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Distribution of local plant knowledge in a recently urbanized area (Campeche District, Florianópolis, Brazil)

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Abstract All over the world, coastal villages are changing rapidly due to the increasing pressures from tourism and urbanization. In this study we investigate ethnobotanical knowledge of current residents of Campeche District, a coastal area that has undergone a rapid process of urbanization, related to 13 native plant species. We also discuss how residents understand and conceptualize the term 'restinga', which corresponds to the areas of native vegetation still found at the study site. We interviewed 176 residents in four strata according to time of residence in the district: 0–9 years, 10-19 years, 20-29 years and +30 years, corresponding to the periods of most accentuated demographic growth in the area. *Psidium guajava* and *Eugenia uniflora* were the most known, recognized and used plants by respondents. Plant recognition, naming and known uses are strongly correlated; yet there was no difference related to the age of respondents. The only stratum with significant differences in the number of plants named, known and used is the + 30 year of residence time, not related to the age of respondents. Explanations given by respondents for the definition of 'restinga' were grouped into: vegetation, physical space and ecosystem. Most answers associated 'restinga' to vegetation. Knowledge on local flora is affected by the increased amount of migrants and the rapid urbanization in the district during the last 30 years.

Keywords Traditional ecological knowledge · Ethnobotany · Migrations · Checklist · Restinga

Introduction

One of the effects of globalization is the increased migration of human populations. Some consequences of this phenomena are already discussed by different authors in the context of dynamic knowledge about plant resources, with a special focus on urban areas (e.g. Pieroni and Vandebroek 2007; Van Andel and Westers 2010; Vandebroek and Balick 2012), and transnational migrations (e.g. Nguyen 2003; Tanaka et al. 2008; Van Andel and Westers 2010;

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Pirker et al. 2012; Vandebroek and Balick 2012). Another consequence of these spatial population rearrangements is the transformation of former rural areas into urbanized areas. According to the United Nations Population Fund (UNFPA 2007), during the last decade the world crossed an invisible line where for the first time in history more than half of the human population is living within urban areas. While some rural areas are left abandoned, other small rural settlements are increasingly attracting a large number of people from other places, rapidly being transformed into urban areas, and affecting local knowledge systems (Merétika et al. 2010; Dey and De 2012; McMillen 2012).

This is the case for areas with touristic attributes, such as coastal areas once inhabited by rural traditional people. With infrastructure development, new roads and economic growth, these areas can be transformed in a short period of time, and outsiders rapidly outnumber traditional inhabitants. In several parts of the Brazilian coastal zone, for example, the intensification of human occupation in recent decades is a result of combined urbanization, industrialization and tourism exploitation (Hanazaki et al. 2007; Strohaecker 2008). Population growth in coastal areas brings a new scenario to rural areas originally occupied by traditional communities, whose livelihoods were primarily intended for subsistence, changing the way people interact with local resources.

One of the challenges of ethnobotany research in these dynamic areas is to understand how local plant knowledge is adapted throughout time. On the one hand, the direct dependence on plant resources is expected to decrease; however, on the other hand, people still depend on and interact with plants and maintain ethnobotanical knowledge for different purposes, such as the use of medicinal plants (Cocks and Møller 2002; Vandebroek et al. 2007) and the choice of ornamental or fruit plants for backyards or homegardens (Winklerprins 2003). Different authors show that the processes of modernization in areas occupied by indigenous or traditional groups result in loss of ethnobotanical knowledge (Case et al. 2005; Reyes-Garcia et al. 2007; Furusawa 2009). However, other studies demonstrated a persistence of this kind of knowledge even in immigrant populations living in large urban centers (Cocks and Møller 2002; Vandebroek et al. 2007; Vandebroek and Balick 2012). Cocks (2006) discusses the concept of biocultural diversity, arguing that its application is not restricted to indigenous and traditional societies living in rural environments, but it can also be found in cities, being recreated and re-signified in a multicultural context. Thus, biocultural diversity in urban areas subject to the dynamics of large migration contingents, and tend to be re-signified and recreated within and between different ethnic groups, rather than just suffering from the processes of erosion and loss of cultural knowledge.

