Plant-Knowledge Adaptation in an Urban Setting: *Candomblé* Ethnobotany in New York City

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Candomblé is an African-Brazilian religion that resulted from the adaptation of West African (especially Yoruba) beliefs in Brazil during and after the slave trade. This study seeks to understand the current evolution of *Candomblé* ethnobotanical knowledge as it travels from Brazil to New York City (NYC), therefore going through a second adaptation process. We identified which Brazilian plant species are still in use, which are being incorporated and/or replaced, and what factors are contributing to the ethnobotanical adaptation that is taking place in NYC. To accomplish this, we compiled an inventory of liturgical plants used by five highly skilled *Candomblé* practitioners living in NYC and then compared the vernacular and binomial Latin names of these plants to inventories previously published in Brazil by other authors. By doing this, we were able to distinguish patterns of knowledge continuity, assimilation, or substitution. Nearly two-thirds of the species identified in NYC's inventory were cases of knowledge continuity, where most plants were used by at least four practitioners. Many of these frequently used species have survived the adaptation process from Africa to Brazil, and now from Brazil to NYC. Practitioners also assimilated (20%) and substituted (16%) some species. The assimilation process was mainly influenced by *Santería*, another Yoruba-derived religion widely practiced in NYC. Substitutions, however, were driven by two distinct forces. In one cohort (7%), species were morphologically and organoleptically similar to the original material, and replacements were mostly influenced by the easy accessibility of botanical materials. The other cohort (9%) was marked by a logical substitution process based on Yoruba rules of plant classification. Our results show that *Candomblé* practitioners in NYC are maintaining a notable level of cultural continuity, while cautiously assimilating new species and consciously or subconsciously replacing others. Although both accessibility of plant material and cultural forces play a role in the adaptation mechanism, the latter appears to be the most relevant to these highly skilled practitioners.

O *Candomblé* é uma religião Afro-Brasileira resultante da adaptação dos costumes religiosos da África Ocidental, especialmente Iorubá, no Brasil. Este estudo busca compreender a evolução do uso de plantas no *Candomblé*, na medida em que esta religião passa por um segundo processo de adaptação ao se deslocar do Brasil para Nova Iorque. Nosso principal objetivo foi identificar quais os tipos de plantas estão sobrevivendo a este processo de imigração e quais estão sendo assimiladas ou substituídas. Este trabalho também investigou quais fatores contribuem para a adaptação do conhecimento etnobotânico depois do processo de migração. Para isso, montamos

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um inventário de plantas litúrgicas usadas por cinco praticantes altamente capacitados no uso de plantas, os quais foram iniciados no *Candomblé* no Brasil e moram na cidade de Nova Iorque. A análise comparativa dos nomes binomial em latim destas plantas com aqueles previamente compilados por outros autores no Brasil, nos permitiu estabelecer quais espécies coletadas em Nova Iorque são casos de manutenção de conhecimento, assimilação ou substituição. Cerca de dois-terços das espécies identificadas constituem casos de continuidade, sendo que a maioria foram usadas pelo menos por quatro praticantes. Muitas destas plantas sobreviveram o processo de adaptação da África para o Brasil e agora do Brasil para Nova Iorque. Nossos resultados também mostram que 20% do inventário constituem casos de assimilação, onde a maioria das plantas são oriundas da *Santería*. Já o processo de substituição (16%) apresentou dois padrões distintos. Em uma coorte (7%), as espécies mostraram-se altamente semelhantes às espécies originais, sendo este processo de substituição influenciados pela fácil acessibilidade ao material botânico. No entanto, a outra coorte (9%) foi marcada por substituições de espécies visualmente diferente dos originais, seguindo processo lógico baseado na regra Iorubana de classificação de plantas. Nossos resultados mostram que embora praticantes estejam mantendo um nível significativo de integridade cultural, eles também estão cautelosamente assimilando e substituindo outras espécies novas. Embora tanto acessibilidade e forças culturais desempenharam papeis importantes neste processo adaptativo, o último parece ser mais relevante neste estudo.

Key Words: Sacred plants, Biocultural adaptation, Traditional knowledge, Santería, Urban ethnobotany, Botánicas.

Introduction

When immigrants arrive in a new environment, they develop strategies to preserve the structure of their ethnobotanical system, especially when the availability of previously known botanical material is scarce (Medeiros et al. 2012). This approach has been documented for different cultures, including the African Diaspora in Latin America (Van Andel et al. 2014) and most notably, *Candomblé* in Brazil (Anthony 2001; Barros 1993; Camargo 1989, 2014; Voeks 2016). *Candomblé* is a religion based on beliefs and practices introduced by enslaved Yorubas, freedwomen and freedmen in Brazil, which over time incorporated aspects of Catholicism, indigenous Brazilian, and other West African-derived traditions. As in the Yoruba's belief, this African-Brazilian religion bears a profound spiritual association between its deities' pantheon, also known as Orixás, and sacred leaves, where each divinity possesses his or her ethnoflora (Barros 1993). Despite the distinct biocultural landscape and restraints imposed by enslavement, West Africans were able to readjust their ethnobotanical knowledge quite successfully in Brazil (Anthony 2001; Barros 1993; Medeiros et al. 2012; Voeks 2016). One factor contributing to this adaptation was an ample supply of familiar species in the Brazilian territory brought about by the Columbian Exchange, a process characterized by a widespread transfer of plants, animals, and cultures between the continents after Christopher Columbus's 1492 voyage. By the peak of slave arrivals, beginning in the 18th century, many Brazilian species were already established in West Africa. *Milho*/maize (*Zea mays* L.), for instance, had been acclimated in those lands as early as 1550. At the same time, newly arrived Africans found a plethora of their native species adapted to the Brazilian ecosystem as well. *Dendê* or African oil palm (*Elaies guineensis* Jacq.) for instance, was also introduced in Brazil by the Portuguese during the early colonial era. This homogenization of the world's flora greatly facilitated the reassemblage of African ethnobotanical knowledge in Brazil (Voeks 2013). The introduction of West African species for religious purposes was also important to the maintenance of Yoruba's ethnobotanical knowledge. *Akoko* (*Newbouldia laevis* P. Beauv. Seem.) is but one example of a species known in Brazil by its Yoruba name only (Anthony 2001; Voeks 1997). Enslaved Africans also assimilated a broad range of Brazilian native species, incorporating ethnobotanical knowledge from local Amerindians and European colonizers (Anthony 2001; Voeks 1997). Substitution of species unavailable in Brazil was another type of adaptation strategy employed by the African Diaspora, as they discovered considerable botanical taxonomic similarities between African and South American plants at the family and genus ranks (Voeks 2016).

