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Medicinal plant knowledge in a context of cultural pluralism: A case study in Northeastern Brazil

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ABSTRACT

Ethnopharmacological relevance: The study of plant use in contexts of migrations can give important insights to cultural evolution, since people face rapid changes in their environments and often start interacting with native dwellers, both constituting forces that can lead to change. Therefore, this study focused on medicinal plant knowledge and transmission in order to understand what happens to such knowledge when people from several regions converge to a single place already inhabited by native people.

Methods: The study was carried out in the rural community of Caeté-Açu (known as Capão Valley), placed in the state of Bahia (NE Brazil). Native and migrant people's knowledge on medicinal plans was accessed with a free listing. People were also asked about whom in the community once taught them about medicinal plants. Four groups (native, regional migrants, national migrants and international migrants) were compared in terms of number of cited plants, plant repertoires and knowledge transmission. For each group we also ran simple regressions between age and number of cited plants and residence time and number of cited plants.

Results and discussion: We found no differences among groups in terms of number of known species. However, plant repertoires differ in some extent among groups. While migrants claim to have learnt with both native people and other migrants, most native claim to have learned mainly with other natives. Age influences plant knowledge only for the natives, what strengthens evidence that this group's knowledge is based on experience while migrants" knowledge is based on an active search. Residence time in the community did not influence migrants' knowledge.

Conclusion: Native and migrant people have differences in their ways of acquiring medicinal plant knowledge and less popular species are also different between groups. However, we can observe a tendency of fusion and indissolubility of migrant and native knowledge since the new generations are in contact with both sources.

1. Introduction

The study of plant use in contexts of migrations can give important insights to cultural evolution, since people face rapid changes in their environments and often start interacting with native dwellers, both constituting forces that can lead to change (Medeiros et al., 2012).

Indeed, several studies have analyzed the influence of migrations in people's medicinal plant knowledge and/or cultural negotiations between native and migrant people (e.g. Belliard, Ramírez-Johnson, 2005; Ceuterick et al., 2008; Pieroni et al., 2011; Quave et al., 2012; Pieroni et al., 2014; Menendez-Baceta et al., 2015). However, there is a lack of studies concerning (1) urban to rural migrations and (2) people from several parts of the world converging to a single area. Urban–rural migration is a recent and important phenomenon in modern society, as many people deliberately chose to scape common problems related to living in

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cities (McCool and Kruger, 2003). The globalization process and the facilities for international movements have also made possible the creation of "multicultural communities" (Castles, 2002). These processes are worth studying because they can be significantly different from the scenarios commonly covered by ethnobotanical research.

We chose the rural community of the Capão Valley (NE Brazil) as a model for this study because it attracts people from diverse cultural and geographic backgrounds coexisting with natives. As the region is known because of its natural attractions, migration significantly increased and migrants are especially searching for a better life quality.

On the one hand, studies have shown that plant knowledge can, at least in a first moment, increase with migration, since people add to their previous knowledge information about the plants of the host area (Nesheim et al., 2006). On the other hand, in contexts such as the Capão Valley, where most migrants come from urban areas (often associated to a lower knowledge), migrant people may not have had time to learn about medicinal plants as natives do. Therefore, our fist hypothesis is that *medicinal plant knowledge is higher among native people than among migrant people*.

However, when native and migrant people interact in terms of medicinal plant knowledge, it is reasonable to expect that such knowledge increases with residence time in the host community. Therefore, our second hypothesis is that *migration time influences medicinal plant knowledge*.

Communities can differ in terms of knowledge acquisition. While some studies have shown that knowledge comes with age and experience (Voeks and Leony, 2004; Silva et al., 2011), others have found that age does not interfere with plant knowledge (Mathez-Stiefel et al., 2012). We believe that age influence is higher in contexts of traditional knowledge, because people may learn through direct observations and when this knowledge is needed (e.g. an illness event). Such events (observation and necessity) increase with time (and age). When knowledge is acquired by non-traditional paths (media, books etc.), active search can influence more than age, so that people may 'skip stages'. So our third hypothesis is that *age influence on medicinal plant knowledge is higher for native people than for migrants*.