Within this context, the objective of this research is to analyze ethnobotanical knowledge of native vegetation from current residents of a coastal area that has undergone a process of rapid urbanization. Considering our hypothesis that the longer time living within the local ecosystem increases residents' ethnobotanical knowledge, we seek to investigate residents' knowledge on a set of native plants according to their time of settlement and the age of respondents. Finally, we also investigate how residents understand and conceptualize the term 'restinga', which corresponds to the areas of native vegetation still found within the study site.

Study area

Campeche District belongs to the Municipality of Florianópolis, Santa Catarina State, in southern Brazil (27° 39′10″S – 48° 28′43″W to 27° 43′02″S – 48° 30′17″W). It is located about 20 km from downtown Florianópolis, on a plain strip (about 3,800 m long) parallel to the sea (Fig. 1). Most of the region is characterized as a flat zone formed by the deposition of sandy sediments during successive advances and retreats of the sea during the Holocene. The

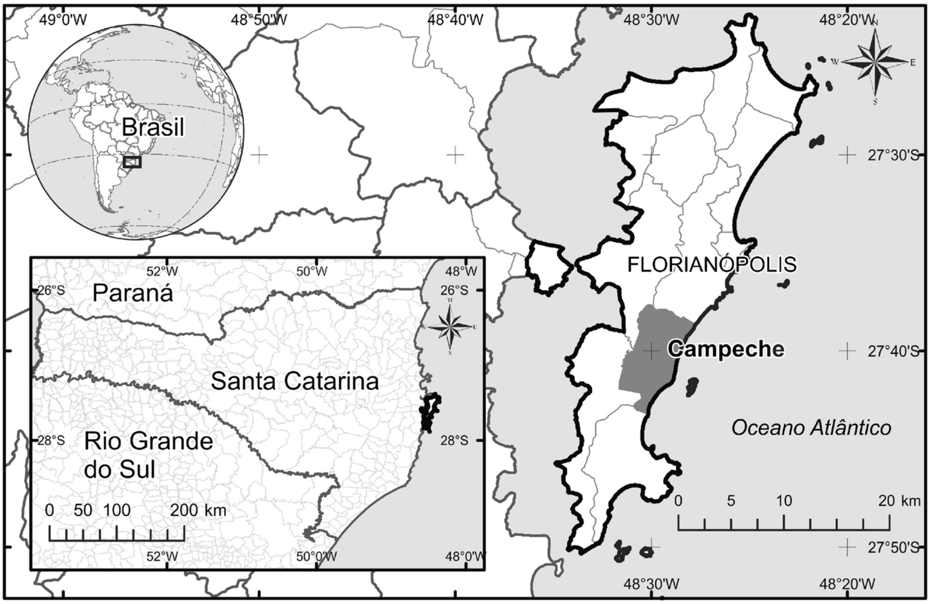

Fig. 1 The Campeche district (grey area), Florianópolis, Brazil

predominant vegetation in the area is called 'restinga', a pioneer tree-shrub vegetation of the Atlantic Forest biome, with a small portion of tropical rain forest.

There are no precise records on the early human occupation of Campeche. Carijó Indians inhabited the region long before European colonists settled in the late nineteenth century. Official European settlement dates from the 1880s, with the arrival of families from the adjacent district of Lagoa da Conceição, an area densely occupied by Azorean immigrants since 1750. Campeche's initial population totalled about 19 families (Neves 2003).