Often, these substitutions were accompanied by superimposing the vernacular names of the original species onto the replacements (Anthony 2001; Van Andel et al. 2014; Voeks 1997).

Immigration to large cities has increased considerably in the last decades, and several authors have studied the complex ethnobotanical biocultural adaptation processes that occur in such situations (for a review, see Medeiros et al. 2012). Briefly, the adaptation process will depend on the floristic similarities of the host and home countries, as well as the cultural characteristics of the migrating groups (Medeiros et al. 2012). When both floristic and cultural landscapes are different, especially in large urban centers where plant material is scarce, immigrants often source plants from their home countries through importation (Van Andel and Klooster 2007; Volpato et al. 2009) or purchase them at local ethnic markets (Ceuterik et al. 2008; Medeiros et al. 2012). Finally, similarly to Africans in Brazil, today's immigrants may also replace and/or include new plant species in their ethnopharmacopeia, especially when they cannot source the desired botanical material from their home countries (Medeiros et al. 2012). Immigrants' ethnobotanical knowledge may also influence the local biocultural system. In a study conducted with Chinese immigrants living in Buenos Aires, Hurrell and Puentes (2017) found that even though most plants used by this group were invisible to the general public, a few botanical species and their products eventually entered into the widespread commercial circuit. These results show that the local community incorporated Chinese plant-related knowledge into their local pharmacopeia, causing a dynamic change in the general biocultural system.

After several centuries of biocultural adaptation in South America, African-Brazilians cultural descendants are now migrating to large urban centers, including NYC (Schmidt 2008). Similarly to what occurred centuries ago, these immigrants are likely going through different degrees of biocultural adaptation to practice their faith. However, unlike the Yorubas brought to Brazil during the slave trade, these newcomers are now subject to factors common to our modern-day society. The present study seeks to understand *Candomblé* ethnobotanical knowledge adaptation regarding plant identification as it goes through this second wave of migration. In particular, we explore the role of accessibility versus cultural forces as the drivers of maintenance, assimilation, and substitution of plant species and their associated ethnobotanical knowledge during this migration process.

Methodology

Practitioner Selection

We chose to interview only individuals who held titles of *Mãe-* (Mother-), *Pai-* (Father-), *Filha-* (Daughter-), or *Filho-de-Santo* (Son-of-Saint). *Mãe-* and *Pai-de-Santo* are respectively the female and male high priestess and priest in a *Candomblé terreiro*, or temple. *Filha-* and *Filho-de-Santo* are respectively a female and male adherent initiated into the *Candomblé* priesthood. Among these individuals, we chose to interview only those who were initiated in Brazil, because their ethnobotanical knowledge was acquired in Brazil using Brazilian plants. This cohort was selected because "initiation" is a critical step in *Candomblé* worship, and a stage when adherents acquire significant training in plant use. These specialists have a broader knowledge about plants than the average non-initiated followers. Importantly, non-initiated adherents consult with *Mães-* and *Pais-de-Santo* (and sometimes with *Filhos-* e *Filhas-de-Santo* as well), from whom they receive prescriptions of plants necessary to perform rituals. Therefore, these individuals are not only adapting their plant knowledge to the NYC biocultural environment, but they are also transmitting their adapted knowledge to non-initiated *Candomblé* followers. We identified the cohort of Brazilian-initiated practitioners through intense community networking and snowball sampling. We were repeatedly told that the community was small, and therefore it was not difficult to identify those individuals who met our study criteria. A total of seven practitioners were contacted, and from these, only five gave their consent: three males and two females, three of them initiated in the Brazilian State of Bahia, one in Rio de Janeiro, and one in São Paulo. Three held the title of *Mãe-* or *Pai-de-Santo*, and two were *Filha-* or *Filho-de-Santo*. Three of them were also initiated into *Santería* and/or *Umbanda*, which are also Afro-Latin American religions with Yoruba roots. All interviewees had been living in NYC for over 10 years at the time of this study and held regular jobs outside their temple activities. Although there is no study concerning the extent of *Candomblé* practice in NYC, we believe that we interviewed a representative sample of the community of initiated individuals living in this city. The Institutional Review Board (IRB) of Columbia University (Protocol number: AAAJ2107) granted permission for

this study, and participants gave their formal and voluntary verbal consent.

