Journal of Ethnopharmacology 143 (2012) 840–850

Contents lists available at SciVerse ScienceDirect

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jep

In search of the perfect aphrodisiac: Parallel use of bitter tonics in West Africa and the Caribbean

Tinde van Andel [a,*], Sylvia Mitchell [b], Gabriele Volpato [c], Ina Vandebroek [d], Jorik Swier [e], Sofie Ruysschaert [f], Carlos Ariel Rentería Jiménez [g], Niels Raes [a]

[a] Naturalis Biodiversity Center, Section National Herbarium of the Netherlands, PO Box 9514, 2300 RA Leiden, The Netherlands
[b] Medicinal Plant Research Group, Biotechnology Centre, University of the West Indies, 2 St. John's Close, Mona Campus, Kingston 7, Jamaica
[c] CERES Research School, De Leeuwenborch, Wageningen University and Research Centre, Hollandseweg 1, 6706 KN Wageningen, The Netherlands
[d] Institute of Economic Botany, New York Botanical Garden, 2900 Southern Boulevard Bronx, 10458 NY, United States
[e] Wageningen University and Research Center, Droevendaalsesteeg 2, 6708 PB Wageningen, The Netherlands
[f] Laboratory of Tropical and Subtropical Agriculture and Ethnobotany, Ghent University, Coupure Links 653, 9000 Ghent, Belgium
[g] Instituto de Investigaciones Ambientales del Pacífico "John Von Neumann", Cra 6 Nro 37–39, Quibdó, Colombia

ARTICLE INFO

Article history:
Received 30 June 2012
Accepted 7 August 2012
Available online 17 August 2012

Keywords:
Ethnobotany
Erectile dysfunction
Plant mixtures
Slave trade
Traditional medicine Africa

ABSTRACT

Ethnopharmacological relevance: Enslaved Africans in the Americas had to reinvent their medicinal flora in an unknown environment by adhering to plants that came with them, learning from Amerindians and Europeans, using their Old World knowledge and trial and error to find substitutes for their homeland herbs. This process has left few written records, and little research has been done on transatlantic plant use. We used the composition of aphrodisiac mixtures across the black Atlantic to discuss the adaptation of herbal medicine by African diaspora in the New World. Since Africans are considered relatively recent migrants in America, their healing flora is often said to consist largely of pantropical and cultivated species, with few native trees. Therefore, we expected Caribbean recipes to be dominated by taxa that occur in both continents, poor in forest species and rich in weeds and domesticated exotics.

Materials and methods: To test this hypothesis, we compared botanical ingredients of 35 African and 117 Caribbean mixtures, using Dentrended Correspondence Analysis, Cluster Analysis, Indicator Species Analysis and Mann–Whitney U tests.

Results: Very few of the 324 ingredients were used on both continents. A slightly higher overlap on generic and family level showed that Africans did search for taxa that were botanically related to African ones, but largely selected new, unrelated plants with similar taste, appearance or pharmacological properties. Recipes from the forested Guianas contained more New World, wild and forest species than those from deforested Caribbean islands. We recorded few 'transatlantic genera' and weeds never dominated the recipes, so we rejected our hypothesis.

Conclusions: The popularity of bitter tonics in the Caribbean suggests an African heritage, but the inclusion of Neotropical species and vernacular names of plants and mixtures indicate Amerindian and European influence. We show that enslaved Africans have reinvented their herbal medicine wherever they were put to work, using the knowledge and flora that was available to them with great creativity and flexibility. Our analysis reveals how transplanted humans adapt their traditional medical practises in a new environment.

1. Introduction

When enslaved Africans were brought to the New World, they were not only challenged to maintain their culture and beliefs under strenuous circumstances but also to find useful plants similar to those of their motherland (Grimé, 1976; Schiebinger, 2005). How did the involuntary transport of nearly 11 million Africans to the Americas influence their ethnobotanical knowledge? Due to slavery's fragmented history, the origins of African–American folk medicine during the colonial period are obscure (Groover and Baumann, 1996). Relatively few African plants crossed the Middle passage on slave ships as provision crop, fodder or weed (Carney and Rosomoff, 2009). Slaves had to reinvent their medicinal flora in an unknown environment by exchanging information with Amerindians and Europeans, using their knowledge of African plants and going through a long process of trial and error to find substitutes for their homeland herbs (Schiebinger, 2005; Voeks, 2009; Van Andel et al., in press

* Corresponding author. Tel.: +31 71 5273585; fax: +31 71 5273511.
E-mail address: Tinde.vanAndel@naturalis.nl (T. van Andel).

0378-8741/$ - see front matter © 2012 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jep.2012.08.008

a). Since medicinal plants are nowadays used and traded by millions of black Caribbeans, this process has been quite successful (Laguerre, 1987; Van Andel et al., 2007; Volpato et al., 2009a; Vandebroek et al., 2010; Mitchell, 2011).

Investigating cultural variations in ethnobotanical practices gives us insight into how they change when people migrate and adapt to new surroundings (Volpato et al., 2009a, 2009b; De Medeiros et al., 2012). Enslaved Africans in the New World only had access to a fraction of their original African pharmacopeia, but they did bring their beliefs about health and illness, as well as their memories of recipes and ingredients (Voeks, 2009). By comparing herbal medicine presently used by Africans and their American diaspora (commonly known as the black Atlantic), we can trace back the two different strategies of migrant ethnobotany: (1) adhering to plants brought from the country of origin or also present in the new environment, and (2) acquiring new plant knowledge and substituting homeland species with new ones from the host environment (Volpato et al., 2009a; De Medeiros et al., 2012).

Few scholars have compared contemporary Afro-American and African plant use. After relating Brazilian ritual plants with those used by the Nigerian Yoruba, Voeks (2009) concluded that the two groups shared a so-called disturbance pharmacopeia: a medicinal flora consisting of common weeds and Old World domesticates that were familiar to the Yoruba before they arrived in South America. The general absence of trees or forest species in the healing flora of Afro-Brazilians was explained by the immaturity of their ethnobotanical knowledge. However, since the enslaved Yoruba both came from and arrived in a severely human-altered landscape, it seems obvious that Brazilians and Nigerians share a disturbance pharmacopeia. In contrast, ritual plants used by forest-dwelling Maroons in Suriname are largely of New World origin and include many primary forest species (Van Andel et al., in press b) The predominant use of roots in Afro-American medicine is also considered to have an African origin. Roots are considered the 'strongest' part of plants and traditional healers are known as 'root doctors' (Laguerre, 1987; Long, 2001; Hernández and Volpato, 2004). The proportion of roots in African healing floras, however, is much higher in dry regions than in wet ones (Cunningham, 1997). So how African is Afro-American plant use? The objective of this paper is to use the composition of aphrodisiac mixtures across the black Atlantic as a case study to discuss the reinvention and adaptation of herbal medicine by African diaspora in the New World.

Across the black Atlantic, men drink bitter tonics to enhance their sexual performance. These boiled, slightly fermented or strong alcoholic plant mixtures are often commercialized as powerful aphrodisiacs, but may also double as a general strengthener, blood purifier, or cure for impotence or venereal diseases (Longuefosse and Nossin, 1996; Ray et al., 1996; Volpato et al., 2009a; Mitchell, 2011). In several West African and Caribbean countries, bitter plant mixtures are also drunk as remedies for malaria (Hermans et al., 2005; Vigneron et al., 2005), respiratory infections (Hernández and Volpato, 2004) and genitourinary conditions (Vandebroek et al., 2010; Telefo et al., 2011). Since the consumption of aphrodisiac mixtures is widespread and does not seem to be related to local disease prevalence, they allow for a comparison of parallel plant use among Africans and their diaspora.

Ethnobotanists have published long lists of aphrodisiacs in West Africa (Abbiw, 1990; Noumi et al., 1998) and the Caribbean (Warner, 2007; Mitchell, 2011), but few have analyzed the botanical ingredients of individual bitter tonics. Plant mixtures are generally understudied (Vandebroek et al., 2010). The identification of small plant fragments is difficult, especially when they consist of wood, bark or roots, organs not often present on herbarium sheets. Chemical processes related to synergism and additive or reduced therapeutic effects are likely to occur during the manufacturing process, which may include boiling for hours or soaking in alcohol for days or even weeks (Wang et al., 2005; Ndhlala et al., 2011). Moreover, as they are commercially valuable, the components of these popular alcohol-based fortifiers are often kept secret (Longuefosse and Nossin, 1996).