Urbanization in Florianópolis substantially increased with immigrants arriving from larger urban centers such as Porto Alegre, São Paulo and Rio de Janeiro. In recent decades, people from other cities came to Florianópolis in search of a better quality of life, and contributed to the daily increase in the city's population (CECCA 1996). According to a study conducted for the Urban Planning Institute of Florianópolis (Campanário 2007), the population of Campeche totalled 4,816 inhabitants in 1980, rising to 8,174 in 1990, more than doubling in 2000 with 21,484 inhabitants, and with a projected increase to 34,738 in 2010. Until the 1970s and 1980s, local livelihoods were based on small-scale agriculture and artisanal fishing, which reflected in the local landscape: made up of swidden and fallow fields as well as areas with original vegetation. Campeche has recently become an area of intense real estate activity, provided of infrastructure to receive tourists during summer season and holidays. Currently, the area is increasingly being dominated by urban blocks and paved streets, but there are still a few areas of original vegetation, especially in a narrow strip covered by sand dunes near the beach.

Methods

We interviewed adult residents (over 18 year of age) selected through a stratified sampling approach, which considered time of residence in the study area according to the following intervals: 0–9 years, 10–19 years, 20–29 years and more than 30 years. Strata were defined based on the increase of population according to census data in the mentioned periods 1980, 1990, 2000 and the estimated population for 2010 (Campanário 2007). Sample size was estimated according to Barbetta (2007) assuming an associated error (E_0) of 15 %, according to the formula $n_0 = 1/E_0^2$. This formula is used for calculating the number of items (n) of the sample relative to the population size (N) according to the expression: $n = (n_0 \cdot N)/(N + n_0)$, which resulted in 44 interviews in each stratum and a total of 176 interviews overall.

The urbanized area of Campeche District was divided into sectors in order to cover the area's heterogeneity. We interviewed residents at their houses in all sectors, after explaining the objectives of the research and obtaining their signed prior informed consent. Interviews were based on a check-list (Albuquerque et al. 2008; Medeiros et al. 2008) of the 13 most cited plants from a previous study with traditional people of the same study area (Gandolfo and Hanazaki 2011): *Eugenia uniflora* L., *Achyrocline satureoides* (Lam.) DC., *Campomanesia litorallis* D. Legrand, *Diodia radula* (Willd. ex Roem. & Schult.) Cham. & Schltdl., *Dodonaea viscosa* Jacq., *Eupatorium casarettoi* (B.L. Rob.) Steyerm., *Gaylussacia brasiliensis*, *Guapira opposita* (Vell.) Reitz, *Psidium cattleyanum* Sabine, *Psidium guajava* L., *Rumohra adiantiformis* (G. Fost.) Ching, *Schinus terebinthifolius* Raddi and *Varronia curassavica* Jacq. These species were selected due to the frequency of citations by traditional inhabitants and because they were considered native species of 'restinga' according to local knowledge (Gandolfo and Hanazaki 2011). For each species we used a card with photographs of the plant, portraying different structures to facilitate identification (the image of the whole plant, leaf, flower and fruit details), as well as samples of fresh plant branches in order to use visual stimulus, smell and touch, in addition to showing the actual dimensions of the plant parts. Teams of two conducted the interviews in order to enable the handling of materials and note taking. Plants were sequentially presented to the interviewee. For each plant, we asked if the respondent knew it or not, noted if she/he named it, and whether the respondent knew uses for that given plant. To avoid deviations in the data due to the sequence in which the plants were shown to respondents, after each set of 10 interviews a new sequence of the 13 plants was sorted at random. Addtionally, respondents were also asked about their knowledge on the word 'restinga'.

We tested normality of the data using Kolmogorov-Smirnov test, which resulted in lack of normality (p <0.05). We used nonparametric Kruskal-Wallis test followed by Dunn's test to compare the number of species known, named and used. In order to remove the effect of age and considering that informants with longer life tend to accumulate more knowledge (Phillips and Gentry 1993; Hanazaki et al. 2000; Fonseca-Kruel and Peixoto 2004; Case et al. 2005; Merétika et al. 2010), Kruskall-Wallis test was redone considering only respondents over 30 years of age in all strata. Pearson correlation was used to investigate the relationships between the number of times each plant was known, named, and had attributed uses mentioned by respondents. We used chi-squared test for independence to compare the number of respondents who defined '*restinga*' in each strata. All analyses were done with the software BioStat (Ayres et al. 2003).