Data Collection

Our methodology was based on a study comparing *Candomblé* ethnobotanical adaptation from West Africa and Brazil (Anthony 2001). From February 2010 to August 2012, we conducted three rounds of semi-structured interviews with each practitioner, where each round consisted of one to three interviews. The first round focused on obtaining information about the plants that were currently in use at the time of the interviews, their vernacular names, parts used, as well as the places where they were sourced. During this phase, we also showed a primer illustrated with plants commonly used in Brazilian *Candomblé* compiled from different inventories carried out in Brazil by different authors. In order to account for regional variation in vernacular names, we selected relevant Brazilian *Candomblé* inventories collected in different parts of the country (Albuquerque 1997; Anthony 2001; Barros 1993 and 2007; Berg 1991; Camargo 1998; Cossard 2006; Lorenzi and Matos 2008; Verger 1995; Voeks 1997). Interviews were conducted mostly in Portuguese, but Spanish and English were also used occasionally. During the second round of interviews, we met with participants to collect specimens at their houses, parks, stores, community gardens, etc. Sometimes, practitioners referred us to the stores where they purchased their botanical material. In such cases, we visited these stores alone to buy the plants, and then we met with practitioners for a third round of interviews to certify that the plants acquired in their absence were the correct ones. All species collected were prepared as voucher specimens, with scientific names determined by specialists at the New York Botanical Garden (NYBG). Once interviews were concluded, all human subject identifiers were destroyed, and all vouchers were combined into one collection.

Data Analysis

Following the collection and identification of botanical material, we made an inventory of all plants collected in NYC, along with their scientific names, number of practitioners (also referred to as "plant usage"), and parts used. Conklin's (1954) definition of ethnobiological species was adopted, wherein each plant recognized by *Candomblé* followers was considered as an individual "ethnospecies." We then crosschecked the vernacular names of NYC ethnospecies with those described in the Brazilian *Candomblé* inventories used to build the primer. This comparison allowed us to establish which vernacular names in the USA corresponded to the same binominal name in Brazil, and which ones corresponded to different taxonomic species. Based on the similarities between vernacular and binomials in both countries, we divided the collected species into three categories: (1) those ethnospecies for which scientific species corresponded to the same vernacular names both in Brazil and in the USA, (2) those whose vernacular names had not been described in Brazilian *Candomblé* literature and therefore were unique to NYC, and (3) those that had the same vernacular names both in the USA and Brazil but corresponded to different botanical species. We considered species in the first category as cases of knowledge maintenance, while those in the second and third categories were cases of plant assimilation and substitution, respectively. Due to the well-known regional variations in vernacular names in Brazil (Lorenzi and Matos 2008), we expected to find cases where one scientific species could be described by two or more Portuguese names. We tried to circumvent this problem by comparing the vernacular names collected in NYC to a combination of Brazilian *Candomblé* plant inventories collected in different parts of the country, as explained above. In such cases, ethnospecies with a vernacular name described in the Brazilian compilations were considered cases of continuity, while those which names were absent were recognized as assimilation examples. Unexpectedly, we observed two distinct patterns of substitution. In one subset, all replacements were visually indistinguishable from those used in Brazil, and in all but one case the species belonged to the same genus. Considering that the morphological characteristics of non-fertile specimens were imperceptible from their Brazilian counterparts and that most plant material available for sale or collection was non-fertile, it is possible that practitioners were not aware of any substitution. We took different measures to confirm whether practitioners were aware that they were using different species. First, whenever we identified such cases of substitution, we met with practitioners another time and initiated an in-depth conversation about how they recognized the plants they were using. Then we picked up the species in question (the one that had been substituted) as an example and asked the practitioner to tell us how he or she identified that species and how he or she

could say whether that was the same species as used in Brazil or not. Practitioners would often point to the morphology, color, taste, smell, texture, etc. Since there were few cases of this type of substitution, it was not difficult to discuss each occurrence separately. Therefore, we called this cohort "subconscious" substitution. The remaining species, on the other hand, were visually distinct from their Brazilian counterparts, i.e., their morphological and organoleptic characteristics were different enough to rule out misidentification. Most of these species belonged to a different family from the Brazilian counterpart, and all had distinct morphological characteristics, such as shape, texture, venation of leaves, etc. When we asked practitioners, they said that these species were suitable to replace the Brazilian ones that they could not find anymore. In all of these cases, practitioners knew they were using a different scientific species from what they were used to using in Brazil. This cohort was labeled "intentional" substitutions, because practitioners considered these distinct scientific species as being the same ethnospecies, preserving the vernacular name.

Consensus about plant selection among practitioners (plant-usage) for each adaptation scenario was also calculated. Plants used by only one person were considered of low usage, as there was no consensus regarding its selection. Species used by two or three practitioners were considered of medium usage, as different people independently selected them. Species used by four and five practitioners were considered of high usage, as there was a high degree of concordance among most participants. Plant usage values were then plotted for each adaptation scenario and the results within each adaptation category were converted into percentages. We also evaluated the importance of cultivation, wild harvesting, and commercial sourcing as an adaptation strategy. First, we compiled the places where each species in our inventory was sourced in NYC during our interviews, and then, we calculated each sourcing place percentage for each adaptation case scenario. Sourcing locations were classified into four categories: (1) foraged from the wild, (2) cultivated, (3) imported, and (4) purchased from commercial sources. The latter category was then sorted according to the ethnic groups they catered to. Stores catering to the general NYC public were called "conventional." We considered "imports" to be all plants acquired directly from Brazil, including material brought over by visiting families and friends. Finally, we compiled the ecozones of origin (Sturtevant 1972) for each identified scientific species, as this information indicates the biocultural region where it is originally from (Olson et al. 2001). Percentages of ecozones of origins were also calculated for each adaptation scenario.