It is likely that in their quest for useful plants in the unfamiliar, Neotropical vegetation, slaves chose plants that were taxonomically related to the African species they knew, a general strategy of migrants when adapting their ethnomedical system in a new environment (Voeks, 2009; De Medeiros et al., 2012). If we assume that bitter tonics were already drunk in West Africa in the era of transatlantic slave trade, we expect that Afro-American recipes are dominated by taxa that are used both in the Old and the New World. Since Africans can be regarded as relatively recent migrants to the Americas (Voeks, 2009), we expect the percentage of forest species to be minimal in the Caribbean mixtures. To test these hypotheses, we need to answer the following questions: (1) which plant species are included in aphrodisiac mixtures in West Africa and the Caribbean?; (2) is there an overlap in families, genera or species used across the black Atlantic?; (3) do cultivated plants, pantropical weeds and roots play a substantial role in Caribbean mixtures?; and (4) are primary forest species more important in Old World recipes than in New World ones?

Using recent fieldwork data from both continents and applying novel methods (McCune and Grace, 2002) to analyze similarity in medicinal plant preparations, we demonstrate how enslaved Africans have reinvented their herbal medicine over and over again, wherever they were put to work, using the knowledge and flora that was available to them with great creativity and flexibility. Results from this study may help to unravel the question of how transplanted humans adapt their traditional practises in a new environment.

2. Materials and methods

2.1. Fieldwork

Of the 152 aphrodisiac recipes used in our analysis, 111 were drawn from (partially) unpublished fieldwork data collected in the Guianas (French Guiana, Guyana and Suriname), the Dominican Republic, Jamaica, Saint Lucia, Cuba, Colombia, Ghana, and Benin (Supplementary Table S1). Recipes were collected among traditional healers, community elders, vendors, lay people, and consumers of bitter tonics. Plant ingredients and mixtures were purchased at herbal markets and when possible later matched with fertile specimens in the field. For each recipe, we recorded the essential (aphrodisiac) ingredients, as well as the plant organs that served as colorants or flavoring agents to mask the bitter taste of the beverage. Voucher specimens (including wood, bark, and root samples) were identified and deposited at the National Herbaria of Suriname (BBS), Guyana (BRG), Ghana (GC), Benin (BENIN), Santo Domingo (JBSD), New York (NYBG), Kingston, Jamaica (UCWI and NHMJ), The Netherlands (L and WAG), Quibdó, Colombia (CHOCO), Camagüey, Cuba (HACC), Santiago de Cuba (BSC) and Ghent, Belgium (GENT). A total of 15 bottles with dry mixtures were deposited at the Economic Botany collection of the Leiden Herbarium (L). Our database was complemented with 27 recipes retrieved from literature and 14 from the internet (Supplementary Table S1).

2.2. Data analysis

Only mixtures that contained at least two plant species and were used orally by men as aphrodisiacs and/or to treat

impotence were included in our analysis. Remedies only drunk to cure sexually transmitted diseases were left out, even though some consumers cited STDs as the cause of sexual weakness. For each species, we recorded the part used, habitat type, cultivation or weedy status, geographical origin and distribution, either in the field or by means of local floras and online collection databases (e.g., www.gbif.org). For tonics sold via the Internet, whose ingredients were often listed with their local names only, we traced back scientific names and plant parts by using (ethno-) botanical publications from the same region. The complete mixture, i.e. the combination of species encountered in one bottle, was used as the sample unit in our analysis. All ingredients and recipes were entered in a presence–absence data matrix with plant species in rows and individual mixtures in columns (Supplementary Table S2). To examine whether Old and New World recipes differed in their percentages of wild species, weeds, plants from forest or open vegetation and certain plant organs, we applied two independent sample tests (Mann–Whitney U), after it appeared that the data were not normally distributed. Differences were considered significant when p values were smaller than 0.05. Statistical analyses were conducted using SPSS Statistics 17.0.

With separate presence–absence spreadsheets for families, genera and species in the 152 mixtures, we performed a Detrended Correspondence Analysis (DCA), downweighting rare species to reduce axe length (McCune and Grace, 2002). DCA is a multivariate statistical technique that is often used by ecologists to define groups or find gradients in large, species-rich data sets often found in plant communities. After eliminating outliers, DCA enables the identification of two main axes that cause the distribution of sample units and species in the environmental space. We plotted the 1st and 2nd axes in two-dimensional graphs for all three taxonomic levels to examine the potential overlap on family, generic or species-level among mixtures and to visualize variation within and between countries. To calculate the percentage of variance represented by the three axes in the distance matrix (r^2), we used an after-the-fact coefficient of determination, using the relative Euclidean distance measure. For a more detailed grouping of the samples based on the similarity of their species composition, we performed a Hierarchical Cluster Analysis (McCune and Grace, 2002), using Sørensen (Bray–Curtis) distance as a measure of dissimilarity and flexible beta as group linkage method ($\beta = -0.25$). A dendrogram was generated to demonstrate the relations between individual samples and groups. Next, we carried out an Indicator Species Analysis to distinguish the botanical ingredients that defined the different groups. Finally, we tested indicator values for statistical significance using the Monte Carlo randomization technique (McCune and Grace, 2002). These three analyses were performed in the program PC-ORD 5.32.

3. Results

3.1. Regional variety in names and recipes

We analyzed the components of 152 aphrodisiac mixtures from 16 countries: five Caribbean Islands, four South American and seven African countries, representing in total 35 Old World and 117 New World recipes (Supplementary Table S1). Multi-species bitter tonics were generally marketed as glass bottles filled with chopped and dried roots, bark or wood (the therapeutic ingredients), some spices (e.g., cinnamon, (star-) anise, allspice, nutmeg or *Xylopia* spp.) or sweeteners (e.g., honey or sugar) to enhance their taste (Fig. 1). Before consuming the drink, the ingredients had to be soaked for a few days in alcohol: rum,

Fig. 1. Bitter tonic sold at Nima market in Accra, Ghana. Bottles with chopped ingredients soaked in alcohol for several days before consumption. Picture by C.A. Van der Hoeven.

wine or cheap cane liquor in the Caribbean, *aguardiente* in Colombia, and fermented or in strong, distilled palm wine in West Africa. Ready-made alcoholic tonics were sometimes sold per 'shot', while commercial, non-alcoholic or slightly fermented drinks were sold in crown cork bottles. Tonics that needed to be boiled at home and eventually fermented afterwards were generally sold as single-dose packages with a few pieces of bark and spices. The beverages were known under a variety of local names and popular among young males. Animal body parts were sometimes added to the herbal mixtures to symbolize sexual vigor: armadillo tails (*Dasypus* sp.) in Suriname, genitals of ring-tailed coatis (*Nasua nasua*) and paca (*Cuniculus paca*) in Colombia (Rentería Jímenez et al., 2008), rooster spoors and deer horns in Cuba (Volpato et al., 2009a), and genitals of sea turtles and pieces of octopus in the Dominican Republic (Vandebroek et al., 2010).

3.2. Floristic diversity in a bottle

Botanical ingredients of all 152 aphrodisiac mixtures are listed with their scientific and local names, parts used, cultivation status, vegetation type and geographical origin in Supplementary Table S2. We recorded at least 112 families, 257 genera and 324 species (of which 17 could be identified only to genus level); 14 ingredients could not be identified to family level. The most diverse families were Fabaceae (30 spp.), Rubiaceae (12 spp.), Loganiaceae (12 spp.), Arecaceae (11 spp.), Apocynaceae, Asteraceae and Rutaceae (each 9 spp.), Annonaceae (8 spp.), Malvaceae, Euphorbiaceae and Smilacaceae (each 7 spp.). Excluding the unidentified ones, 39 families (35%) were represented by just one species. Including 11 unidentified ones, 180 species (56%) were only recorded in a single recipe. The number of ingredients

per bottle varied from 2 to 27, with a mean number of 7.9 species per bottle. Details on number of ingredients and percentages of plant parts are given in Supplementary Table S3. About 19% of the mixtures were composed of two or three plants, 21% of four to five plants, 36% of six to ten species, while 24% contained more than ten different species.