Since migrants can store knowledge (acquired in their homelands and other areas) which cannot be developed (or exchanged) in the host community and since native people may know native plants that migrants do not have contact with, our fourth hypothesis is that *plant repertoires are partially different between native and migrant people*.

Finally, considering that cultural negotiations commonly occur when different communities interact, our fifth hypothesis is that *native and migrant people exchange information on medicinal plants*.

2. Methods

2.1. Study area

The study was carried out in the rural community of Caeté-Açu, also known as the Capão Valley, placed in the Municipality of Palmeiras, Bahia, Northeastern Brazil (Fig. 1). Capão is placed in the geographical region of Chapada Diamantina ("Plateau of diamonds") and is bordered by the Chapada Diamantina National Park, the biggest conservation unit in Brazil outside the Amazon (Funch et al., 2009).

The municipality of Palmeiras was first colonized in the second half of the 18th century by small farmers (Giudice and Souza,

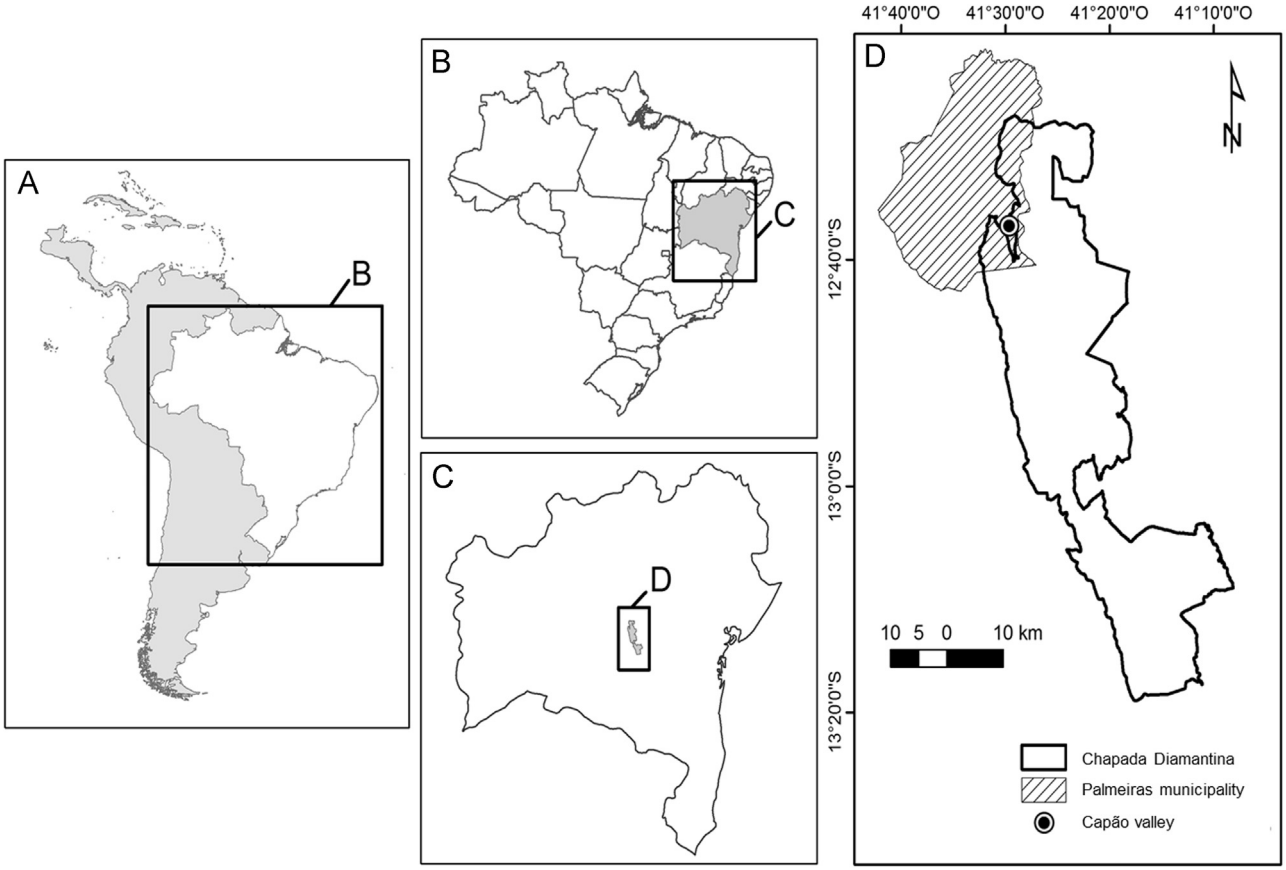

Fig. 1. Location of the Capão Valley, placed in the municipality of Palmeiras and boardered by the Chapada Diamantina (D), State of Bahia (C), Brazil (B), South America (A).

2009). In the second half of the 19th century the municipality experienced a significant increase in its population due to the discovery of diamonds and the beginning of mining (Giudice and Souza, 2009). Mining irreversibly decreased in the area in the 1920s of the 20th century and many people migrated to Southern and Southeastern Brazil to work with the coffee culture (Matta, 2006). In the 1980s of the 20th century, Capão started to be a common site for ecotourism and an increasing process of migration took place in the valley, mainly by people seeking to live in contact with nature and looking for a healthier way of life (Nascimento, 2008).

The valley is currently inhabited by people from several countries and provinces. They coexist with native people, mostly descendants of miners. Regional migrants (migrants from other parts of the Chapada Diamantina) come from both urban and rural areas and they moved to Capão because of job opportunities, for family reunion (marriage) or to live in contact with nature. National migrants (migrants from other parts of Brazil) are mostly from urban areas and they moved to Capão seeking for a better life quality and contact with nature. International migrants come from many countries, especially from Latin America and Europe. A better life quality and contact with nature are also the most common reasons for their migration.