Throughout our field work, we encountered a considerable number of plants described by their common Spanish names only, i.e., practitioners did not provide a Portuguese vernacular equivalent. Interestingly, most of these specimens were acquired in *botánicas*, which are ethnic healing stores catering mainly to *Santería* followers (Vandebroek et al. 2010). Seeking to understand the importance of *Santería* in *Candomblé* ethnobotanical adaptation, we asked practitioners where they learned about these new additions and also compared how many of the species used in NYC's *Candomblé* were also used in *Santería*. For that, we selected relevant inventories (Brandon 1991; Cabrera 2000; Melander 2006; Mesa 2000; Porter-Utley 1997; Rodriguez et al. 1995) of *Santería*'s plants collected in the USA and Cuba and then compared the Spanish and scientific names of the species collected in NYC to the Spanish vernacular described in these inventories. Interestingly, we noticed that few of the assimilated scientific species designated by a Spanish-only name were also present in Brazilian inventories. Since their Portuguese names were not mentioned during the interviews, we reasoned that practitioners learned about them from a Spanish-speaking person, which was confirmed when we asked. Therefore, even though these scientific species were present in the Brazilian inventories, they were still considered cases of assimilation because practitioners learned about them from a different culture in NYC. We then calculated the percentage of plant species that were common to both religions and plotted their rate per adaptation scenario.

Results

Plant Inventory and Name Analyses

We compiled 188 vernacular names of ethnospecies, of which 151 (Appendix 1, Electronic Supplementary Material—ESM) were vouchered. These resulted in 155 distinct scientific species, where 147 were identified at least to genus. The remaining eight species could not be identified due to the poor condition of the material. Although most vernacular names collected in this study were Portuguese, practitioners also described many

ethnospecies by their Spanish and/or English names as well. Figure 1 shows that 64% of the species in this inventory were identical to those used in Brazil, i.e., both vernacular and Latin names were the same, and as such, they were considered to be cases of knowledge continuity. We then compared our results to Pierre Verger's (1995) classic study of plants used for *Orixá* devotion in Bahia and West Africa (data not shown). We found that half of the species in our continuity subset were described in these inventories, which indicates that their use is common to all three continents. Examples of plants that withstood the adaptation from West Africa to Brazil and from Brazil to NYC are *akoko* (*Newbouldia laevis*), *espada-de-Ogum*/snake plant (*Sansevieria trifasciata* Prain), and *peregum*/cornstalk dracaena (*Dracaena fragrans* (L.) Ker Gawl). Twenty percent of the compiled vernacular names were not described in Brazilian *Candomblé* inventories, so they were classified as "assimilation" cases. Surprisingly, while most of these plants were described by a Spanish-only name, there were solely two ones with an English-only name. We also observed four species described by Portuguese names that were not present in the Brazilian *Candomblé* inventories.

The number of substitution cases was modest (16% total) and the percentage of cases within the subconscious subset (10 out of the 24 substitution cases) was slightly lower than in the intentional one (14 out of 24 cases). Examples of subconscious and intentional substitutions are, respectively, *Solanum ptycanthum* Dunal and *S. nigrum* L. (*erva-moura*/*erva-de-santa-maria*/black nightshade) substituting for *S. americanum* Mill. and *Kalanchoe daigremontiana* Raym.-Hamet & H. Perrier (*dinheiro-em-penca*/mother of thousands) substituting *Pilea nummulariifolia* (Sw.) Wedd. Finally, there was a singular case where one scientific species was described by two different Portuguese vernacular names, both present in the Brazilian inventories. However, one of these vernacular names corresponded to a different scientific species. While two practitioners described *Lantana camara* L. by its Portuguese name *cambará*, two others described it as *abre-caminhos*, a Portuguese name used for *Lygodium volubile* Sw. When we asked these last two practitioners where they learned about this plant, they said it had been in NYC, and that they used it because this was *Santería*'s version of the Brazilian *abre-caminhos*. In *Santería*, this species is known as *abre camiños*, therefore both Portuguese and Spanish names mean the same: to open the ways. In the first case, practitioners learned about *L. camara* in Brazil, indicating continuity of use.

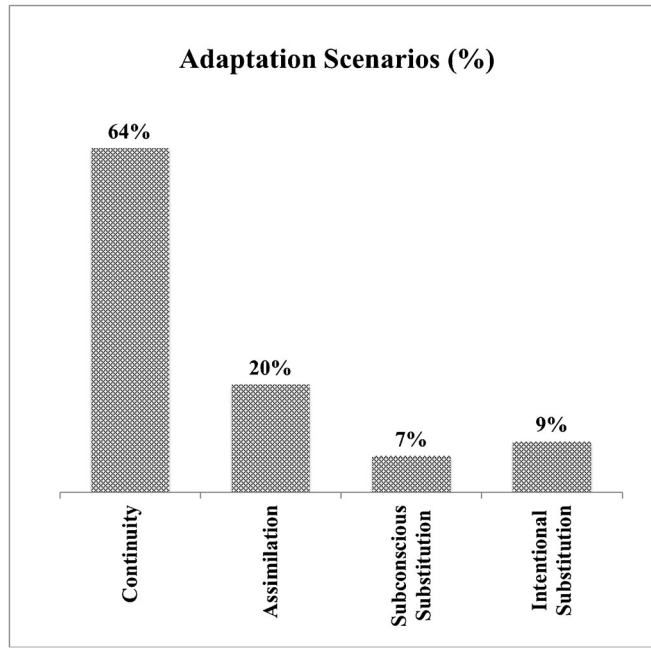

Fig. 1. Percentage of species in each adaptation scenario. .

The second instance, however, was a case of substitution.