3.3. Plant parts and provenances

Plant parts used in the mixtures consisted of roots, including other underground parts like rhizomes and bulbs (38% of the species), bark (11%), wood (15%), leaves or entire herbs (19%), seeds (5%), and other parts like flowers or fruits (11%). African mixtures contained significantly more roots than American ones, but less bark, wood and leaves (Table 1). In Jamaican 'root tonics', ca. 46% of the ingredients were present as roots, more than in any other Neotropical country. Still, this percentage was lower than most African bottles, which contained an average root percentage of 53%, and up to 80% in Benin and South Africa. Recipes from Cameroon did not contain any roots, but we retrieved only three reliable literature references from that country (Supplementary Table S3). Leaves were the most prominent ingredient ($>30\%$) in Cuba, Trinidad and Colombia, while comparable percentages for wood were found in Ivory Coast and the Guianas.

New World mixtures contained significantly more weeds, cultivated species and plants from open vegetation than African mixtures, and less forest or savannah species (Table 1). Savannah plants were mainly encountered in recipes from Ghana and Benin, countries substantially covered by this vegetation type. Recipes from countries with vast tracts of tropical rain forests (Cameroon, Ivory Coast, Ghana, the Colombian Chocó and the three Guianas), contained more than 50% forest species. Recipes from heavily deforested countries (e.g., Cuba, the Dominican Republic and South Africa) generally had less than 8% forest species. The average percentage of weeds in the New World bottles was relatively low (14%), although the Dominican Republic and the Jamaican recipes contained substantial amounts of weeds (32% and 20%, respectively). The number of pantropical species was low in all mixtures. Only in Cuba, Saint Lucia and Trinidad, more than 60% of the ingredients were cultivated; in all other countries the majority of the plants were harvested from the wild. For Guyana and French Guyana, the percentage of wild ingredients was even higher than 80%. Very few New World species were encountered in African bottles, while the mean percentage of Old World species in American mixtures was 30%, varying from 4–17% in the Guianas to more than 70% for Cuba and Trinidad.

Table 1
Comparison of ingredients between Old and New World recipes.

Continent	Old World ($n=35$)	New World ($n=117$)	Mann–Whitney U values	p
No. of species	5.8 ± 4.3[a]	8.6 ± 5.1	1296	0.001
Root (%)	52.7 ± 39.7	33.6 ± 21.4	1413	0.005
Bark (%)	10.2 ± 20.9	11.7 ± 12.7	1578	0.029
Wood (%)	4.2 ± 10.8	17.7 ± 18.4	1034	0.000
Leaves (%)	9.6 ± 22.1	21.6 ± 16.7	1045	0.000
Seeds (%)	4.6 ± 12.0	4.9 ± 9.9	1981	0.700[b]
Weeds (%)	2.4 ± 7.4	14.4 ± 17.3	1072	0.000
Cultivated species (%)	30.8 ± 33.0	44.0 ± 27.8	1402	0.005
Forest species (%)	45.8 ± 27.9	25.7 ± 26.3	1201	0.000
Savannah s pecies (%)	14.7 ± 18.4	0.2 ± 2.1	1078	0.000
Open vegetation (%)	36.8 ± 33.0	71.8 ± 25.8	879	0.000
Old World species (%)	88.8 ± 22.8	30.0 ± 28.9	322	0.000
New World species (%)	3.4 ± 12.3	63.7 ± 29.2	230	0.000
Pantropical species (%)	5.4 ± 11.3	4.5 ± 7.3	1930	0.543[b]

[a] All values represent means $\pm$ standard deviations.
[b] No significant differences.

3.4. Overlap in species

When the DCA results on species level were plotted in a two-dimensional scatterplot (Fig. 2), the South African mixture was clearly visible as an outlier on the far right. In Kwazulu-Natal, were the data collected (Ndhlala et al., 2011), the vegetation is radically different from West Africa. Furthermore, South Africans have never been part of the cultures and knowledge systems shared between West Africans and Afro-Americans. The gap between the South African and West African recipes is probably filled by mixtures from Central and Southwestern Africa, for which data are currently lacking.

Excluding South Africa from our presence–absence matrix allowed us to observe the similarities and differences between species composition in Caribbean and African countries more closely (Fig. 3). In general, we found little or no overlap in species composition between countries, except in the case of Saint Lucia, Trinidad and several recipes from Cuba and the Dominican Republic. There existed also a substantial variation in species composition within countries. Jamaican mixtures (and to a lesser extent those from Saint Lucia and Cuba) were much more similar in their ingredients than those from Suriname, the Dominican Republic or Ghana. There was almost no overlap in species composition between Africa and the Caribbean, apart from three Ghanaian recipes (Gh01, Gh06 and Gh08). The first was a mixture made by a Togolese migrant consisting largely of introduced species, the latter two were mixtures sold via the Internet (Supplementary Table S1) that contained several Jamaican aphrodisiacs (*Smilax regelii*, *Turnera diffusa*). The few plants that occurred in recipes on both sides of the Atlantic were either widely domesticated exotics like mango (*Mangifera indica*), lemongrass (*Cymbopogon citratus*), lime (*Citrus aurantifolia*) and ginseng (*Panax ginseng*), or African species that were taken along with the slave ships and planted in the Caribbean, like *Xylopia aethiopica* in Cuba and *Cola nitida* in Jamaica. The three DCA axes represented a variance of 26.4%, of which the first axis accounted for 16.4%.

When the DCA scores of the first axis were plotted against the longitudinal gradient (Fig. 4), it appeared that 80% of the variation was explained by geographical distance (DCA1 scores $=9.836 \times$ longitude $+910.49$ $R^2=0.7974$). The three outliers on the lower

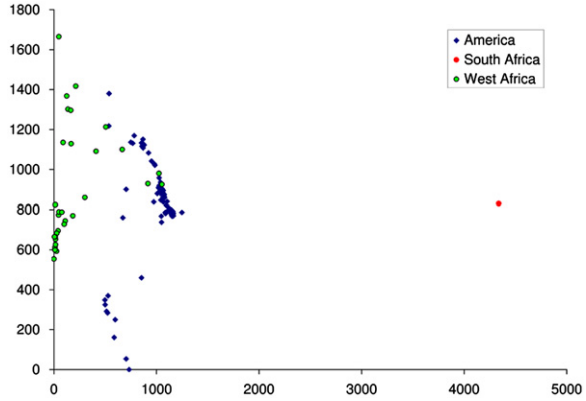

Fig. 2. DCA scatterplot on species level. Each of the 152 points represents one recipe with a unique combination of species.

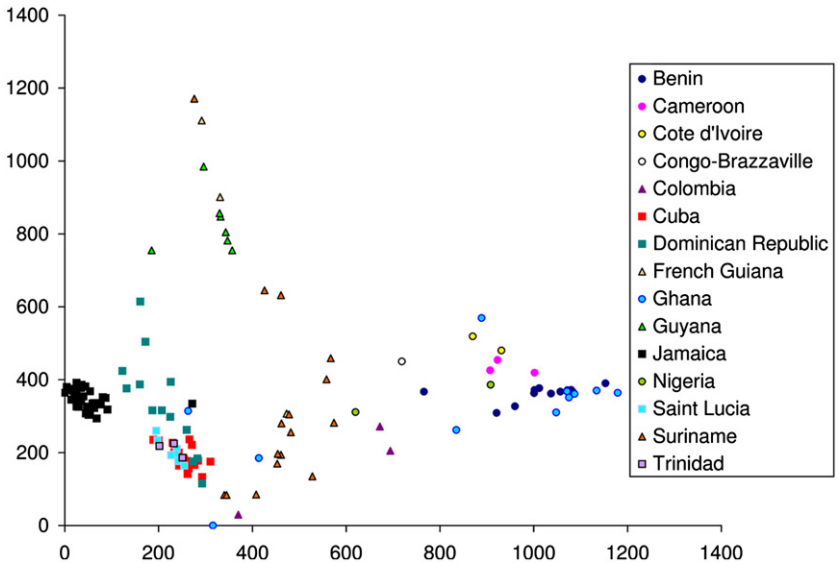

Fig. 3. DCA scatterplot on species level. Circles refer to African mixtures, squares refer to Caribbean islands and triangles to the South American mainland. Total number of samples is 151; the South African mixture has been excluded.

