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Untangling Biocultural and Socioeconomical Drivers of African Plum Tree (*Dacryodes edulis*) Local Nomenclature Along a Rural-Urban Gradient in Central Cameroon

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Abstract

In Cameroon, the African plum tree (*Dacryodes edulis* [G. Don] H. J. Lam) is widely cultivated for its fruits, which contribute significantly to household food security and economy. In order to analyze the links between the social and ecological systems that result in the remarkable fruit diversity, we focused on how the important varietal diversity of African plums was perceived and named by tree owners. We conducted semi-structured interviews in Center-Cameroon with 142 people belonging to the Beti ethnic group, in urban (Yaoundé), peri-urban and rural areas, and analyzed the data qualitatively and quantitatively. Along this urbanization gradient linking production to consumption regions, 158 different translated names were recorded. Most names (80%) were cited once, but some names based on fruit size and taste were common across the gradient. Although the highest total number of names was recorded in the rural site, many different names were also found along the urban–rural gradient. We did not detect difference in the number of named African plums between respondents with different characteristics. The local classification of African plums among the Beti was structured predominantly according to morphological and organoleptic criteria, but also to symbolic and practical criteria. African plums' names were based on people's fruit preferences, that favor large, oily, and blue to black fruits, and disregard pink-colored watery plums. This study is an entry point to explore the rising trade and thus ongoing domestication of the African plum tree from an often neglected perspective, that of local nomenclature.

Keywords Beti ethnic group · Central Africa · *Dacryodes edulis* · Domestication · Ethnobotany · Local nomenclature

Introduction

In view of the variability among living organisms, people name diverse animal and plant species. Systems classifying this diversity can be formal and scientific with the aim of universal validity, or local. Local classifications, also called folk classifications, are intuitive and experience-based, forged by a group of individuals who create their own logic of grouping, specific to a given environment. Local classification of biodiversity within crop species leads to the definition of 'ethnovarieties'. These ethnovarieties or "farmer's varieties" arise from the recognition and naming of intraspecific diversity by local people (Karambiri et al., 2017; Rivera et al., 2006). The nomenclature scheme is defined by the number of ethnovarieties, which is itself the result of cultural heritage and selection (Stampella, 2016). It is a key element to understand the intraspecific diversity of a species, as it is the basis on which farmers select individuals, so that,

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for each named type, their distinctive traits are preserved (Boster, 1985). Moreover, the number of ethnovarieties on which the nomenclature is based is affected by cultivation practices, which are themselves highly dependent on social, economic and cultural factors, and whose effect has rarely been considered (Adan et al., 2016).

Because local nomenclatures are based on phenotypic variations, they change throughout time, for instance to include new phenotypes and exclude those that have disappeared. Varietal names are not always consistent across regions, village communities or even within the same household (Appa Rao et al., 2002; Assogbadjo et al., 2008; Sambatti et al., 2001), and some varieties remain unnamed (Perales et al., 2003). The local nomenclature system is often based on the preference system of local communities (Mengue Efanden et al., 2003), with names being motivated, i.e., having an definite meaning. Local nomenclatures also result from two different dimensions of knowledge: theoretical knowledge, related to cognitive aspects ("I know the name of a variety, but I am not able to recognize or to describe it"), and practical knowledge, corresponding to the concrete application, skills and experience of this theoretical knowledge ("I know the name of a variety and I am able to recognize and describe it") (Reyes-García et al., 2007). As a consequence, a diverse local nomenclature is indicative of the diversity of uses, preferences and practices, for instance of seed and seedling exchanges, of local populations.