Plant Usage

Plant usage analyses provided interesting insights into practitioners' agreement on the identification and choice of plant species. Table 1 shows that significant consensus was achieved within continuity (45, 37, and 18% for high, medium, and low-usage, respectively). Barros (2007) has argued that, while there is a high variation of plants used among *Candomblé* temples, some species tend to be more frequently used than others. According to Anthony (2001), some species are so essential to *Candomblé* that they are named *feuilles de la tradition*, which translates to Portuguese as *folhas-de-tradição* or traditional leaves. The author observed that these key species are used both in Brazil and West Africa, representing a continuity of plant knowledge. During our interviews, practitioners used the term *folhas-de-fundamento*, or core leaves, interchangeably with *folhas-de-tradição*, to designate unique and revered species which sacred use dates back to Africa. Interestingly, 61% of high-usage species in the continuity subset were described in Anthony's study. Even more revealing, this proportion increased to 84% when we narrowed our analysis to only high-usage species used in NYC, Brazil, and West Africa (data not shown). *Akoko* (*Newbouldia laevis*), *aridan* (*Tetrapleura tetraptera* (Schumach. & Thonn.) Taub., and *noz-de-cola*/kola nuts (*Cola acuminate* (P. Beauv.) Schott & Endl.) are examples of *folhas-de-fundamento*. Consensus for assimilated species was low (70% of low usage) as expected. However, there was 30% medium usage, indicating a possible reasoning behind their integration into NYC's pharmacopeia. Close examination showed that most of these specimens were described by a Spanish-only name and sourced in *botánicas*. Subconscious and intentional substitution patterns were somewhat similar.

Sourcing Location

Table 2 describes the proportion of species collected in each sourcing location according to their adaptation status. In continuity, species were mostly bought in stores (70%), while a small number were cultivated (20%), imported (6%), or wild harvested (5%). Among purchased plants, *botánicas* and conventional stores (30% each) provided the bulk of species. We also observed a small percentage of specimens (4%) purchased at West African shops. Interestingly, all of them were *folhas-de-fundamento*. Plants in the assimilation category were mostly procured in *botánicas* (81%).

Although commercial sites were again the primary provider for both subgroups of substituted species, we observed some interesting variations within these different cohorts. While nearly one-third of the species in both cases were sourced in *botánicas*, the proportion of plants acquired in conventional stores was much higher for intentional (38%) than for subconscious (17%) replacements. At the same time, we observed a sharp increase in the percentage of subconscious substitutions (33%) sourced from the wild, which was not observed for the intentional (6%) group nor in any other adaptation scenario.

Geographic Origins

Table 3 shows the ecozones of origins for scientific species collected and identified in this study. Continuity was marked by a balanced incidence of Palearctic (32%), Neotropic (27%), and Afrotropic (21%) species. Assimilation, however, showed a higher prevalence of Neotropic (44%) and Palearctic (24%) species. Although subconsciously substituted species were mostly of Palearctic

Table 1. Percentage of plant usage for each individual adaptation scenario.

	Adaptation scenarios			
Plant usage	Continuity (%)	Assimilation (%)	Subconscious substitution (%)	Intentional substitution (%)
Low (1 practitioner)	18	70	30	29
Medium (2–3 practitioners)	37	30	50	43
High (4–5 practitioners)	45	0	20	29
Total	100	100	100	100

TABLE 2. PERCENTAGE OF PLANT SPECIES ACQUIRED IN EACH SOURCING LOCATION PER EACH INDIVIDUAL ADAPTATION SCENARIO. MANY SPECIES WERE SOURCED IN MORE THAN ONE LOCATION.

		Adaptation scenarios			
Sourcing places		Continuity (%)	Assimilation (%)	Subconscious substitution (%)	Intentional substitution (%)
Commerce	Conventional	30	12	17	38
	Botánicas	30	81	33	31
	West African	4	0	0	0
	Brazilian	1	0	0	0
	Latino	1	0	0	0
	Other ethnic	4	0	0	0
Commerce total		70	92	50	69
Imported		6	0	0	0
Cultivation		20	4	17	23
Wild		5	4	33	8
Grand total		100	100	100	100

(40%) origin, there was a considerable increase in the proportion of Nearctic replacements within this cohort (30%), not observed in other adaptation scenarios. Intentionally substituted species were mainly from Palearctic (32%) and Neotropic (26%) zones.

SANTERÍA'S PLANTS

Figure 2 (and Appendix 2, ESM) shows that although *Santería*'s plants were most noticeable in the assimilation category (81%), there was a substantial proportion of these species in continuity (65%) as well. Interestingly, the percentage of *Santería*'s species in the subconscious (75%) cohort was nearly twice as high as in the intentional (38%) one.

Discussion

CONTINUITY

Our studies show that nearly two-thirds of the species collected in NYC were cases of continuous cultural use (Table 1), most used by at least four practitioners (Table 2). Half of these highly used species in the continuity subset are also used for *Orixá* devotion in West Africa (Verger 1995), and therefore, withstood two adaptation processes—from West Africa to Brazil and now from Brazil to NYC. Most of them were *folhas-de-fundamentos*, suggesting that practitioners are focusing on a core of highly regarded species within the *Candomblé* faith. The occurrence of a core of plants within a medical system has been observed by other authors

TABLE 3. PERCENTAGE OF SPECIES GEOGRAPHICAL ECOZONES OF ORIGINS PER EACH INDIVIDUAL ADAPTATION CASE-SCENARIO.