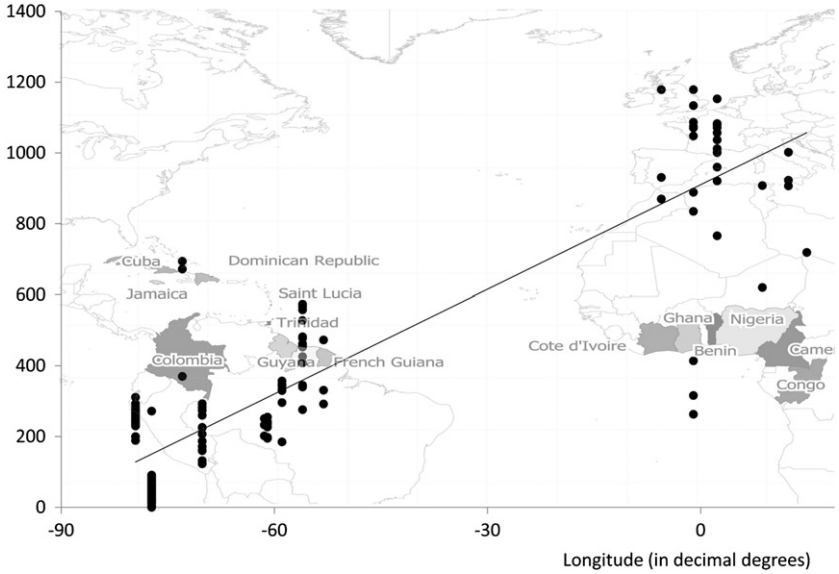

Fig. 4. DCA1 scores plotted against geographical distance. Longitudinal values represent the central coordinate of each country. Total number of samples is 151; the South African mixture has been excluded.

right side of the graph represent the three Ghanaian recipes (Gh01, Gh06 and Gh08) that contained Asian and Caribbean species.

3.5. Cluster analysis

The dendrogram resulting from Hierarchical Cluster Analysis grouped the 151 samples into eight groups (Fig. 5). Cluster 1 included 41 of the 42 Jamaican samples and a Ghanaian sample (GH06) with Jamaican ingredients, cluster 2 contained 13 of the 23 Cuban mixtures (based on the presence of *Artemisia absinthium*), cluster 3 had all but one Surinamese samples and one from French Guiana collected on the Surinamese border. Cluster 4 comprised of only West African recipes, while cluster 5 was a combination of recipes from Caribbean Islands and Gh08, cluster 6 grouped several Dominican recipes and cluster 7 grouped all recipes from Guyana with some from French Guiana. Finally, the least supported cluster 8 grouped the remaining recipes.

3.6. Key ingredients that make the tonic

Those ingredients that were defined by consumers as having aphrodisiac properties and that distinguished bitter tonics from other medicinal mixtures were remarkably country-specific (Supplementary Table S3). However, they did not always coincide with the indicator species emerging from our cluster analysis. A species like *Mondia whitei* was used in several countries, but only became the dominant ingredient in Benin. The liana *Paullinia pinnata*, present in almost half of the Ghanaian samples, is also very common in the Guianas, but did not end up in any of the recipes from that region. Spices like ginger and cinnamon were added across the regions, but they were not always considered as therapeutic ingredients. The tonics varied in their taste from very bitter (those containing *Quassia amara*, *Colubrina* spp., *Aristolochia* spp., and *A. absinthium*) to less bitter (drinks with *M. whitei*) or even sweet (Saint Lucian spice rum).

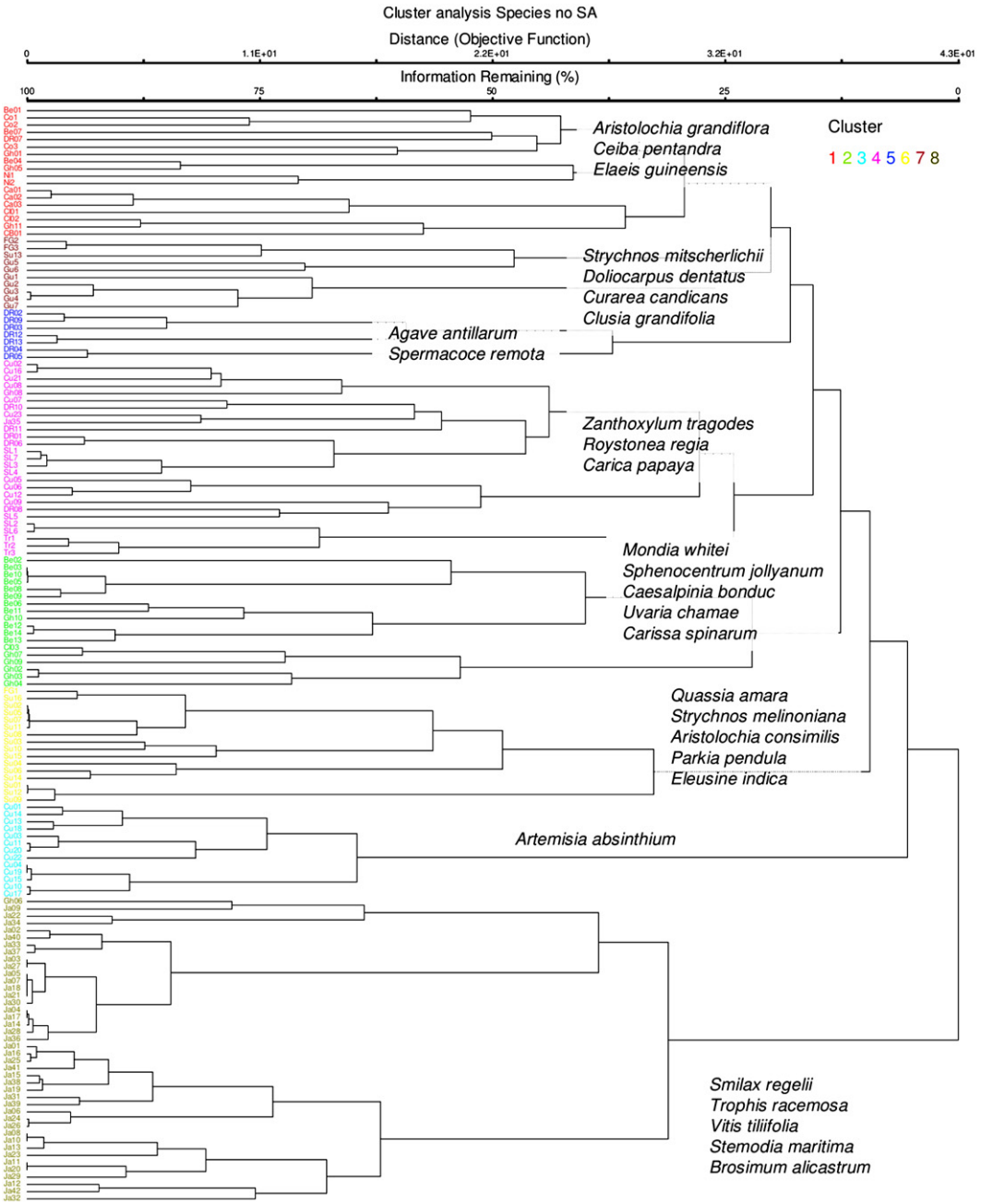

Fig. 5. Dendrogram resulting from the Hierarchical Cluster Analysis, separating the eight groups based on their indicator species. Only statistically significant indicator species ($p < 0.05$) are listed.

3.7. Overlap in genera

When the DCA results on generic level were plotted, the South African mixture was again an outlier, composed of totally different genera than the rest (Fig. 6). The other 151 samples had somewhat more genera in common. The three DCA axes represented a variance of 86.1%, of which the first two axes accounted for 45.9%. Mixtures from Cuba, Jamaica and the Dominican Republic clustered tightly together (sharing many genera), while mixtures from the Guianas and West Africa showed a wider generic variation. Except from the few Ghanaian mixtures that now ended up close to the Caribbean ones, there was again little overlap between both sides of the Atlantic. The main 'transatlantic genera' were *Zanthoxylum* (used in three Old World and two New World countries), *Morinda* (OW:NW = 2:2), *Caesalpinia* (2:3), *Cyperus* (2:3), *Xylopia* (2:2), followed by *Strychnos* (1:4), *Cola* (3:1), *Paullinia* (3:1) and *Dioscorea* (1:2).