Dacryodes edulis, commonly known as the African plum (Burseraceae family), is one of the most traded non-timber forest products (NTFP) in Central Africa. Although recent and accurate data of trade flows between Central African countries are lacking, African plums are among the five main NTFP crossing national borders in the region (Tabuna, 2007). Cameroon is the leader in African plum's exportation, with hundreds of tons exported to Gabon, the Republic of Congo or Equatorial Guinea (Vunda, 2021). With its fruiting season extending over seven months of the year and its production alternating between north and south of the equator, it represents one of the most produced fruits in Central Africa, thus bringing a long-term source of food and income to local populations (Awono et al., 2002). The African plum is a major component of the Central African diet, notably in production regions where it is a staple food eaten roasted, boiled or dried and accompanied by cassava, corn or plantain (Tabuna & Tanoe, 2009). It is rich in lipids, proteins, vitamins, fatty acids and amino acids (Ajibesin, 2011; Tee et al., 2014) and can therefore be a significant source of energy for local populations. This emblematic Central African tree is mainly present in intertropical forest areas that offer favorable conditions for its cultivation, particularly in Southern Cameroon (Todou, 2015). It is abundant as an isolated tree in villages and in-home gardens, and as a shade tree in cocoa- or coffee-based agroforestry systems (Schreckenberg et al., 2002, 2006). A study by Jagoret et al. (2014) cites *D. edulis* as the only species found in all the cocoa farms inventoried in Central Cameroon. It is also one of the most common indigenous species in the urban area of Yaoundé (Mala, 2009).

The African plum shows a wide spectrum of diversity in terms of color, shape, size and taste (Anegbeh et al., 2005; Kengue et al., 2002; Leakey et al., 2002; Waruhiu et al., 2004). This phenotypic diversity can primarily be explained by the multiple selection pressures oriented by local agricultural practices (Leakey et al., 2002; Rimlinger et al., 2019), in conjunction with the allogamous reproductive system of the species (Kengue et al., 2002). Due to its highly traded fruits, the African plum tree has been well studied for breeding, domestication, cultivation and management aspects but there are still few studies about its local nomenclature system: the ones published refer to names given by different ethnic groups (Chevalier, 1949; Omonhinmin, 2012). Recently, it has been shown that the nomenclature used by three Cameroonian ethnic groups was highly varied for this species, especially for the Beti (Rimlinger, Duminil, et al.,2021). Beti indeed cited half of the names identified in this study (58% of the recorded local names), calling for a detailed account of the nomenclature for this group, and of the varieties that fall outside of it. There is also a need to recognize cultivators' knowledge and preferences within the pool of varieties they maintain in their field; this is especially crucial in places integrated to commercial trade, as trade can focus on some phenotypes and hence prompt more selective dynamics. We address this by following one value chain of African plums in Central Cameroon, stretching from the urban consumption area of Yaoundé to the rural production area connected to it, and by considering the specific preferences associated with its trade.

The aim of this study is to describe the African plum nomenclature system and analyze its rationales and drivers. We do so among the Beti people, one Cameroonian ethnic group heavily involved in the cultivation of this species, and along an urbanization gradient including an urban, a peri-urban and a rural zone. Our first objective (1) is to explore the breadth of the local Beti nomenclature in each site including varieties that evade this nomenclature (unnamed varieties), and its links with socio-economic variables of African plum tree owners. Considering that traditional knowledge can vary with social characteristics and urbanization status of owners (Aswani et al., 2020; Gandolfo & Hanazaki, 2014), we specifically expect more varieties to be named in rural areas by older owners. Then, we further employ the classification scheme with the different classes of names observed, aiming at our second objective (2), to know how their distribution varies along the urbanization gradient. In our last objective (3), we

finally investigate the drivers of Beti local nomenclature in the light of its current trade, in particular through the fruit preference system.

We hypothesize that the weak selection of trees and seeds, as clonal reproduction is infrequent and cultivators keep trees even when they lack the right morphotype, the important networks of exchanges, and the allogamous reproduction system of this species favor a particularly rich nomenclature system in each site along the urbanization gradient (Rimlinger, Duminil, et al., 2021). We expect local varietal names to be linked to a range of motivations related to the organoleptic and morphological preference system of the fruit. Given the central place of Yaoundé in the African plum trade, we expected a majority of names motivated by the taste or the size of the fruit. Looking specifically at the distribution of those names along the gradient, we hypothesize that shared names reflect ongoing exchanges of information between Beti, which could illustrate the ubiquity and cultural significance of this species of fruit tree from rural to urban sites. Finally, we discuss the idea that the rich local nomenclature, because of its diversity of names, can also be the reflection of an existing artificial selection and therefore of a domestication in progress.