	Adaptation scenarios			
Ecozones	Continuity (%)	Assimilation (%)	Subconscious substitution (%)	Intentional substitution (%)
Palearctic	32	24	40	32
Nearctic	5	4	30	5
Afrotropic	21	8	0	11
Neotropic	27	44	20	26
Australasia	0	8	0	5
Indomalaya	16	12	10	11
Oceania	0	0	0	11
Total	100	100	100	100

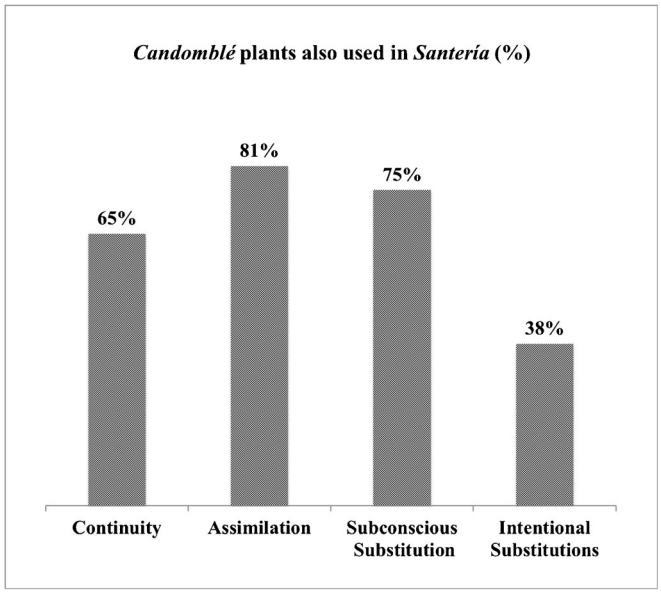

Fig. 2. Percentage of plants used both in NYC's *Candomblé* and in *Santería* in each adaptation scenario.

(Ferreira Junior and Albuquerque 2015), who, after reviewing the literature, drew several hypotheses concerning consensus of plant use. One of these hypotheses highlights the conservative aspect of the core, i.e., core plants are less susceptible to replacement over time, and as such, species substitution would mainly occur with plants that fall outside the backbone structure. Our study supports this hypothesis, because it indicates the presence of a core of species that have survived the adaptive process from Africa to Brazil and now from Brazil to the USA. Intriguingly, we also observed a considerable number of low-usage species within the continuity scenario. This discrepancy could reflect the large variation in species selection among *Candomblé terreiros* in Brazil (Barros 2007), which probably stems from Yoruba's flexible plant classification system (Anthony 2001), plus the high degree of autonomy in terms of plant selection and use (Voeks 1997) and secrecy among their high-priests (Anthony 2001; Barros 2007). Since each *terreiro* has its own set of favorite plants (Barros 2007) and since most practitioners interviewed were initiated in different *terreiros*, it is very likely that each one of them had his/her own set of preferred species, aside from the common core. It is also possible that practitioners did not learn about all these species or did not recall some of them during the interviews.

Commerce was the main provider for plants in continuity. These were mostly sourced in conventional stores (30%) and *botánicas* (30%). In the former, we encountered many widely known botanicals that have been subject to Columbian Exchange. This indicates that similarly to what happened to Africans in Brazil (Voeks 2013), plants, disseminated as part of the exchange, are once more contributing to the continuity and adaptation of Brazilian *Candomblé* in NYC. West African stores contribution was modest (4%) when compared to other ethnic establishments. However, all species sourced in these stores were *folhas-de-fundamentos* that could not be found elsewhere in the city. This low number of species appears to reflect the United States' tight importation restrictions on fresh botanical material. The owner of a popular West African shop in the Harlem told us that she has many regular *Candomblé* customers who continually requests fresh ritualistic plants imported from Nigeria. However, strict US importation rules prevent this woman from offering most of these species in her shop. Unlike Brazilian temples, where a considerable percentage of medical-religious species are either cultivated or otherwise spared or encouraged (Voeks 2013), cultivation contributed only modestly (20%) to the maintenance of *Candomblé* ethnobotanical knowledge. Factors such as different climate, small sizes of housing, lack of private gardens,

and high financial costs associated with gardening have all contributed to cultivation's diminished importance in this city. Yet, despite the low contribution of cultivated plants when compared to commercial species, we witnessed several improvised but lush indoor gardens inside small apartments, which contained even tropical woody species. This included *akoko*, a *folha-de-fundamento* endemic to West African that now is being cultivated in NYC for its African liturgical value (Fig. 3). This species is an interesting case of *Candomblé* ethnobotanical adaptation strategy. While it is revered in West Africa and held in considerable esteem by *Candomblé* practitioners in Bahia, there was apparently only one specimen in Salvador, jealously guarded until the 1940s. To supply the demand, the anthropologist Pierre Verger carried some cuttings back from Nigeria and gave them to several *Candomblé* temples in Salvador. *Akoko* is now a relatively common liturgical species in Bahia (Voeks 1997). We were told in one of our interviews that the specimen shown in Fig. 3 was a cutting from an *akoko* tree brought to Brazil direct from Africa.

Fig. 3. *Akoko* (*Newbouldia laevis*) specimen growing in a Manhattan apartment. A small cutting was brought to NYC in the 1960s; now this specimen supplies many *Candomblé* practitioners in this city.

The percentage of plants foraged from the wild was minor, and this was expected due to the climatic differences between Brazil and the Mid-Atlantic US. However, climatic differences do not seem to be the sole reason for this low number, as even invasive species abounding in NYC were preferably acquired from commercial sources. When we inquired about why practitioners preferred to purchase plants that were freely available in wild spaces, most expressed a fear of contaminants such as chemicals and animal waste matter. This reliance on commercial sources points to a major divergence from traditional *Candomblé* literature, which emphasizes the importance of collecting liturgical plants in the wild to maintain the plant's *axé*, or power (Verger 1995). However, as *Candomblé* moves from rural settings toward major urban centers, and as wild spaces become encroached upon by sprawling urbanization, the importance of commerce as a viable source of liturgical and medicinal plants appears to be increasing in Brazil as well (Albuquerque 1997; Silva 1995). Our findings corroborate those of other diasporic communities. For example, for Turkish immigrants living in Cologne, the number of plant species sourced from local shops was higher than those cultivated and/or gathered from the wild (Pieroni et al. 2005). Van Andel and colleagues (2010) similarly observed that over 70% of Surinamese immigrants in the Netherlands either purchased their plants in Surinamese ethnic stores or imported them directly from Suriname. Our results not only reinforce the notion that home gardens in the host country may not always be the primary reserve for culturally important botanical material (Corlett et al. 2003; Medeiros et al. 2012) but also strongly point to the importance of commerce in the maintenance of ethnobotanical practices in large urban centers.