Results

The average number of plants known, named and used by respondents in each stratum (Table 1) reflected an increase in the number of species according to residence time in the three categories analyzed: the longer the residence time, the higher the average known plant, used and named. The Kruskal-Wallis test confirmed a significant difference in the three categories analyzed (plants known H = 40.35, p <0.0001; plants used H = 60.72, p <0.0001; plants named H = 68.72, p <0.0001), however the only stratum with significant difference compared to the others was the one with more than 30 years of residence. The majority of respondents living in the area for less

Table 1 Mean and standard deviation (in parenthesis) of the number of plants considered known, named and used by 176 informants divided into groups according to the time of residence in the Campeche district, Florianópolis, Brazil

Strata	Plants known	Plants used	Plants named
0-9 years of residence	8.14 (3.02)[a]	4.32 (2.16)[a]	4.52 (2.38) [a]
10-19 years of residence	9.00 (2.55)[a]	5.20 (1.92)[a]	4.93(1.87)[a]
20-29 years of residence	9.68 (2.63)[a]	5.50 (2.15)[a]	5.20 (2.22)[a]
30+ years of residence	11.61 (2.17)[b]	8.77 (2.44)[b]	9.50 (2.43)[b]
Kruskal-Wallis	H=40.35, p<0.0001	H=60.72, p<0.0001	H=68.71, p<0.0001

Different letters indicate statistical differences

time came from urban areas where there is no '*restinga*' vegetation: 93 % for stratum 0–9 year, 91 % for 10-19year, and 57 % for 20–29 year of residence, contrasting with interviewees with more than 30 year of residence, who were mostly native or born in areas with 'restinga' (95 %).

When we excluded the effect of age (considering only interviewees over 30 years of age), the total number of respondents was different in each stratum (0–9 year $n = 28$; 10–19 year $n = 41$; 20–29 year $n = 32$; 30+ yrs $n = 44$). Kruskal-Wallis test resulted again in the existence of significant differences between the groups (plants known $H = 31.08$, $p < 0.001$; plants used $H = 49.66$, $p < 0.001$; plants named $H = 58.74$, $p < 0.001$), with significant differences only for the interviewees with more than 30 years of residence. We also tested for correlation between the number of species recognized and age, which showed no significant results ($r = 0.15$, $p = 0.0524$).

Recognition, naming and attributed uses are strongly correlated. Plants most recognized are also plants most frequently named ($r = 0.87$, $p = 0.0001$) and with most known uses ($r = 0.83$, $p = 0.0004$). Plants most named are also those with most known uses ($r = 0.93$, $p < 0.0001$).

Psidium guajava (goiaba) and *Eugenia uniflora* (pitanga) top the ranking of most known, recognized and used plants (Fig. 2). Both are plants whose fruits are edible and have a wide distribution in Brazil, also known for their medicinal properties. The species *Rumohra adiantiformis* ('samambaia-preta') had its name linked to the common name of this type of fern, which are recognized by the morphology of their fronds. The main use of this plant was ornamental. *Schinus terebinthifolius* is locally called 'aroeira', or 'aroeira-vermelha', and is used for seasoning food and as ornamental. *Achyrocline satureioides* is known as 'macela', which has medicinal uses, but also traditionally used for stuffing pillows. Some informants recalled the tradition of harvesting this plant on Good Friday, before Easter, when families of native residents head to the beach before sunrise to gather branches of *A. satureoides* and take sea baths for purification. *Psidium catleyanum* is a native Myrtaceae called 'araçá', with similar uses to *P. guajava*.