Material and Methods

Study Site

This study was carried out with Beti people in the Centre region of Cameroon, along an urbanization gradient, composed of an urban, a peri-urban and a rural site (Fig. 1). People and languages classified as Beti (or Fang), pertaining to Bantu-speaking populations, are diversified. Beti language includes many dialects such as Bebele-Bebil or Bulu-Bene, which are mutually intelligible (Zamponi, 2009). As this study focuses on the region around the capital city of Yaoundé, mostly Eton and Ewondo were considered among Beti dialects. These locally dominant cultural linguistic groups were chosen because of their involvement in one of the major African plums value chains in Central Cameroun

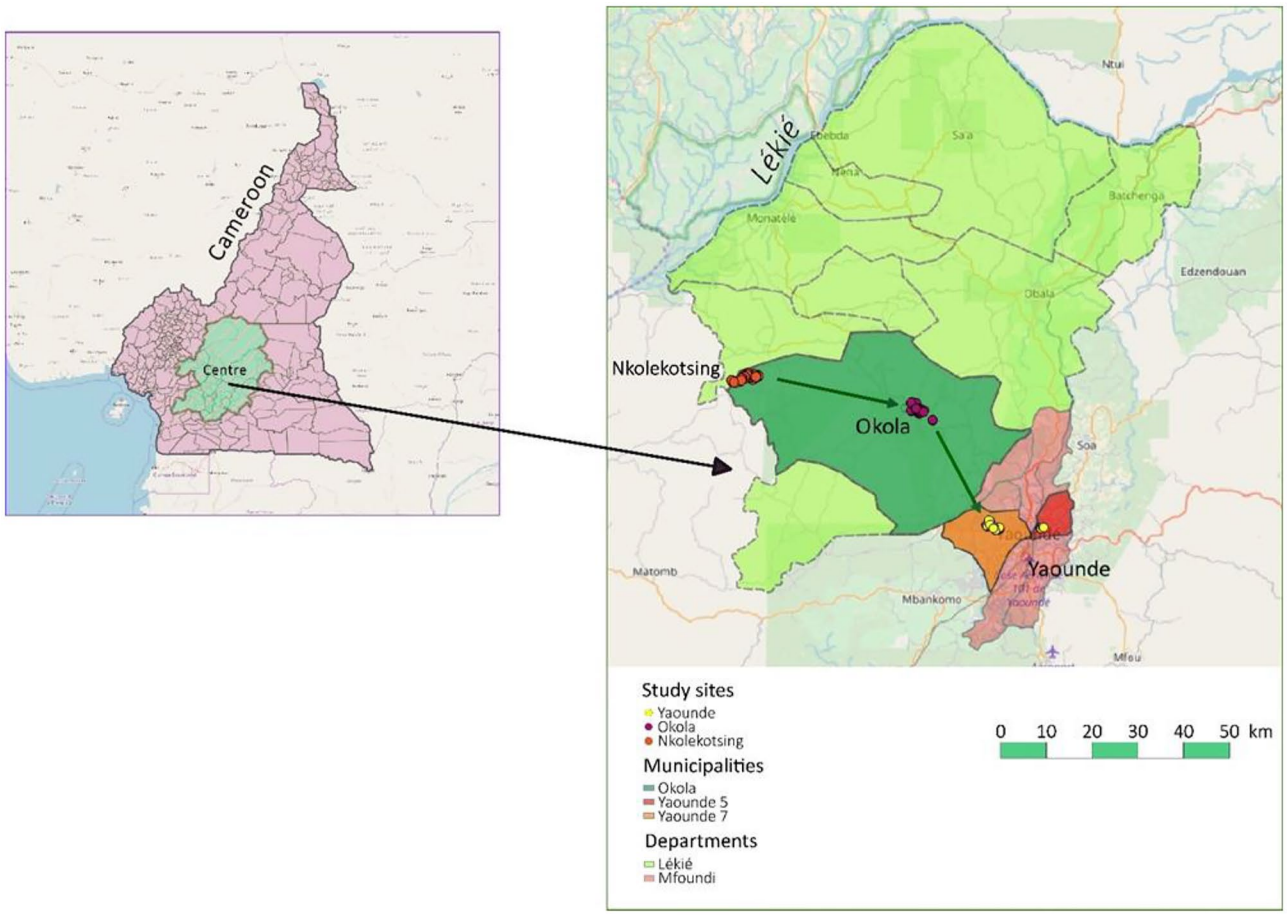

Fig. 1 Map illustrating the survey area along a city-countryside gradient in Cameroon. Study sites were precisely located at the following coordinates: Yaoundé (3° 52′ 0.001" N 11° 31′ 0.001" E), Okola (4° 1′ 0" N, 11° 22′ 60" E) and Nkolekotsing (4° 3′ 36" N, 11° 10′ 48" E)

(Awono et al., 2002). The Eton are strongly represented in the Lékié department, North of the capital of Yaoundé (Van de Velde, 2008).

The three sites chosen along an urbanization gradient were: 1) the Oyom-Abang district in the Yaoundé city area (urban site); 2) the town of Okola, in the Yaoundé conurbation (peri-urban site); 3) the village of Nkolekotsing, in an isolated rural area chosen to be out of the direct influence of the city of Yaoundé, and especially out of the influence of the main road from Okola to Yaoundé (rural site; Fig. 1). Sites were chosen to ensure that Beti people were the majority group, in order to avoid a confounding effect between the ethnic group and the gradient.