3.8. Overlap in families

When the DCA results on family level were performed, samples DR11 (a Dominican mixture with as much as 27 species, including many non-typical ones) and the South African mixture distorted the results disproportionally. After omitting these two outliers and plotting the DCA results of the remaining 150 samples (Fig. 7), the mixtures showed much more overlap, in particular between West Africa and the South American mainland. The three DCA axes represented 36.8% of the variance, of which the first two axes accounted for 31.0%. Overlap was not restricted to diverse, frequently occurring medicinal plant

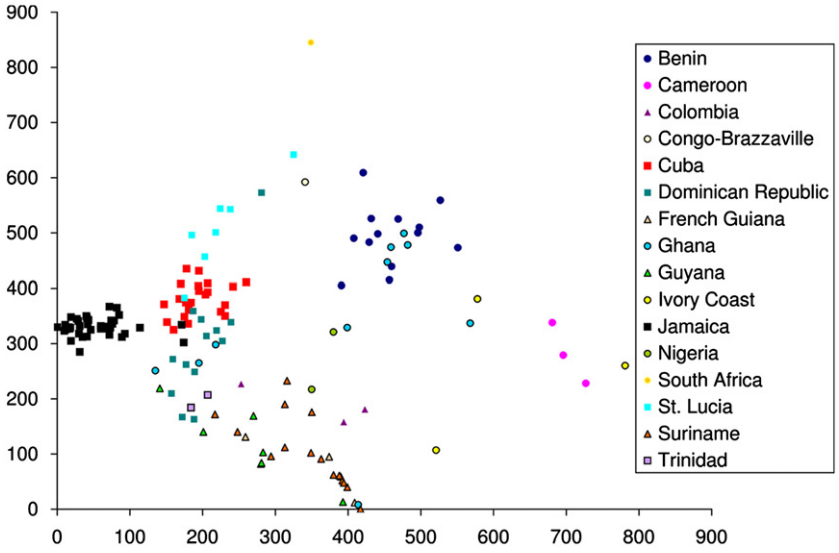

Fig. 6. DCA scatterplot on the generic level. Each point represents one of the 152 mixtures.

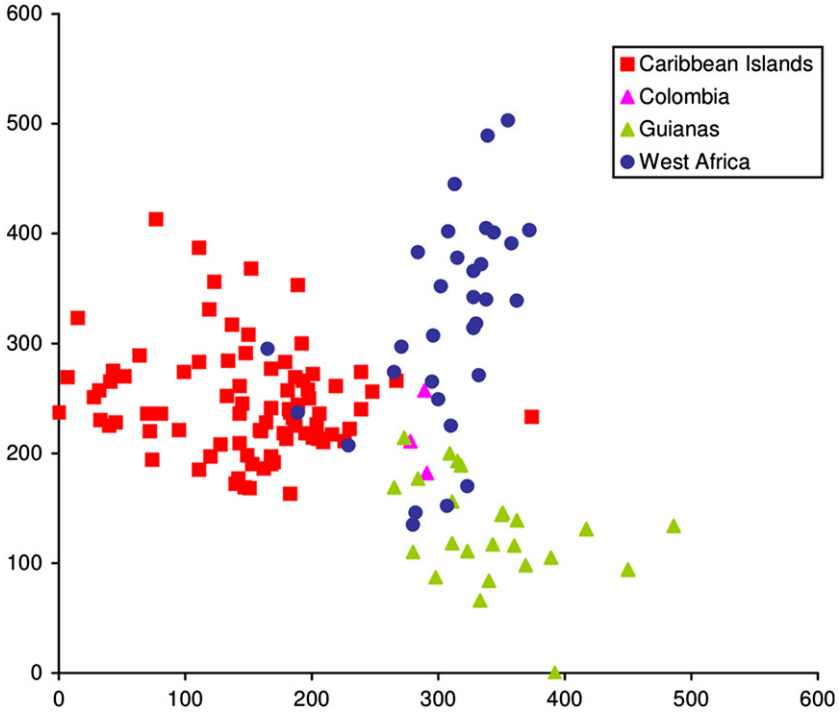

Fig. 7. DCA scatterplot on family level. The total number of samples is 150; the South African mixture and DR11 (Dominican Republic) were omitted as outliers.

families in the Old and New World, such as Fabaceae, Euphorbiaceae or Rubiaceae. Less abundant and less diverse families (e.g., Loganiaceae, Sapindaceae, Polygalaceae, Rutaceae and Menispermaceae) were selected on both continents, probably for their bitter taste and their reputed aphrodisiac effects. Apocynaceae, a widely distributed family on both sides of the Atlantic that contains many bitter, medicinal species, only figured in African recipes. In the Americas, Apocynaceae were probably replaced by other bitter-tasting families like Simaroubaceae and Aristolochiaceae. The overlap between West Africa and the Caribbean islands was substantially lower. Families like Moraceae, Amaranthaceae, Plantaginaceae, Rosaceae and Rhamnaceae were commonly used on these islands, but were absent in recipes from Africa and the Guianas.

3.9. Does globalization lead to uniformity?

Most variation in species composition was found among traditionally prepared, crude plant mixtures. The tight clustering of Jamaican recipes may have been caused by the fact that almost all were commercially produced drinks that were marketed via the Internet. The two commercial Ghanaian bottles (Gh06 and GH08) contained not only Jamaican *Smilax* species but also Asian botanicals (e.g., *Ginkgo biloba*), and other non-native aphrodisiacs like the Peruvian *Dulacia inopiflora* and Central African *Pausinystalia yohimba*. The latter species also figured in one Jamaican mixture (Ja09). Extracts of these plants are easily purchased via the web. A mixture sold at Benin's national airport (Be01) consisted solely of ginseng root and *Aloe vera* leaves. Consumers

of these 'globalized' aphrodisiacs were West African and Afro-Caribbean migrants, who must have become familiar with botanicals from other cultures in their new European or North American surroundings. Globalization and large-scale production of these multispecies drinks apparently leads to uniformity. On the other hand, the shift in ingredients also suggests that the quest for the perfect aphrodisiac has not ended yet.

4. Discussion

4.1. Multispecies bitter tonics: an African tradition?

According to Hernández and Volpato (2004), Africa has provided the main cultural contribution to the Cuban *materia medica*. In 19th century Brazil, many white males believed that Africans possessed an intimate understanding of sexual magic, especially herbal aphrodisiacs and philters (Walsh, 1831). As early as 20 October 1755, Linnaean student Daniel Rolander (2008) gave a detailed description of an alcoholic bitter in Suriname: 'the blacks' household drink (…) is a draught of rum in which highly bitter plant roots and bark, snake fragments, and the large, bare larvae of *Coleoptera*, and also the woolly and prickly larvae of butterflies have all been steeped for some time. The proper dose for an adult black man is one conical glass full of this liquid. It is a bitter drink—abominable to a conscious patient'. The origin of the Cuban mixture *pru*, drunk as digestive, blood purifier and cure for venereal diseases, was dated back to the 18th century, when African slaves from Haiti, Jamaica and the Dominican Republic came to work at the Cuban sugarcane and coffee plantations (Volpato and Godínez, 2004). Their favorite drink was known as 'root champagne', because of its color, flavor, ingredients and slightly fermented, foaming character. The African heritage of *pru* is reflected in its name, which is possibly derived from the word *okpurú* ('*Dioscorea* root') in several Nigerian languages (Burkill, 2000; Volpato and Godínez, 2004), a frequent tonic component in Nigeria, Colombia and Guyana. Other Caribbean drinks with African names are the spicy Cuban beverages *aloja*, derived from the Bantu terms *loha* (palm wine) and *sambumbia*, from the Bantu *mbi* for 'bad tasting' (Volpato and Godínez, 2004).