Species such as *Diodia radula* and *Guapira opposita* were recognized by 70 % of respondents, yet its uses and names were reported by less than 20 % (Fig. 2). *D. radula* is a ruderal species locally called 'erva-de-lagarto', often observed at the edges of trails and roads, and sprouts spontaneously in backyards where it is considered a weed. This species is used to feed chickens and cattle, and sometimes as medicinal. *G. opposita* ('maria-mole') is a small and common tree in 'restinga' areas, whose main uses are related to its ecological role as food for birds and forage for cattle. *Varronia curassavica* ('caramona') is known as a medicinal plant due to its anti-inflammatory potential. Other reported uses were related to its ecological role to hold sand dunes, as well as forage for cattle. *Dodonaea viscosa* and *Eupatorium casarettoi* are native shrubs/trees, named generically as 'vassouras' (literally translated as brooms), or by its variations, such as 'vassoura-vermelha' for *D. viscosa* or 'vassoura-de-bicho' for *E. casarettoi*. The latter name refers to the commonly observed interactions between Lepidoptera larvae and

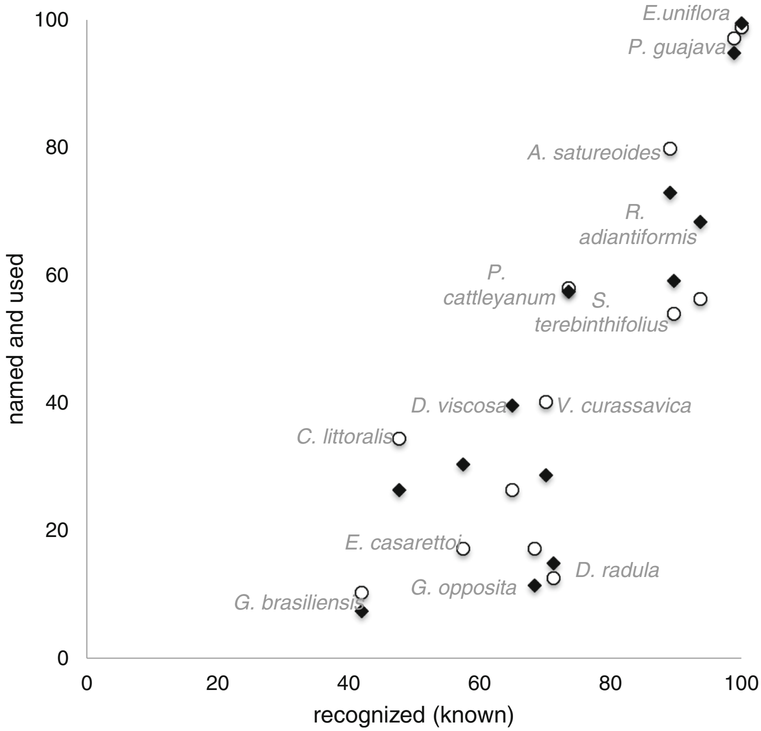

Fig. 2 Percentage of interviews in each species was recognized (x axis), named (y axis, *diamonds*) and had attributed uses (y axis, *circles*), $n=176$ interviews with residents from the Campeche district, Florianópolis, Brazil

E. casarettoi. The main use of these species is for broom manufacturing, fuelwood and as plants with ecological importance to hold sand dunes. *D. viscosa* is also used as livestock forage and ornamental.

Plants recognized by less than half of the interviewees were *Campomanesia littoralis* and *Gaylussacia brasiliensis*, and for the latter less than 10 % named or knew its uses (Fig. 2). Another Myrtaceae, *C. litorallis* ('gabiroba'), has its fruits used as food, followed by a medicinal use with the same purpose as *P. guajava*, *E. uniflora* and *P. cattleyanum*. It was also recalled with ecological use since its fruits are consumed by birds and cattle, and as an ornamental tree. The only use cited for *G. brasiliensis* ('camarinha') is as food, referring to its sweet fruits. *G. brasiliensis* is a less abundant species, which may be the reason this plant is ignored by most interviewees.