Main economic activities in the community are related to commerce. Although small-scale agriculture is still common, the presence of tourist-destined restaurants, stores and alternative health centers is remarkable. Other services (educational, artistic etc.) are also common. A great diversity of religions and beliefs is found in Capão. Catholicism and Protestantism are predominant, although oriental religions (e.g. Buddhism and Shintoism) and Santo Daime[1] are increasing.

According to the local health center (non-published data), there are 693 families and 1177 people over 15 living in the community. The health center data only considers as dwellers those who have lived in the community for more than three months and this is also true for having access to consultations in the center. This distinction is performed because the community attracts many backpackers, who spend some time in Capão but do not establish themselves in the community. Registered people have access to a health center that is located in the center of the community (main village). People can also access official medicine facilities in the center of the municipality (21 km from Capão) and in neighboring cities (Seabra, Lençóis and Iraquara).

2.2. Data collection

The community of Capão was fully informed concerning the goals of this study, and members who agreed to participate were invited to sign a Free and Informed Consent Term. This study was conducted in accordance with guidelines developed by the National Health Counsel by means of the Research Ethics Committee (Resolution 196/96), and the protocol was approved by that committee (CAAE 44962515.5.0000.5026).

We employed an accidental sample, when interviewees are conveniently chosen, e.g. for being in their homes at the moment of the interview (Albuquerque et al., 2014). We employed a confidence level of 87.8% so that 199 dwellers were involved. Accidental sampling was employed due to the difficulties in performing a random sampling in the area. However, we were careful in order not to bias our sample and all community districts were visited and had people involved in the survey. We used the same criterion employed in the health center to consider someone as a permanent dweller.

The interviews were performed in 2014 and 2015. We first recorded socioeconomic information of the interviewees (gender, origin, age, level of school education, residence time in Capão and job). Then we employed a free listing (Alexiades, 1996) so that interviewees could mention the medicinal plants they knew, as well as their therapeutic indications. We also asked with whom in the community they have learnt about medicinal plants.