A preliminary study of the African plum's value chains around the city of Yaoundé highlighted the main peri-urban areas involved in the production of plums that supply Yaoundé markets (Awono et al. in prep.). Among these areas, the rapidly expanding town of Okola is located in the Yaoundé conurbation, 32 km away from the city center. The peri-urban area was defined as being less than 50 km from Yaoundé and within the strong influence of the capital, with regard to its trade (Temple & Moustier, 2004): the city dwellers of Okola easily go to the capital for work or to sell their crops. Finally, the rural village of Nkolekotsing, 32 km away from Okola, was selected owing to its significant role in the cultivation of African plum trees, as informed by preliminary interviews in Okola. The majority of the 1500 inhabitants (census of 2018; MINEPAT & PDNP, 2018) of the village actively cultivates African plum trees and sells its different varieties.

Data Collection

In order to obtain collective and individual knowledge, we conducted several focus groups during four months of field work; 43 individual interviews in the urban site, 50 in the peri-urban site and 49 in the rural site. A consent form has been signed by all of the people surveyed.

Interviews focused on local nomenclature (the template used is provided as Supplementary Electronic Material 1). In general, plant local nomenclature is based on a series of well-known morphological descriptors, but also on perceived descriptors, that are more labile or subjective (e.g. fruit taste; Boster, 1985).