Overall, Old World species predominated in this adaptation scenario (Palearctic, 32% and Indomalay, 16%). Our results differ from what Anthony (2001) observed when comparing the origins of plant species experiencing continuous use from Africa to Brazil. In her study, Eurasian species were less than one-fourth of the total species. Other authors have observed a predominance of New World species in Brazilian *Candomblé* (Voeks 2013), but their results did not take into consideration different adaptation scenarios. This preference for Old World plants in NYC *Candomblé* may be explained by the easy accessibility to these species,

which have been long introduced in the city through Columbian exchanges.

Assimilation

Although NYC's practitioners assimilated some new species (20%), there was a weak consensus regarding these selections (70% of low usage). Based on a combination of results, we reasoned that *Santería* was the primary factor influencing these new additions. First, we observed a massive occurrence of plants described by a Spanish-only vernacular name, suggesting that practitioners were acquiring this knowledge from a Spanish-speaking population. We also found that a large percentage of plants were sourced in *botánicas* (73%) but not in Latino (0%) stores, pointing to a religious, rather than secular, influence in these assimilation cases. The analyses of *Santería*'s inventories confirmed that 81% of assimilated species were also used by this Afro-Caribbean religion. Finally, practitioners told us that when in doubt, they would prefer to select a plant used in *Santería* than to try something completely unknown to them. It became apparent that most practitioners saw *Santería* as an agent of legitimacy to some extent. Current biocultural adaptation studies show that immigrants tend to adopt their host country's local plant knowledge (Van Andel et al. 2014; Ceuterick et al. 2008; Medeiros et al. 2012; Pieroni et al. 2005). However, in our case, *Candomblé* followers appear to be integrating plant knowledge from Cuban *Santería*, which, despite being a foreign culture as well, bears a strong resemblance to *Candomblé*, due to its shared Yoruba ancestry. A similar scenario may have occurred in Brazil when newly arrived Yorubas and other West Africans met Africans of different ethnicities, such as the Bantus, which had already been living there for many centuries. According to Camargo (2014), species such as *alecrim*/rosemary (*Rosmarinus officinalis* L.) and *couve*/collard green (*Brassica oleracea* L.) entered into *Candomblé* practice through Bantu's influence. We also observed a small number of newly adopted species with Portuguese names. It is not clear why practitioners chose to incorporate these Brazilian species into *Candomblé* practice in the USA. It is possible that a combination of factors, such as abundance, affordability, and freshness, may have played a role. As one practitioner explained: "I use 'hera' (*Hedera helix* L.) to cover the floor of my temple during Oxóssi's feast. It is vigorous and beautiful. Besides, I can collect enough plant material to cover my entire floor. What else can I use to cover the entire floor? Plants here in NYC are so expensive". Finally, it is also possible that some of these Portuguese-named species have only been introduced to Brazilian *Candomblé* practice recently. Assimilation of new species appears to be more relevant to the adaptation of religious knowledge than to medicinal ones (Voeks 2016), as spiritual and magical plants are less often ingested and therefore less likely to cause toxic reactions. When comparing the ethnofloras of native Italians to immigrant Albanians living in the Lucania region, Pieroni and Quave (2005) observed that Albanian descendants employed the local flora more often to treat illness of magical origins, while Italians used many more species for physical healing. In our work, we observed only a modest introduction of new religious species. The reason for this discrepancy is not clear, and more studies focusing on the factors influencing the assimilation of new religious species are warranted.

Substitution

Plant substitution was the least used adaptation strategy. However, in spite of the small percentage of specimens in this case scenario, we were able to observe two distinct patterns of replacement. In the subconscious cohort, replacements belonged to the same genus and were strikingly similar to their Brazilian counterparts. After speaking to practitioners, it became clear that they were not aware that these species were different from the ones used in Brazil. However, in these cases, even taxonomists would be troubled to differentiate a non-fertile specimen. Taking into consideration that most of the botanical material found in NYC is in its vegetative form, it is not surprising that practitioners did not see the difference between these species. We also observed in this cohort an increase in the proportion of Nearctic species and cases of collection from wild sources, suggesting that this type of replacement may be driven by the accessibility of biological material, rather than by cultural forces. Although seemingly contradictory, the high incidence of *Santería* plants in this cohort can also be explained by the easy accessibility of these species in *botánicas*. The low incidence of high usage in subconscious replacements also indicates that such substitutions may be mostly driven by opportunity, rather than by a logical substitution process.

Intentional substitutions, on the other hand, belonged to different families and were markedly