The species cited in the free listing where identified and incorporated to the herbarium Dárdano de Andrade Lima (Empresa Pernambucana de Pesquisa Agropecuária) and to the herbarium Professor Vasconcelos Sobrinho (Universidade Federal Rural de Pernambuco).

2.3. Data analysis

To test the first hypothesis (*medicinal plant knowledge is higher among native people than among migrant people*) we performed a Kruskal–Wallis test comparing the number of medicinal plants cited by native people, regional migrants, national migrants and international migrants. This test is commonly used to compare three or more samples and it was chosen because it is a non-parametric alternative to ANOVA and our data wasn't normally distributed.

For the second hypothesis (*migration time influences medicinal plant knowledge*) we performed three simple regressions, plotting the number of plants cited $\times$ residence time only for the migrant groups (regional, national and international). We did not directly opt for linear regressions since we wanted to investigate the best fit for our models. We rather tested several transformations available in the software Statgraphics Centurion XVI.

The third hypothesis (*age influence on medicinal plant knowledge is higher for native people than for migrants*) was also performed with simple regressions, plotting the number of plants cited $\times$ residence time for the four groups (now including natives). The same procedures described for the previous analysis were performed here. The first three hypotheses were tested with ethnospecies, since we assume that each plant cited by a single interviewee is a different entity.

For the fourth hypothesis (*plant repertoires are partially different between native and migrant people*) we only considered the identified species, since two people may have named a single species differently and the inclusion of ethnospecies in the analysis could lead to inflation in the matrix and to an underestimation of similarities in plant knowledge. For the former hypotheses, using ethnospecies does not bring these kinds of issues because analyses were based on individual knowledge and a single person would not name differently the same species (or at least the interviewee would mention that he or she was using more than one name to the same plant).

The fourth hypothesis was tested by constructing a multivariate matrix with people as samples and plant species as variables. Then we performed a permutational multivariate analysis of variance using Jaccard's coefficient and 1000 permutations, considering origins as factors.

The fifth hypothesis (*native and migrant people exchange information on medicinal plants*) was tested with two different tools. Differently from the other analyses, here we considered only two groups: natives and migrants. First we developed a chi-squared goodness-of-fit test to compare the number of people that learns exclusively within their group to the number of people who also learns outside their group. Then we ran a chi-squared in a 2×2 contingency table. The two columns were categorized as 'learning exclusively within the group' and 'learning outside the group'. The two lines were categorized as 'natives' and 'migrants'. The table was completed with the number of people that matched each

[1] Santo Daime is a syncretic religion based on the use of a psychoactive beverage called Ayahuasca.

Table 1
The most popular medicinal plants in the Capão Valley (NE Brazil). NA – Native people, RM – Regional migrants, NM – National migrants, IM – International migrants. E – Exotic, N – Native.

Species	Frequency	Origin	NA ranking	RM ranking	NM ranking	IM ranking
Plectranthus amboinicus (Lour.) Spreng	0.45	E	2°	7°	3°	4°
Plectranthus barbatus Andrews	0.45	E	2°	7°	3°	4°
Plectanthus neochilus Schlechter	0.45	E	2°	7°	3°	4°
Cymbopogon citratus (DC.) Stapf	0.43	E	8°	1°	6°	8°
Lippia alba (Mill.) N.E. Br. ex Britton & P. Wilson	0.43	E	1°	2°	14°	25°
Chenopodium ambrosioides L.	0.36	E	5°	12°	10°	7°
Mentha × *vilosa* Huds.	0.34	E	7°	3°	16°	23°
Rosmarinus officinalis L.	0.34	E	10°	4°	11°	9°
Citrus × *limon* (L.) Burm. f.	0.32	E	13°	15°	7°	3°
Pimpinella anisum L.	0.31	E	9°	5°	18°	16°
Aloe arborescens Mill.	0.31	E	41°	24°	1°	1°
Aloe vera (L.) Burm. f.	0.31	E	41°	24°	1°	1°
Cymbopogon densiflorus (Steud.) Stapf	0.28	E	11°	6°	15°	22°
Stryphnodendron rotundifolium Mart.	0.26	N	17°	10°	12°	10°
Abarema cochliacarpos (Gomes) Barneby & J.W. Grimes	0.26	N	17°	10°	12°	10°

Table 2
Average number of medicinal plans cited by native people, regional migrants, national migrants and international migrants in the Capão Valley (NE Brazil).