4.2. Amerindian influence

In the early decades of slavery, Africans and Amerindians lived and worked together (Voeks, 2009). Slaves put to work on remote plantations and Maroon communities had direct and frequent contact with local indigenous communities, who have prepared mild alcoholic drinks (cassava beer or *chicha* from fermented fruits) for centuries. Vernacular names like *bejuco de Indio* for the aphrodisiac liana *Gouania polygama* in the Dominican Republic and Cuba or the Arawak name *kapadula* for Dilleniaceae in Guyana are evidence for the exchange of ethnobotanical knowledge between Africans and Amerindians. In 1997, Carib Indians living in the interior of Guyana harvested roots and barks in the forest to sell to urban Afro-Guyanese as ingredients for their bitter tonics. Caribs called these bottles 'black man's medicine', something they hardly used themselves, but they reported several cases of poisoning among black Guyanese who collected the wrong species for their aphrodisiac mixtures. In spite of the popularity of bitter tonics among Afro-Guyanese, they were apparently not that familiar anymore with the crude ingredients as their ancestors who worked on the plantations bordered by forests.

4.3. European terminology

The European influence in the manufacture of bitter tonics is illustrated by the Haitian multispecies drink *tifey*, which has its origin in the adoption of the absinthe-based liquor drunk by French settlers on the island. The word *tifey* comes from the French *petit feuille*, referring to the small leaves of *A. absinthium*, its main ingredient (Volpato et al., 2009a). In the 1680s, physician and botanist Hans Sloane cured both white and black Jamaican women from venereal diseases by giving them an infusion of Madera wine and the roots of several imported European herbs (Churchill, 2005). Apart from having a Nigerian origin, the Cuban term *pru* might also come from the Haitian French *pousse*, an alcoholic digestive taken after a meal (Volpato and Godínez, 2004). The Trinidadian bitter tonic *mauby* originates from the French *ma bière* (my beer), and also refers to its principal ingredient *Colubrina elliptica* (Volpato and Godínez, 2004). The Cuban terms *galones*, the Surinamese *batra* and the Dominican *botellas* and *mamajuana* (from English *demijohn* and French *Dame Jeanne*) all derive from the glass bottles in which the bitter tonics were traditionally prepared. Other terms, like *waist and power mixture* (Ghana), *force de l'homme* (Benin), *pump it up* or *front end lifter* (Jamaica) or *bois bandé* ('hard (penis) wood') in the French Caribbean refer to the lust-enhancing properties of the drinks. Confusingly, no less than ten different species were being commercialized under the name *bois bandé*: *Roupala montana* (Proteaceae) in Grenada and Guadeloupe, *Richeria grandis* (Euphorbiaceae) in Martinique, Trinidad and Saint Martin, *Ptychopetalum olacoides* (Olacaceae), *Faramea lourteigiana* (Rubiaceae) and *Abuta grandifolia* (Menispermaceae) in French Guiana, *Strychnos* sp.TvA 4788 (Loganiaceae) in Suriname, *Chiococca alba* (Rubiaceae) in Cuba, *Zanthoxylum tragodes* (Rutaceae) in Saint Lucia, *Parinari campestris* (Chrysobalanaceae) in Trinidad, and *Chione venosa* var. *venosa* (Rubiaceae) in Grenada (Grénand et al., 2004; Hawthorne et al., 2004; Lans, 2006).

4.4. The genus Smilax

As early as 1535, Europe started importing China root (probably *Smilax glabra* Roxb. and *S. china* L.) from the Far East as a cure for syphilis (Sloane, 1707). Local Indians probably knew the medicinal properties of the many American *Smilax* species, but Europeans also recognized these prickly vines soon after their arrival in the New World. This is reflected in their local names (e.g., 'bastard China root' or 'chainey root') and in scientific names like *S. pseudochina* L., described in 1753 (Sloane, 1707; Grimé, 1976). In 1648, naturalist William Piso reported that Brazilian doctors prescribed local *Smilax* species as a substitute for the Chinese roots (Rolander, 2008). In the 1680s, Sloane reported the trade in *Smilax* roots between Jamaica and Honduras, Mexico and Peru. He considered the Jamaican roots to be of better quality than the original Chinese ones (Sloane, 1707). The root of the only African *Smilax* (*S. anceps* Wildd.) is used in West Africa as an aphrodisiac and diuretic for venereal diseases (Burkill, 2000), but no references were found of its use in multispecies drinks. Whether the displaced Africans recognized *Smilax* vines from their motherland or adopted their uses from local Indians or Europeans remains unknown. The present popularity of *Smilax* as an aphrodisiac and remedy against STDs must result from the exchange of indigenous, African, and European knowledge among the culturally diverse Caribbean population in the 17th century.

4.5. Geographical overlap in plant use

The results from our DCA and cluster analysis indicate that the variation in recipes is largely caused by geographical distance. The limited overlap in used species between West Africa and the Caribbean and the variation within individual countries on both sides of the Atlantic, suggest that people have reinvented their aphrodisiac mixtures many times in history. To find new ingredients of their favorite drink, enslaved Africans had to rely on the wild

and domesticated plants that surrounded them. Evidence for their successful experiments with a previously unknown flora is provided by the indicator species emerging from our cluster analysis. Several of them are local endemics, such as *Aristolochia consimilis* and *Curarea candicans* for the Guianas and *Trophis racemosa* and *Agave antillarum* for Central America and the Caribbean Islands.

Although New World mixtures contained more species from anthropogenic habitats than Old World ones, our results do not support the general assumption that Afro-Caribbean herbal medicine is poor in forest species and dominated by cultivated exotics and pantropical weeds. Recipes from the heavily forested Guianas contained high percentages of New World species, trees and lianas. Deforested countries like Cuba and the Dominican Republic contained more domesticated exotics and herbs from disturbed habitats, a trend also noted for other herbal mixtures in that region (Hernández and Volpato, 2004; Vandebroek et al., 2010). Weeds, however, did not dominate any of the recipes. Savannah plants were common in recipes from Ghana and Benin, and Old World rainforest species figured in recipes from Cameroon, Ivory Coast and Ghana. Medicinal plant selection is an ongoing process, humans adapt themselves with great flexibility to the available ingredients in new environments (Hernández and Volpato, 2004; De Medeiros et al., 2012). No recipes for multispecies drinks were recorded in times when there was more forest in Cuba and the Dominican Republic, so we do not know whether the use of forest plants in these mixtures has declined over time. However, we have shown that ingredients change when consumers migrate to Europe and the US and purchase aphrodisiac extracts from all over the world online.

Including introduced species and pantropical ruderals, the number of species shared between West Africa and tropical America has been estimated at 350–500, which is less than 1% of their total number of species. The two continents share 67% of their total number of families (Thorne, 1973). The percentage of Old World species in the American samples (4–71%) was higher than would be expected on the basis of the limited floristic similarity of the two continents. Thus, Afro-Caribbeans selected several American plants that were taxonomically related to familiar African species. They must have recognized Neotropical Annonaceae as spice-producing trees, since they were given similar local names, *pechereku* (in the Beninese Fon language) for *X. aethiopica* and *pedreku* in Surinamese for *X. discreta*. The discovery of the genus *Zanthoxylum* in the New World was also captured in its local name, *hé*, used for both *Z. zanthoxyloides* in Fon and for *Z. pentandrum* in a Surinamese Maroon dialect. However, the limited taxonomical similarity among recipes across the Atlantic does not support our hypothesis that New World recipes were *dominated* by transatlantic 'aphrodisiac' taxa. Although in recipes from some Caribbean Islands the percentage of species of Old World origin was high, these ingredients were different from the ones used in West African aphrodisiacs.

The importance of roots in Caribbean multispecies preparations may have an African origin, but the percentage of roots in the samples differed greatly between countries on both sides of the Atlantic. Mixtures from dry countries like Benin and South Africa consisted almost entirely of underground plant organs, while even in the Jamaican 'root tonics', less than half of the ingredients were represented by their roots. Similar percentages of roots were encountered in Cuban multispecies drinks that were not used as aphrodisiacs (Hernández and Volpato, 2004).

The diversity of bitter tonic mixtures in Africa is probably much higher, given the variation in recipes within and between Old World countries found during our study. The position of the Kwazulu-Natal mixture as an outlier suggests that there might be a continuum between Southern and West Africa, from which information on aphrodisiac mixtures is lacking. We know that bitter tonics are drunk in Zimbabwe (Ray et al., 1996), Uganda (Kamatenesi-Mugisha and Oryem-Origa, 2005), Nigeria (Olowokudejo et al., 2008), and Cameroon (Van Dijk, 1999; Takougang et al., 2008), but reliable information on botanical ingredients is scarce. Among the 69 species listed as aphrodisiacs in Cameroon (Noumi et al., 1998), the 'transatlantic genera' *Strychnos* and *Zanthoxylum* were represented with several species, but the authors did not specify whether plants were combined and soaked in alcohol or fermented. More information on aphrodisiac mixtures along the African West Coast and from New World countries with a substantial population of African descend (e.g., Brazil, Venezuela) would allow for a better overview of the diversity and similarities in recipes across the black Atlantic.