distinct from Brazilian counterparts. In these cases, practitioners clearly stated that they knew these plants were different from the ones used in Brazil. Interestingly, this type of substitution was marked by an increase in the proportion of high-usage specimens, suggesting a reasoning behind it. Notably, *Santería* did not appear to influence these replacement cases. Since morphological features of the replacements in this cohort retained unique ritualistic characteristics from their predecessors, it is likely that these substitutions were done based on Yoruba's plant classification rules (Barros 1993). When comparing Pierre Verger's inventories of religious plants collected in Bahia, Nigeria, and Benin, Anthony (2001) noted that several species with the same Yoruba vernacular names corresponded to different scientific species. Although many of these species belonged to the same genus or family, there were many others that corresponded to entirely different families. The author argued that these latter substitutions were based on Yoruba's system of botanical classification. Van Andel et al. (2014) also observed that Afro-Surinamese used similar vernacular names for botanically unrelated species, but that the lack of information about these names' meanings and uses made it difficult for them to decide whether the similarities were coincidental or intentional cases of substitution. Overall, plant substitution appears to be a common feature of Yoruba's ethnobotanical system. According to Verger (1995), it is common for one specific Yoruba vernacular name to correspond to several scientific species, and for one distinct scientific species to have several different vernacular names. This diversity is necessary, because a plant must have a vernacular name containing a syllable that can function as the *verbo atuante*, or active verb, which indicates the purpose of the incantation ritual. Since this syllable must be present in all plant names used in the incantation, one species may have as many different vernacular names as necessary, each with a pertinent syllable. In Yoruba tradition, a plant's name is of vital importance to the ritualistic incantations. In fact, names are considered as important as the plant itself, and Yoruba priests (*Babalawos*) may change them to include the syllable necessary for the incantation. It is possible that the tradition observed in both *Candomblé* and *Santería* of naming a plant with a vernacular name indicating the action that the plant is intended for is a cultural vestige of Yoruba's active verb. Several Portuguese and Spanish vernacular names collected in this study indicate the incantation these plants are used for. A few examples of vernacular names collected in NYC that indicate their use are *abre-caminhos* (open the ways) in Portuguese, and *amansa guapo* (brute tamer) in Spanish. Moreover, Yoruba culture shows remarkable plasticity regarding plant classification, which also facilitates substitutions. This flexibility was transmitted to *Candomblé*, and it is based on matching plants' morphological characteristics to Orixás' archetypal features (Anthony 2001; Barros 1993; Voeks 1997). Therefore, although morphologically distinct from the taxonomical context, these replacements are similar enough from the Yoruba's perspective to justify the substitution. *Dinheiro-em-penca* (abundant money) is a simple and yet visual example. In Brazilian *Candomblé*, this vernacular name is associated with *Pilea nummulariifolia*, but in NYC, it was substituted with *Kalanchoe daigremontiana*. Although visually distinct, both species share the ability to grow profusely under little care, producing abundant amounts of tiny rounded leaflets resembling coins. In fact, many *Bryophyllum* species are believed to attract "abundant money" in Brazil (Robert Voeks, personal communication, July 2016).

Conclusions

New York City is a melting pot where many people and plants from all over the world come together. Among these many different cultures, there are Brazilian immigrant adherents to *Candomblé* who, in spite of the difficulties imposed by an unfamiliar biocultural landscape, have found creative strategies to maintain a considerable level of ethnobotanical knowledge. Thanks to an ample supply of Old World species introduced in the USA through Columbian exchanges and to a vast array of plants in common with *Santeria*, available in *botánicas*, practitioners can find plenty of species that were used in Brazil. Yet, in spite of the presence of many familiar species, these individuals consistently relied on a set of core species, or *folhas-de-fundamentos*, whose associated knowledge has survived two stages of adaptation—from West Africa to Brazil, and now Brazil to NYC. Cultural factors appear to be the principal force influencing assimilation, as practitioners prefer to adopt plants from a foreign, yet culturally related religion, i.e., *Santería*, then from local plants, as has been observed in many other immigrant communities (Medeiros et al. 2012). Although there were considerably fewer

cases of substitutions, we found indications of two distinct patterns. "Subconscious" replacements were apparently driven mostly by easy accessibility to the botanical material. "Intentional" substitutions, however, seem to follow Yoruba's rules of plant classification. One of our most significant findings was the importance of commerce in the overall process of *Candomblé* adaptation in NYC. Besides supplying the bulk of continuity plants, it also provides most of the assimilated and substituted species as well. This importance is likely due to a combination of factors such as the plethora of botanical material commercially available to support the needs of the many immigrant communities living in this city and challenges in procuring plants directly from sources in the local environment.

Although our study underscores relevant trends on *Candomblé* biocultural adaptation in NYC, it has some limitations. First, the small number of practitioners in this urban center limited our sampling, and as such, it does not allow for the strict assurance of a larger sample. It would be interesting, for instance, to apply our methodology to studying the mechanism of adaptation employed by the *Candomblé* community living in Miami, Florida, a Neotropical area of the USA where, according to practitioners in this study, there is a much larger number of adherents. Additionally, since Miami is also home to a large *Santería* community (Porter-Utley 1997), this city would also provide an ideal background to further investigate *Santería*'s role in *Candomblé* biocultural adaptation, and also to study the process of plant substitution in greater detail. Another relevant limitation in our study was the comparison of an up-to-date plant inventory to a collection of inventories published from 1991 to 2007 by different authors. In such cases, the lack of a particular plant species in the Brazilian compilations does not necessarily mean the plant is not used in *Candomblé*. This absence may reflect a gap in the literature (Medeiros et al. 2012), or additions that made their way into *Candomblé*'s pharmacopeia after the inventories were compiled. According to Silva (1995), *Candomblé* has been going through fundamental changes as it migrates to large urban centers such as São Paulo, opening up to influences such as *Umbanda*, for instance. As more adherents turn to *Candomblé*, it is possible that *Umbanda*'s plants will be assimilated as well. Finally, it is also possible that the Brazilian inventories may not describe all common names by which one particular species may be known by the studied population. Had any plant with these characteristics been collected in our inventory, they would have been classified as assimilation cases, not as cases of continuity. Although we tried to circumvent these problems by discussing each specific case with practitioners, this may not be possible with a larger sampling number. But in spite of the issues summarized above, this study shows relevant trends of biocultural adaptation in large urban centers. It also reinforces the observation that some forms of traditional knowledge, such as those associated with medicinal plants, in fact, increase when an immigrant group arrives in a highly urbanized and transnational community such as NYC (Vandebroek and Balick 2012).

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