Groups	Mean ± standard deviation
Native	16.9605 ± 10.89
Regional migrants	15.6842 ± 9.88
National migrants	13.7368 ± 9.67
International migrants	15.2368 ± 9.24

situation (e.g. a migrant that also learns outside the group of migrants). We first wanted to test the overall learning pattern to then identify if intergroup learning was generalized or just present in a single group.

Except for the regressions, the statistical tests were performed with the software R. version 2.13.2 (The R Foundation for Statistical Computing). We used the 'adonis'function of the R package 'vegan' to test the fourth hypothesis.

3. Results

3.1. Group profile and the most popular medicinal plants

The 199 interviewees were accidentally distributed among groups as follows: 76 native, 31 regional migrants, 60 national migrants and 32 international migrants. 51.6% of the regional migrants come from urban neighboring areas. The proportion of national and international migrants from urban areas is much higher (88.3 and 75.8% respectively). The overall proportion of migrants from urban areas is 75.8%.

An amount of 466 ethnospecies were mentioned by the community members and 152 were identified up to the genus or species level (Appendix 1). Many plants could not be identified for one of the following reasons: (1) absence of fertile material, (2) citations of plant species that do not occur in the community surroundings.

Because of the great amount of migrants in the community, the most popular medicinal plants are exotic[2] species (Table 1). Three species of the genus Plectranthus (*Plectranthus amboinicus* (Lour.) Spreng, *Plectranthus barbatus* Andrews and *Plectranthus neochilus* Schlechter) are the most known medicinal plants since they were cited by 47% of the interviewees. These species had the same frequency value because they are used indistinctively. *Cymbopogon citratus* (DC.) Stapf. and *Lippia alba* (Mill.) N.E. Br. ex Britton & P. Wilson were the other two species cited by at least 40% of the interviewee (Table 1).

3.2. Medicinal plant knowledge is not higher among native people than among migrant people

We found no significant differences between the number of medicinal plants cited by native and migrant people ($H=5.73$; $p>0.05$) and our first hypothesis was rejected. The average number of medicinal plants cited for each group, as well as the standard deviations, are shown in Table 2.

3.3. Migration time does not influence medicinal plant knowledge

Our second hypothesis was also rejected since we could find no relation between number of medicinal plants cited by the interviewees and migrant's residence time (Table 3). R^2 values for the three migrant groups ranged from 0.04 to 0.07 ($p>0.05$).

3.4. Age influence on medicinal plant knowledge is higher for native people than for migrants

Our third hypothesis was confirmed since age only influenced medicinal plant knowledge for the group of the natives ($R^2=0.21$; $p=0$). As we can see in Fig. 2, medicinal plant knowledge increases until 50 years-old and then starts stabilizing. Table 4 exhibits results for the three migrant groups.

3.5. Plant repertoires are partially different between native and migrant people

Our last hypothesis was also confirmed. The permutational multivariate analysis of variance found significant differences

Table 3
Simple regressions with residence time as the independent variable and number of known species as dependent variables in the Capão Valley (NE Brazil). Transformations were performed to return the best fit of the models.

Group	Transformation	R^2
Regional migrants	Double reciprocal	0.04
National migrants	Squared-X	0.05
International migrants	Reciprocal-Y, Squared-X	0.07

[2] The term exotic is used here to define "Plant taxa in a given area whose presence there is due to intentional or unintentional human involvement, or which have arrived there without the help of people from an area in which they are alien" (Pyšek et al., 2004).