In this study, we also pay attention to the knowledge gap, by considering the varieties that are known or observed but not (yet) named. To do so, we asked the respondents during individual interviews about the varieties of African plum trees they knew ('known' varieties) or had planted ('observed' varieties) on her/his property and about the detailed morphological and organoleptic description of their fruits (including fruit taste and texture; also see Rimlinger, Duminil, et al., 2021; Fig. S1 and Table S1), leading to six characteristics described by ethnovariety (fruit size, skin color, fruit shape, pulp color, texture and taste). We then asked for the names of these ethnovarietes (in Beti language and their translation in French), and these names could be known ('named' variety) or unknown ('unnamed' variety). Translations were carried out in French by the respondents themselves during most interviews, or sometimes by a third person (a relative). One of the researchers spoke Eton and could thus validate the proposed translations. Untranslatable (and thus unclassifiable by us) names were removed from the study. Additionally, questions targeted related knowledge about agricultural practices, fruit conservation, fruit preferences (desirable/undesirable fruit characteristics when buying an African plum fruit) and marketing of the African plums. For each interview, the respondent was questioned on his/her status (gender, age, family and residence status, ethnicity, main activity) and on the attributes of the household's fields (field size area, number of fruit tree species).

We chose people who owned at least one plum tree in their field or home garden as respondents and did so through a snowballing sampling. We conducted a total of 142 interviews with a balanced number of men and women (53% and 47% respectively), as well as seven focus groups in the three study sites. Focus groups aimed to present the researchers, the research project and its objectives to local populations in the different sites: although data collected during focus groups were not used per se, they helped understand the local context regarding history, cultivation, consumption and marketing of African plum in the different sites. The age of respondents ranged from 16 to 94 years old. The sample was relatively homogeneously distributed between age groups,

Table 1 Summary of the socio-economic characteristics of respondents as a percentage of the total for each category (age, gender) along the urbanization gradient. The Total line and column represent the total number (N) of respondents per socio-economic characteristic and site

Site	*Age (years)*				*Gender*		
	[0 ; 25]	**]25 ; 50]**	**]50 ; 75]**	**]75 ; 100]**	**Men**	**Women**	**Total (N)**
Urban	25	42	28	5	47	53	43
Peri-urban	28	42	24	6	60	40	50
Rural	27	45	24	4	51	49	49
Gradient	27	43	25	5	53	47	
Total (N)	38	61	36	7	75	67	142

with the dominant age group of respondents between 25 and 50 years old (Table 1). Most of the respondents in the peri-urban and rural sites were cultivators of fruit trees and market gardening crops, and sometimes went to sell them in Yaoundé or in local markets.

Local Nomenclature Classification

From the French translations of the names collected in the local language, the local names were classified into major naming classes, according to their linguistic motivation. All of the names that could not be translated by the respondents (12 local names) or that were too generic (e.g., the local name *sa'a* which only means "African plum") weren't considered. From the local names designating the ethnovarieties, we defined four naming classes of linguistic motivation: morphological, organoleptic, symbolic and topographic. Linguistic motivation of variety names does not concern the African plum variety as a biological object, but rather the way in which the names of varieties are linguistically constructed, by using either morphological, organoleptic, symbolic or topographic feature.

These four main classes of linguistic motivation were defined by us a posteriori to encompass the different types of motivation behind local names and were independent of the six morphological and organoleptic characteristics of varieties. For each ethnovariety, the descriptors (fruit size, skin color, pulp taste, …) and their modalities (black color, white color, small size, large size, good or bad taste, i.e., sub-classes) were given by respondents and could be, or not, informative of local names. They were systematically collected in order for us to understand the logic of the local nomenclature.

Data Analysis

All data analyses were performed using the statistical software R version 3.6.1 (R Development Core Team, 2005). Following our hypothesis on the decrease in varieties named with younger age and proximity to urban center, the socioeconomic characteristics of the respondents that could influence the number of African plum ethnovarieties named in the central region of Cameroon (objective 1) were analyzed using a Poisson regression model with a *glm* function from *stats* package. The dependent variable is the quantitative variable that counts named varieties for each person. The explanatory variables include the age, a continuous quantitative variable; the site, a categorical variable with three indicators; the average number of varieties observed and known per individual, which is a discrete quantitative variable. In order to obtain the most parsimonious model, we proceeded to the reduction of our model (forward selection) and thus chose the model with the lowest Akaike Information Criterion (AIC). A chi-square analysis was performed to establish whether there was a significant difference for the respective proportions of local names given for each of the naming classes (morphological, organoleptic, symbolic and topographic) between sites along the gradient (objective 2).