Sixty-two percent of the residents declared that they knew the meaning of '*restinga*', with no statistical differences between strata (chi-square = 4.75, d.f. = 3, $p = 0.191$). The explanations given by the respondents could be grouped into three major groups: vegetation, physical space and ecosystem. Explanations relating to the vegetation were the most frequent, accounting for 86 % of the answers. Of these, 26 % related to the life forms predominant in the vegetation (herbs, shrubs and near-the-ground vegetation), 41 % related it to the sandy soil, dune or beach area, 17 % was associated to the native vegetation. Other answers were considered vague or misleading to other types of vegetation such as wetlands, marshes, mangroves, or even the dry savanna. Other responses related 'restinga' to the term sandbank, as a physical space (6 %) between the hills and the sea, near the beach, or the area between the dunes, while another 6 % associated the term with the whole ecosystem that develops close to the beach.

Discussion and conclusions

The absence of differences in the most recent strata of residence time (0–9 year, 10–19 year and 20 or 29 year) reflects the presence of informants that have expressed interest in knowing the local flora despite their time living in the region. The difference in the stratum of over 30 years of residence indicates a major change in local livelihoods since this period, with an increased migration and population growth in Campeche. In a study on the variation of knowledge according to gender, age, and origin in 'mestizo' communities in Venezuela, Souto and Ticktin (2012) found that origin was the most important predictor of useful plant knowledge, but often with significant interactions among the variables. For our case study, it can be concluded that not only time, but also coexistence with the natural environment, may contribute to the local knowledge systems. In a former study with traditional inhabitants in the same area, use and frequency of cited plants decreased considerably from the rural past to the urban present (Gandolfo and Hanazaki 2011).

Ethnobotanical knowledge is constructed through the interaction between people and local flora, increasing according to the time of contact between them. Knowledge is built through experience, and knowledge transfer is an important factor in this construction (Esser et al. 2003; Cruz-García 2006; Quave et al. 2008; Giday et al. 2009; Flatie et al. 2009; Souto and Ticktin 2012). Residence time in the region contributes to increased knowledge regarding plants found on site. Since this study considered only plants most cited in interviews with native residents (Gandolfo and Hanazaki 2011), the process of cultural transmission seems to be involved in this process of increase.

Age itself is not a determinant of greater or lesser knowledge on local flora present in the community, which may be due to the increased amount of migrants and the rapid changes in the district during the last 30 years. We may also consider that current residents of older age who are not native may have less knowledge than younger residents of native families. However, once new residents bring knowledge from their regions of origin, it could be interesting to investigate which new knowledge is being incorporated into the cultural context of the study area. An interesting approach for achieving this objective would be not to rely on pre-determined species as done in the present study.

The most recognized plants, *E. uniflora* and *P. guajava*, can be found both in native areas of 'restinga' and grown in backyards and homegardens. They were probably most recognized because of their fruits that are widely consumed. Even migrants from other regions of Brazil are familiar with these species (Begossi et al. 2002; Vendruscolo and Mentz 2006). Other highly recognized plant, *R. adiantiformis* is also known in other parts of Brazil (Comte et al. 2000; Coelho-de-Souza et al. 2006) and is used by florists worldwide, being grown and exported by countries such as Costa Rica and the United States, while in South Africa and Brazil it is harvested by means of extraction (Coelho-de-Souza et al. 2006). *S. terebinthifolius* is cited as the most recognized plant in another community on the southernmost part of the island of Florianópolis (Melo et al. 2008), and it was also well recognized in this study. Native to tropical America, this species was introduced in several other countries with ornamental purpose, which is now considered an invasive plant (Lenzi and Orth 2004). Medicinal properties of other species from our checklist were reported by different authors, such as Polydoro et al. (2004) and Kadarian et al. (2002) for *A. satureoides*, Coelho-de-Souza et al. (2004) for *P. catleyanum*, and Sertie et al. (1991), Medeiros et al. (2007) and Passos et al. (2007) for *V. curassavica* (formerly *Cordia verbenaceae*); the latter known widely along the Brazilian coast (Fonseca-Kruel and Peixoto 2004; Merétika et al. 2010). Recognition of the plants through photographs and fresh parts allowed comparable data but also had its limitations (Medeiros et al. 2008), since the absence of specific parts of the plants, or even the possibility to visualize the size of whole plants in their natural environments can negatively influence the informant. In the case of photographs, images representing different proportions of the same species sometimes caused a false impression of the dimensions. For example, the flowers of *Psidium guajava* represented in macro photography gave the impression of having larger dimensions than the flowers when observed in the tree. Due to differing phenological phases during fieldwork, we could not assure that all structures in the collected samples were shown to the respondents.