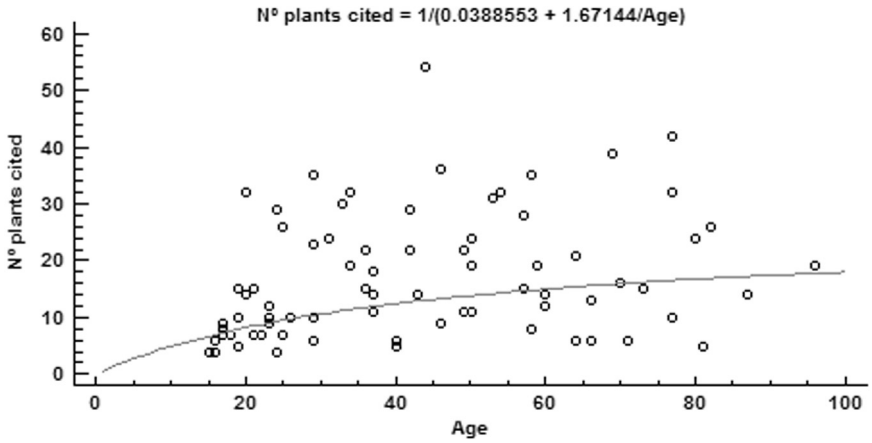

Fig. 2. Simple regression plotted with age as the independent variable and number of medicinal known plants as the dependent variable (double reciprocal model) for the community of the Capão Valley, NE Brazil.

Table 4
Simple regressions with age as the independent variable and number of known species as dependent variables in the Capão Valley (NE Brazil). Transformations were performed to return the best fit of the models.

Group	Transformation	R^2
Natives	Double reciprocal	0.21*
Regional migrants	Squared-X	0.01
National migrants	Double Reciprocal	0
International migrants	Double Reciprocal	0.03

All other models had $p > 0.05$.

* $p < 0.0001$.

between the four groups in terms of species repertoires ($F=4.46$; $R^2=0.06$; $p < 0.001$).

Average Jaccard similarities within the native and regional migrant groups were higher than the overall average similarity, what indicates that those groups have a more homogeneous knowledge compared to the others (Table 5).

3.6. Migrants learn outside their group, but this is a one way path

We found that most interviewees have also learnt about medicinal plants outside their groups. Nine interviewees claimed not to have learnt with anyone in the community. From the remaining 190, 60 have only learnt about medicinal plants within their groups (natives and migrants) and 130 have also learnt outside their groups. We found significant differences between those values ($\chi^2=25.8$; $p < 0.0001$).

However, we also found that migrant people have learnt outside their group proportionally more than native people ($\chi^2=50.8$; $p < 0.0001$). Most natives have learnt only within their group while most migrants have also learnt outside it (Table 6). Therefore, our hypothesis is only partially confirmed, since intergroup learning seems to be only a one way patch.

Table 5
Average similarity of known medicinal plants between groups and overall similarity for the Capão Vlley (NE Brazil).

Group	Mean ± SD
Natives	0.14 ± 0.09
Regional migrants	0.13 ± 0.10
National migrants	0.10 ± 0.09
International migrants	0.10 ± 0.09
Overall similarity	0.10 ± 0.09

Table 6
Number of people that claims to have learnt about medicinal plants exclusively within their group (native r migrant) and also outside their group. Data for the Capão Valley (NE Brazil).

Group[a]	Within group	Outside group
Natives	46	29
Migrants	14	101

[a] Nine interviewees claimed not to have learnt from anyone in the community.

4. Discussion

Medicinal plant knowledge in the Capão Valley is mostly based on exotic species. In the context of migrations, studies have shown that people try to continue using their known plants by turning to species that are available in both the original and the host place (Balick et al., 2000; Palaniswamy, 2007; Volpato et al., 2009a, 2009b; Medeiros et al., 2012). Therefore, the outstanding presence of cosmopolitan species in the Capão Valley may have allowed migrants to continue using some of the species they already knew before migrating.