4.6. Unrelated plants with similar properties

The lack of taxonomic similarity among West African and Caribbean mixtures implies that slaves in the Americas have substituted African plants with unrelated American ones with similar morphological, organoleptic or pharmaceutical properties. The inclusion of phallic-shaped roots in Africa (e.g., *Spenocentrum jollyanum*) seems to have persisted in America with the use of adventitious palm roots. In both continents, a bitter taste is considered essential for specific therapeutic properties of herbal medicine (Abbiw, 1990; Vigneron et al., 2005; Volpato et al., 2009a). Moreover, the ability to drink very bitter remedies is seen as a clear sign of manliness (Odonne et al., 2007).

Several West African ingredients have proven to be effective aphrodisiacs, the roots of *M. whitei* significantly increase sperm density, testicular weight and testosterone in rats (Watcho et al., 2004), while *Securidaca longepedunculata* relaxes the smooth muscles of the erectile tissue (Marion Meyer et al., 2008). The effect of *Pausinystalia yohimba* extracts in the treatment of erectile dysfunction has been proven in randomized, placebo-controlled trials (Clark et al., 1984). Several of the spices added to multispecies drink to enhance their taste (e.g., nutmeg, *Aframomum melegueta*), appear to possess androgenic properties as well (Melnyk and Marcone, 2011). Apart from the anxiogenic properties of *Ptychopetalum olacoides* (Da Silva et al., 2002), evidence on the therapeutic efficacy of the many Caribbean aphrodisiacs on human erectile dysfunction has yet to be published (Awang, 2011; Melnyk and Marcone, 2011).

4.7. From syphilis cure to national drink

How should we understand the therapeutic purpose of aphrodisiacs in Africa and the Caribbean? Consumers of *botellas* in the Dominican Republic believed that combining plants in mixtures increased their potency and versatility as medicines (Vandebroek et al., 2010). However, since multispecies drink are often said to 'cure many illnesses', their use as aphrodisiacs was not always explicitly mentioned by consumers, which limited the number of samples we could analyze from the large pool of mixtures recorded in Cuba and the Dominican Republic (Hernández and Volpato, 2004; Volpato and Godínez, 2004; Volpato et al., 2009b; Vandebroek et al., 2010). Most mixtures from the Guianas were said to have diuretic, digestive and laxative properties as well, which could help to remove 'cold' from the body (Odonne et al., 2007; Van Andel and Ruysschaert, 2011). Cuban and Dominican informants referred rather interchangeably to aphrodisiac use as they did in reference to treatments for STDs, urinary tract infections and kidney problems (Vandebroek et al., 2010). These ailments of the reproductive organs were often related to the presence of 'dirt' inside a man's body, reducing his strength and his capacity to have intercourse and reproduce. Haitians and Dominicans believe that lack of strength and sexual potency is due to 'dirty blood' of dark red color. The blood must therefore be cleaned

through diuretics. In Ghana, bitter tonics are recommended to remove toxic substances like from heavy metals, cigarette smoke, pollution and pesticides from the blood and body. The belief in a tendency of the body to accumulate filth ('cold') in the blood, and in the properties of specific plants and preparations as blood purifiers is shared in African and Afro-Caribbean folk medicine (Laguerre, 1987; Abbiw, 1990; Vigneron et al., 2005; Van Andel and Ruysschaert, 2011). This belief is probably the main underlying reason for the popularity of bitter tonics and explains the eagerness with which the enslaved Africans reinvented their favorite medicine in the New World. Some of these mixtures are nowadays even promoted among tourists and citizens as a national drink, as in the case of Trinidadian *mauby*, Saint Lucian spice rum, Dominican *mamajuana* and Jamaican root tonics. The sale of these mixtures at airports and via diaspora food websites further illustrates the importance of these preparations as markers of a cultural identity (Volpato et al., 2009a). Still, patterns of use, composition, medicinal and cultural significance may continue to change in the future when Africans and Afro-Caribbeans migrate and adapt themselves to new natural and social environments.

5. Conclusions

The popularity of bitter tonics in the Caribbean suggests an African heritage, but the inclusion of Neotropical species and vernacular names of plants and mixtures indicate Amerindian and European influence. From the hundreds of different botanical ingredients, the limited overlap in species, genera and families between West Africa and the Caribbean and the variation within countries, we can conclude that enslaved Africans have reinvented their aphrodisiac mixtures wherever they were put to work, using the knowledge and flora that was available to them with great creativity and flexibility. Although it seems that they did search for species that looked like the African medicinal plants they knew, our results also suggest that they largely selected new species from the local flora, including forest trees, liana's and endemics. The 'globalized' recipes of bitter tonics sold among African migrants in Europe and the US reveal that the quest for the perfect aphrodisiac has not yet ended.

Role of funding sources

This study was funded by the Netherlands Organization for Scientific Research (NWO ALW-Vidi). The contribution of N. Raes was made possible by NWO - ALW grant 819.01.014. Student participation was facilitated by the Alberta Mennega Stichting. These funds had no involvement in the collection, analysis, interpretation of data, or on the publishing of the results.

Author's Contributions

TvA, SM, GV, IV, JS, SR and CR contributed fieldwork data. TvA and NR analyzed the data; TvA and GV drafted the manuscript. All authors revised the draft manuscript and read and approved the final version.

Acknowledgments

We thank wood anatomists Pieter Baas and Lubbert Westra for identifying part of our wood samples, Roy Erkens and Melvin Smith for supplying information from Saint Lucia and Christiaan van der Hoeven for his picture.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.jep.2012.08.008.