To analyze the link between the six morphological and organoleptic characteristics of African plum varieties and the naming classes (morphological, topographic, etc.) in order to objectivate the preference system (objective 3), we carried out a multiple correspondence analysis (MCA), a method of factor analysis adapted to qualitative data. A three-dimensional space was obtained with the function *dudi.acm* from *ade4* package. The four naming classes (morphological, organoleptic, symbolic and topographic) were added as additional variables to analyze their association with the six morphological and organoleptic characteristics of African plum varieties, without a direct contribution to the MCA axis construction.

Based on consumer responses on their fruit purchase preferences (desirable or undesirable morphological and organoleptic fruit characteristics), we identified key descriptors (fruit size, skin color, pulp taste,…) and sub-classes (black color, white color, small size,…) predicting purchase that may constitute motivations in the nomenclature of African plum and explains the dominance of some descriptors in local nomenclature (objective 3). The decision tree (DT) designed in the present study was based on the standard CART algorithm build with the function *rpart* from the package *rpart* (Therneau et al., 2013). The DT is a tree-like structure, where each internal node denotes a test on an attribute, each branch represents conjunctions of input features that resulted in those outcomes of the test, and each leaf node (terminal node) holds a class label. The two classes are fruit purchase (1) or rejection of fruit purchase (0).

Results

Beti African Plum Nomenclature: A Diversity of Local Names

Named and Unnamed Varieties Along the Gradient

At the species level, the people interviewed commonly refer to the species *D. edulis* as either "prunier" in French or "sa" in Beti. At the intraspecific level, a total of 173 different local names (ethnovarieties with a Beti origin, whether translated or not) were cited along the gradient (out of a total of 276 local names collected; Fig. 2 and Table S1). They were cited during interviews at home, based on memories (both from "known" and "observed" varieties). Local names were recorded in all sites along the gradient. Rural site had the highest total number of names, with 79 different names of which 16 were cited twice or more (a cited total of 121 names). It was followed by the peri-urban site,

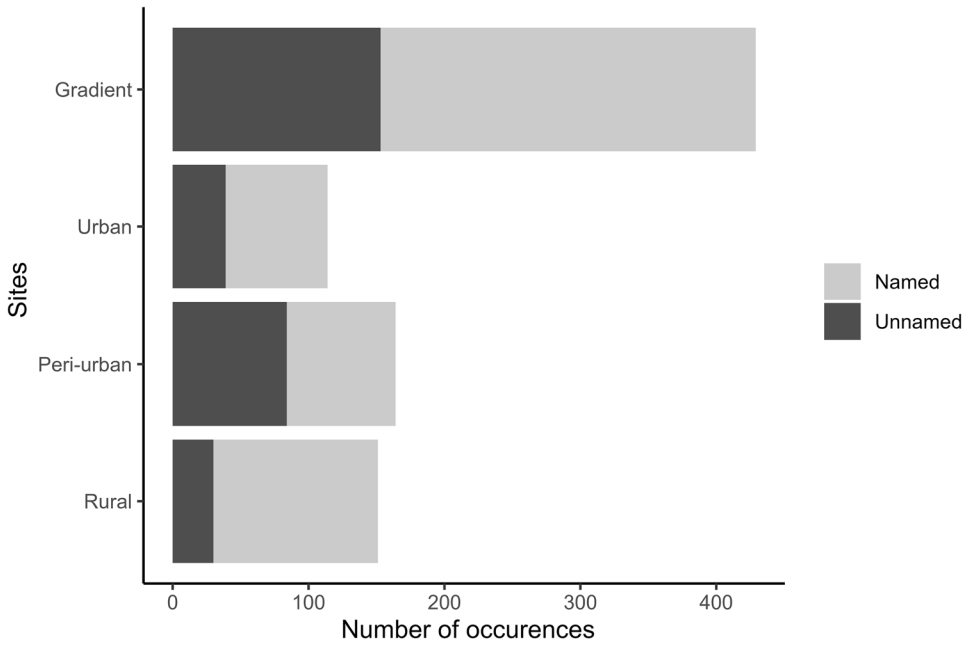

Fig. 2 Number of named and unnamed Beti varieties along the gradient, both from "known" and "observed" varieties

