investigate these contexts and interactions, and botanical gardens can contribute to these multidisciplinary approaches.

Botanical gardens can catalyze such studies since they maintain collections of plants, seed banks, laboratories, databases, libraries, and non-formal spaces for exchanging knowledge about species, in urban environments. These non-formal spaces can improve public engagement, aggregate different social groups, and expand various knowledge.

POLITICAL ETHNOBIOLOGY IN THE CITIES

Urban ethnobiology also focuses on the environmental conflicts that arise due to the different relational ontologies/cosmovisions of communities and social groups inhabiting cities. Cities are a result of a colonial project of domination from a Eurocentric perspective, with the capitalist modernization project seeking to erase rural elements in cities. However, communities on the periphery and traditional peoples continue to produce biocultural diversity in urban spaces, with humans and nonhumans establishing alliances and mutual care in homegardens, community gardens, forest fragments, streams, markets, *quilombos* (maroon/cimmarón/maroon communities), and "terreiros de candomblé" ("Candomblé Temples- places where practitioners of the Afro-Brazilian religion gather for worship, rituals, and community events) (Almada 2023; Stålhammar and Brink 2021; Almada and Oliveira 2017). Environmental conflicts and racism proliferate in metropolises, with state attempts and dominant economic groups trying to control or suppress certain ways of living based on alliances between traditional peoples and their companion species (see Almada and Oliveira 2021; Hoshino and Chueiri 2019; Oliveira 2021). Urban ethnobiology can contribute to the ethnographies of these ways of life and urban landscapes production through multispecies studies (Kirsey and Helmreich 2010), new cosmopolitical oriented studies (Blaser 2016), and decolonial ecologies (Ferdinand 2021). Through this approach, urban ethnobiology can enhance itself and promote public policies that promote the biocultural diversity of cities.

Research on the diversity of ontologies inhabiting the urban space is essential to regenerate the sustaining bases of our lives, both human and more-than-human, in the face of the civilizational crisis of the Capitalocene. The diversity of ontologies of city dwellers implies meeting two important challenges: 1) generating and/or strengthening social institutions based on self-management (not only from vertical governance schemes) and 2) creating and/or fostering a social fabric for the exchange of knowledge and practices among people who generally do not share a common cultural history. Although individualism and isolation prevail in many urban contexts, at the same time, experiences of cooperation, alliances and associations have arisen in various parts of the planet that de Santos (2017) described as "an other globalization". Under the principles of horizontal institutions, collaboration (rather than competition), and solidarity, thousands of experiences of counter-hegemonic and counter-colonial projects have been created, especially for agroecological products, based on cooperativism (for case studies in Spain, India, Japan, and elsewhere, see review by Toledo (2015). The existence of social networks favors these forms of organization. They constitute solidary and humane responses that are gradually transforming the dominant capitalist system towards benefiting human beings rather than money. Urban ethnobiology has a key role to play in studying, strengthening, and contributing to these forms of urban organization and the generation and transmission of knowledge.

CHALLENGES

Urban ethnobiology is a field of research that explores the complex and dynamic biocultural systems that encompass the multiple connections between humans and other life forms that inhabit urban ecosystems.

Within these urban systems, there is a significant social and cultural influence on how the biodiversity within the cities is utilized (see Chan et al. 2016). Additionally, these systems also impact the interactions and exchanges between urban and rural areas.

The exchange of goods and services between urban and rural areas can have significant impacts on biodiversity and ecological systems. Urban areas rely on the resources and services provided by rural areas, such as food, water, and energy. Understanding these connections and their impacts on biodiversity requires an interdisciplinary approach that brings together experts from different fields.

Cities are often seen as disconnected from nature, but they are home to a wide range of plant and animal species that have adapted to the urban environment. The presence of these species is often overlooked or undervalued, but they play crucial roles in maintaining urban ecological systems. Urban ethnobiology seeks to understand these interactions between people and other life forms in urban environments. The way that people in cities interact with nature is shaped by their cultural beliefs, values, and practices (see Svendsen et al. 2016). For example, certain plant species may be considered important as medicines (e.g. Brown 2016) or for spiritual purposes, while others may be valued for their aesthetic qualities. These cultural values can influence the way that urban biodiversity is managed and conserved.

One of the key challenges of studying urban ethnobiology is the complex and often unpredictable character of urban ecosystems in a globalized world. Urban environments are constantly changing at a fast rate, and the interactions between people and other life forms are influenced by a wide range of factors, including socioeconomic dynamics, and rapid cultural exchanges. Therefore, urban ethnobiologists need to adopt a diversified approach to their research, drawing on insights from different disciplines.

In conclusion, urban ethnobiology is a critical field of research that seeks to understand the complex and dynamic biocultural systems that are shaped by and exist in urban environments. By examining the interactions between people and other life forms in cities, urban ethnobiologists can gain insights into the social, cultural, political, and ecological dimensions of biodiversity in urban areas. In summary, we can highlight the following reflections:

- Urban ethnobiology research is crucial for understanding LTK patterns in urban and diaspora communities. It also opens avenues to study contemporary modes of transmission, such as social media, and how these are impacting LTK patterns. Furthermore, the lack of green spaces in Latin American and Caribbean cities represents a significant challenge for human well-being, particularly during the COVID-19 pandemic. However, citizen-led appropriation and/or co-management of public areas can transform these spaces into places for food production, artistic expression, sports, recreation, physical and spiritual health and wellbeing.

- Urban markets that sell vegetables as well as medicinal and spiritual plants serve important multiple functions beyond economic and social purposes. They also conserve and transfer knowledge, and have become important places for urban food sovereignty and plant-based foods due to agroecological, vegan, and vegetarian movements. Urban parks reflect different cosmovisions and drivers typical of multicultural contexts, and socioeconomic factors are significant determinants of urban plant richness patterns. Additionally, the diversity of owners and management types contributes to the diversity of vegetation management styles, thereby influencing the structure, composition, and distribution of plant communities in the urban landscape.

- Despite their potential to address innovative research questions about plant blindness, patterns of biocultural heritage, and colonial power imbalances, university campuses in urban areas with significant green space have been overlooked as sites for ethnobiology research. These spaces represent significant biocultural diversity and offer important opportunities for students to conduct ethnobotany research and reflect on important questions about the uses of plants and animals, their origins, and the multiple cultural services they provide.

- Botanical gardens play an important role in conservation, research, public engagement, education, and the safeguarding of LTK associated with biocultural diversity. They have great potential for research and education, public engagement, and inclusion. Furthermore, generating and/or strengthening social institutions based on self-management and creating a social fabric for the exchange of knowledge and practices among people who generally do not share a common cultural history is crucial. Urban ethnobiology plays a key role in studying,

strengthening, and contributing to these forms of urban organization and the generation and transmission of knowledge.

- The biocultural diversity found in cities, particularly those located on the periphery of the world-system, is attributable to the power structures of modernity-coloniality. Such structures have been significantly influenced by the Green Revolution, which occurred in the latter half of the 20th century. Consequently, the scope of urban ethnobiology ought to extend beyond the generation, transmission, and preservation of local traditional knowledge mechanisms. Instead, it should also provide an avenue for addressing the epistemicide and ecocide associated with the Capitalocene, by considering the biocultural diversity of traditional communities inhabiting urban areas.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: UPA.
Wrote the first draft of the manuscript: All the authors.
Review and final write of the manuscript: All the authors.

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