References

Abbiw, D.K., 1990. Useful Plants of Ghana. Royal Botanic Gardens, Kew.
Awang, D.V.C., 2011. Assessing the potential of Caribbean phytomedicinals. Focus on Alternative and Complementary Therapies 16, 281–284.
Burkill, H.M., 2000. The Useful Plants of West Tropical Africa 5. Royal Botanic Gardens, Kew.
Carney, J.A., Rosomoff, R.N., 2009. In the Shadow of Slavery: Africa's botanical legacy in the Atlantic World. University of California Press, Berkeley.
Churchill, W.D., 2005. Bodily differences? Gender, race, and class in Hans Sloane's Jamaican medical practice, 1687–1688. Journal of the History of Medicine and Allied Sciences 60, 391–444.
Clark, J.T., Smith, E.R., Davidson, J.M., 1984. Enhancement of sexual motivation in male rats by Yohimbine. Science 225, 847–849.
Cunningham, A.B., 1997. An Africa-wide overview of medicinal plant harvesting, conservation and health care. In: Bodeker, G, Vantomme, P. (Eds.), Medicinal Plants for Forest Conservation and Health Care. FAO, Rome, pp. 116–129.
Da Silva, A.L., Bardini, S., Nunes, D.S., Elisabetsky, E., 2002. Anxiogenic properties of *Ptychopetalum olacoide*s Benth. (Marapuama). Phytotherapy Research 16, 223–226.
De Medeiros, P.M., Soldati, G.T., Alencar, N.L., Vandebroek, I., Pieroni, A., Hanazaki, N., Albuquerque, U.P., 2012. The use of medicinal plants by migrant people: adaptation, maintenance, and replacement. Evidence Based Complementary and Alternative Medicine 807452, 1–11.
Grénand, P., Moretti, C., Jacquemin, H., Prévost, M.F., 2004. Pharmacope´es traditionnelles en Guyane: Creoles, Wayapi, Palikur. IRD Editions, Paris.
Grimé, W.E., 1976. Botany of the Black Americans.. Scholarly Press, St. Clair Shores.
Groover, M.D., Baumann, T.E., 1996. They worked their own remedy: African–American herbal medicine and the archaeological record. South Carolina Antiquities 28, 21–32.
Hawthorne, W.D., Jules, D., Marcelle, G., 2004. Spice Island Plants. Oxford Forestry Institute, Oxford.
Hermans, M., Akoègninou, A., Van der Maesen, L.J.G., 2005. Medicinal plants used to treat malaria in Southern Benin. Economic Botany 58, S239–S252.
Hernández, J.C., Volpato, G., 2004. Herbal mixtures in the traditional medicine of Eastern Cuba. Journal of Ethnopharmacology 90, 293–316.
Kamatenesi-Mugisha, M., Oryem-Origa, H., 2005. Traditional herbal remedies used in the management of sexual impotence and erectile dysfunction in western Uganda. African Health Sciences 5, 40–49.
Laguerre, M., 1987. Afro-Caribbean Folk Medicine. Bergin & Garvey Publishers, South Hadley.
Lans, C., 2006. Creole remedies of Trinidad and Tobago. Lulu.com, Port-of-Spain.
Long, C.M., 2001. Spiritual Merchants: Religion, Magic and Commerce. University of Tennessee Press, Knoxville.
Longuefosse, J.L., Nossin, E., 1996. Medical ethnobotany survey in Martinique. Journal of Ethnopharmacology 53, 117–142.
Marion Meyer, J.J., Rakuambo, N.C., Hussein, A.A., 2008. Novel xanthones from *Securidaca longepedunculata* with activity against erectile dysfunction. Journal of Ethnopharmacology 119, 599–603.
McCune, B., Grace, J.B., 2002. Analysis of Ecological Communities. MJM Software Design, Gleneden Beach.
Melnyk, J.P., Marcone, M.F., 2011. Aphrodisiacs from plant and animal sources: a review of current scientific literature. Food Research International 44, 840–850.
Mitchell, S.A., 2011. The Jamaican root tonics: a botanical reference. Focus on Alternative and Complementary Therapies 16, 271–280.
Ndhlala, A.R., Finnie, J.F., Van Staden, J., 2011. Plant composition, pharmacological properties and mutagenic evaluation of a commercial Zulu herbal mixture: Imbiza ephuzwato. Journal of Ethnopharmacology 133, 663–674.
Noumi, E., Amvan Zollo, P.H., Lontsi, D., 1998. Aphrodisiac plants used in Cameroon. Fitoterapia 69, 125–134.
Odonne, G., Bourdy, G., Beauchene, J., Houel, E., Stien, D., Chevolot, L., Deharo, E., 2007. From tonic-cups to bitter-cups: Kwasi bita beker from Suriname: determination, past and present use of an ancient galenic artefact. Journal of Ethnopharmacology 110, 318–322.
Olowokudejo, J.D., Kadiri, A.B., Travih, V.A., 2008. An ethnobotanical survey of herbal markets and medicinal plants in Lagos State of Nigeria. Ethnobotanical Leaflets 12, 851–865.
Ray, S., Gumbo, N., Mbizvo, M., 1996. Local voices: what some Harare men say about preparation for sex. Reproductive Health Matters 4, 34–45.
Rentería Jímenez, C.A., Lagarejo, M.A., Arriaga, R.C., Palacios, L.Y., 2008. Validación de tratamientos basados en medicina tradicional dirigidos a la cura de enfermedades de alta ocurrencia mundial y nacional. Instituto de investigaciones ambientales del Pacifico "John von Neumann", Quibdó.
Rolander, D., 2008. The Suriname journal: composed during an exotic journey. In: Hansen, L. (Ed.), The Linnaeus Apostles: Global Science & Adventure 3(3). IK Foundation, London, pp. 1215–1576.
Schiebinger, L., 2005. Prospecting for drugs: European naturalists in the West Indies. In: Schiebinger, L., Swan, C. (Eds.), Colonial Botany: Science, Commerce,

and Politics in the Early Modern World. University of Pennsylvania Press, Philadelphia, pp. 119–133.
Sloane, H., 1707. A voyage to the Islands Madera, Barbados, Nieves, S. Christophers and Jamaica. British Museum, London.
Takougang, I., Ngogang, J., Sihom, F., Ntep, M., Kamgno, J., Eyamba, A., Zouré, H., Noma, M., Amazigo, U., 2008. Does alcohol consumption increase the risk of severe adverse events to ivermectin treatment? African Journal of Pharmacy and Pharmacology 2, 77–82.
Telefo, P.B., Lienou, L.L., Yemele, M.D., Lemfack, M.C., Mouokeu, C., Goka, C.S., Tagne, S.R., Moundipa, F.P., 2011. Ethnopharmacological survey of plants used for the treatment of female infertility in Baham, Cameroon. Journal of Ethnopharmacology 136, 178–187.
Thorne, R.F., 1973. Floristic relationships between tropical Africa and tropical America. In: Meggars, B., Ayensu, E., Duckworth, W.D. (Eds.), Tropical Forest Ecosystems in Africa and South America: A Comparative Review. Smithsonian Institute Press, Washington DC, pp. 27–47.
Van Andel, T.R., Behari-Ramdas, J.A., Havinga, R.M., Groenendijk, S., 2007. The medicinal plant trade in Suriname. Ethnobotany Research and Application 5, 351–372.
Van Andel, T.R., Ruysschaert, S., 2011. Medicinale en rituele planten van Suriname. KIT Publishers, Amsterdam.
Van Andel, T.R., Maas,. P.J.M., Dobreff, J., (in press a). Ethnobotanical notes from Daniel Rolander's *Diarium Surinamicum* (1754–1756): Are these plants still used in Suriname today? Taxon 61.
Van Andel, T.R., Ruysschaert, S., Van der Putte, K., Groenendijk, S. (in press b). What makes a plant magical? Symbolism and sacred herbs in Afro-Surinamese rituals, In: Voeks, R.A., Rashford, J.H. (Eds.), African Ethnobotany in the Americas. Springer, New York.
Van Dijk, J.F.W., 1999. Non-timber forest products in the Bipindi-Akom II Region, Cameroon: a socio-economic and ecological assessment. Tropenbos-Cameroon Series 1, Wageningen.
Vandebroek, I., Balick, M.J., Ososki, A., Kronenberg, F., Yukes, J., Wade, C., Jiménez, F., Peguero, B., Castillo, D., 2010. The importance of botellas and other plant mixtures in Dominican traditional medicine. Journal of Ethnopharmacology 128, 20–41.
Vigneron, M., Deparis, X., Deharo, E., Bourdy, G., 2005. Antimalarial remedies in French Guiana: a knowledge attitudes and practices study. Journal of Ethnopharmacology 98, 351–360.
Voeks, R.A., 2009. Traditions in transition: African diaspora ethnobotany in lowland South America. In: Alexiades, M.N. (Ed.), Mobility and Migration in Indigenous Amazonia: Contemporary Ethnoecological Perspectives. Berghahn Publishers, London, pp. 275–294.
Volpato, G., Godínez, D., Beyra, A., 2009a. Migration and ethnobotanical practices: the case of tifey among Haitian immigrants in Cuba. Human Ecology 37, 43–53.
Volpato, G., Godínez, D., Beyra, A, Barreto, A., 2009b. Uses of medicinal plants by Haitian immigrants and their descendants in the Province of Camagüey, Cuba. Journal of Ethnobiology and Ethnomedicine 5, 1–16.
Volpato, G., Godínez, D., 2004. Ethnobotany of pru, a traditional Cuban refreshment. Economic Botany 58, 381–395.
Walsh, R., 1831. Notices of Brazil in 1828 and 1829. Richardson, Lord and Holbrook, Boston.
Wang, M., Lamers, R.A.N., Korthout, H.A.A.J., Van Nesselrooij, J.H.J., Witkamp, R.F., Van der Heijden, R., Voshol, P.J., Havekes, L.M., Verpoorte, R., Van der Greef, J., 2005. Metabolomics in the context of systems biology: bridging traditional Chinese medicine and molecular pharmacology. Phytotherapy Research 19, 173–182.
Warner, M., 2007. Herbal Plants of Jamaica. Macmillan Caribbean Publishers, Oxford.
Watcho, P., Kamtchouing, P., Sokeng, S.D., Moundipa, P.F., Tantchou, J., Essame, J.L., Koueta, N., 2004. Androgenic effect of *Mondia whitei* roots in male rats. Asian Journal of Andrology 6, 269–272.