Even in academic circles the term 'restinga' has different conceptualizations. A geomorphological definition refers to marginal portions of sand coast, with small elevation, or strips of sand located between a bay or lagoon and the ocean (Suguio and Tessler 1984). Under a phytogeographic perspective, Rizzini (1979) reveals three ways to understand this concept: 1) referring to all forms of vegetation that occupy the Holocene sands deposited by successive retreats and advances of the ocean, 2) the landscape formed by the sand beside the sea and its vegetation, and 3) the woody plants from the inner coastal plains. Falkenberg (1999) defines 'restinga' as a set of coastal ecosystems whose vegetation is in distinct floristic and physiognomic communities that colonize sandy soils with different origins forming a complex edaphic vegetation. Under the Brazilian law, 'restinga' is protected as Permanent Preservation Area since the 1965's Forest Code, however, only when stabilizing sand dunes or mangroves. These are also areas which had their protection declared by other federal resolutions and laws, yet with several conflicts because many coastal towns were built on 'restingas', and other urban and industrial developments are frequently planned over such coastal and fragile areas (Hanazaki et al. 2012).

'Restinga' is an ecosystem that is directly affected by the perturbations caused by increasing urbanization of the coast. Meanwhile, the dynamic local knowledge about 'restinga' can be tied to preservation efforts by identifying gaps of knowledge about these ecosystems. For instance, although many informants who claimed to know the term 'restinga', considered it to be the type of vegetation which grows on sandy soil or the shrubby vegetation which grows on sand dunes; however, 'restinga' areas with taller shrubs and trees were majorly ignored, even though they represent the most impacted areas due to urbanization pressures.

Campeche District, in the fast-growing city of Florianópolis, stands out as one of the main areas of urban expansion within the municipality. In this context, traditional inhabitants cohabit with newcomers migrating from other parts of Santa Catarina State and other Brazilian states, or even other countries, such as Argentina and Uruguay. Ethnobotanical knowledge as part of the local culture is dynamic and is expected to change over time, as it is directly related to changes in the environment and local livelihoods. Old inhabitants still retain memories of past times, while new residents incorporate knowledge about the remaining native flora. In this dynamic relationship between people and plants, part of the ethnobotanical knowledge associated with activities that were gradually abandoned will be lost. Ethnobotanical knowledge also tends to be heterogeneous as different cultural strands coalesce and live side by side in urban centers.

The importance of ethnobotanical knowledge related to the local flora of particular localities, as well as local ecological knowledge in general, can add valuable information to efforts in biodiversity conservation (Hanazaki 2003), by raising awareness about native vegetation, for example. This does not mean that knowing plants necessarily entail the desire to preserve them in the environment, but prior knowledge helps in communication. Vandebroek and Balick (2012) demonstrated that in a cosmopolitan metropolis, local knowledge of traditional plants used for food and medicine can be higher than in the original source areas of such knowledge, showing the importance of keeping one's cultural identity through the plants used and known. A question that arises is how to encourage the existence and persistence of ethnobotanical knowledge related to the local flora in an urban and multicultural context, so that knowledge is not lost once constructed within a new reality, but instead can blend into the dynamic knowledge that may arise from the interaction between people and plants.

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