However, even native people's repertoires are completely dominated by those plants. The most plausible explanation for this phenomenon is that native people diminished their interaction with native plant species after the establishment of a protected area with harvesting prohibition in the community's surroundings. Other studies have also associated loss of native medicinal plant knowledge to legal restrictions concerning their use (Medeiros et al., 2013). Since native people's knowledge is mostly based on exotic species, migrants, apart from having their own knowledge on exotic species, also learn about those species with natives. This scenario indicates that the maintenance of knowledge on native species is uncertain in the community.

It seems that knowledge acquisition has different logics for native and migrant people. While natives acquire knowledge with experiences formed via direct observations and necessity, migrants perform an active search for medicinal plant knowledge. This assumption is based on the following reasons: (1) the lack of differences in the number of cited species between native and migrant people, even considering the urban origin of most migrants; (2) the fact that age influences plant knowledge only for the native group, and (3) as perceived during the fieldwork, migrant people quite often consult books and websites about medicinal plant use and during the interviews they usually asked if they could take a look at their books and sources to give us the information we required.

We thought that, apart from actively searching for knowledge on this domain, migrants could have their knowledge improved by the increasing contact to native people and such contact would be increased with residence time. But it was not the case. Although migrants actually learn with natives, such learning is probably not related to residence time, and/or it probably does not influence the overall number of known species. For the migrant groups, it really seems that those who are more interested in searching information on medicinal plants are actually the greatest reservoirs of such knowledge.

Therefore, two paths of medicinal plant learning are present in the community: (1) the traditional path, based on oral transmission and (2) the non-traditional path, more important for migrant people and based on media and source consultation. The role of mass media in the knowledge of medicinal plants is increasingly being reported in the literature (Hurrell, 2014; Hurrell and Pochettino, 2014) and may be causing significant additions in local pharmacopoeias. The joint presence of traditional and non-traditional paths of medicinal plant knowledge acquisition has also been reported elsewhere (Hurrell and Pochettino, 2014). However, most observations of this phenomenon are related to urban areas.

The fact that migrant people are learning with natives (and the opposite is not necessarily happening) means that (1) migrant's plant repertoire include a mix of information acquired though traditional and non-traditional paths and (2) native people's knowledge based on the traditional path is being preserved. Although the logic of knowledge acquisition is different between migrant and native people, such difference did not interfere in the main species known by each group, as discussed above. However, such differences (together with the particularities of people's geographic and cultural backgrounds) may have influenced the details (less cited species), since we found a certain difference in repertoires.

Knowledge heterogeneity increases with the geographic extension of a group. International migrants are the most dissimilar group and natives are the most similar. Indeed, it is expected since migrant groups are not really cultural groups, but denominations employed for analytic purposes. However, although natives are a more similar group, their average similarity is very low. It indicates that intracultural variation is also high, as found in previous studies (Barrett, 1995; Hopkins and Stepp, 2012; Santoro et al., 2015).

5. Conclusions

This study has some limitations that need to be commented. First, sample is slightly underrepresented, as the typical confidence levels (i.e. the likelihood that the results for the sample are true for the entire population) are 90%, 95% or 99% (Raosoft, 2005). Sample is also not random, although we tried not to significantly bias it. Moreover, many species could not be identified and our analysis based on repertoire similarities was somehow compromised. This is a common problem when studying contexts of migrations. However, as most unidentified species were those that do not occur in the region, we believe that their identification would only accentuate the group differences found in our study.

The study has shown that, although knowledge acquisition behaves differently between groups, their knowledge have similar structures, only differing in terms of specific repertoire, as the most popular plant species and the number of known medicinal plant are the same. Such similarities are a result of the availability of high popularity cosmopolitan plant species and migrant learning with native people.

Finally, as migrants are establishing in the region and having their own native children, future studies should analyze plant knowledge within the group of migrants' children. We believe that they are reservoirs of a mixed (and indissoluble) knowledge that includes native and migrant information. But their logic of knowledge acquisition remains unclear.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi:10.1016/j.jep.2015.09.019.

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