with 53 different names of which 13 were cited multiple times (80 names in total) and the urban site, with 59 different names of which 7 were cited multiple times (75 names in total). Higher numbers of unnamed varieties (both from "known" and "observed" varieties) were mostly recorded in the peri-urban site (84 varieties) and urban (39 varieties) site whereas only 30 unnamed varieties were found in the rural site (Fig. 2; see Table S2 for the number of named and unnamed in observed or known varieties according to the socio-economic variables).

Named and Unnamed Varieties According to the Socio-Economic Variables

Age, gender and farming activity did not provide additional information to explain the average number of African plums named and were therefore excluded through the model selection method. The site had a significant effect ($p < 0.001$; Table S3) on the average number of African plums named per person with an alpha risk of 5%. In both the peri-urban and in the urban site, there were fewer named varieties on average per individual compared to the rural site (Tukey method: $p < 0.001$). Additionally, we found a significant association ($p < 0.001$; Table S3) between the average number of "observed" and "known" varieties per individual and the average number of African plums named per person with an alpha risk of 5%. On average, "observed" varieties were less named than "known" varieties per individual in our gradient.

Local African Plum Classification Scheme

Naming Class and Characteristics Used by Beti People

Across the gradient, a total of 158 translated different local names were listed at least once. The collected names of ethnovarieties were related to one of the four naming classes or linguistic motivations considered (Table 2; for the exhaustive list of variety names see Table S1): (1) morphological (fruit size, shape, color of skin and pulp, pulp thickness; 46%), which can be illustrated, for example, by the name of *apouma sa'a* meaning 'white plum', (2) organoleptic (fruit taste and smell, oily or watery texture of the pulp; 23%), such as the name *bissono*, which translates to 'tears', suggesting the fruit's extreme sourness; (3) symbolic (linked to the family or tree's history, linked to a special event of the tree or the people, metaphoric name of cultivators or the trees; 20%), like the name *ntongo benui* meaning 'the foster mother'; and (4) topographic (characteristics of the environment in which the plum tree is planted, or its geographic description; 12%), for instance, the name *zang i keukeu* designating the 'middle of the cocoa farm' and *milo'midouk*, translated as 'toilet fly', referring to the place where the waste is put, often located at the back of the kitchen, between the house and the cocoa farm. The first three naming classes are further broken down into different sub-classes, whereas the topographic class is not (Table 2).

Table 2 Local classification of naming classes, cultivators' descriptors and sub-class examples. The frequency per descriptor corresponds to the descriptor's proportion among all the names along the gradient. The frequency of sub-class corresponds to the sub-class proportion among the naming classes. To characterize these naming classes, we only worked with names that had a translation

Naming class	Descriptor	Frequence (%)	Sub-class	Frequence (%)
Morphological	Fruit size	29.7	Large fruit	40
			Small fruit	24
	Fruit shape	6.6	Long fruit	9
			Short fruit	2.5
			Original fruit	2.5
	Skin colour	5.8	White skin	7.6
			Black skin	2
			Mottled skin	2
			Special skin	2
	Pulp colour	2.7	Red pulp	5
			Green pulp	0.8
	Pulp thickness	1	Fleshly pulp	2.5
Organoleptic	Fruit taste	17	Good fruit	34.5
			Sour fruit	41.4
	Pulp texture	5	Watery pulp	3.5
			Oily pulp	17
	Fruit smell	0.8	Anst smell	3.5
Symbolic		19.7	History	35
			Planter's name	28
			Name of a third party	37
Topgraphic	Environment	12		

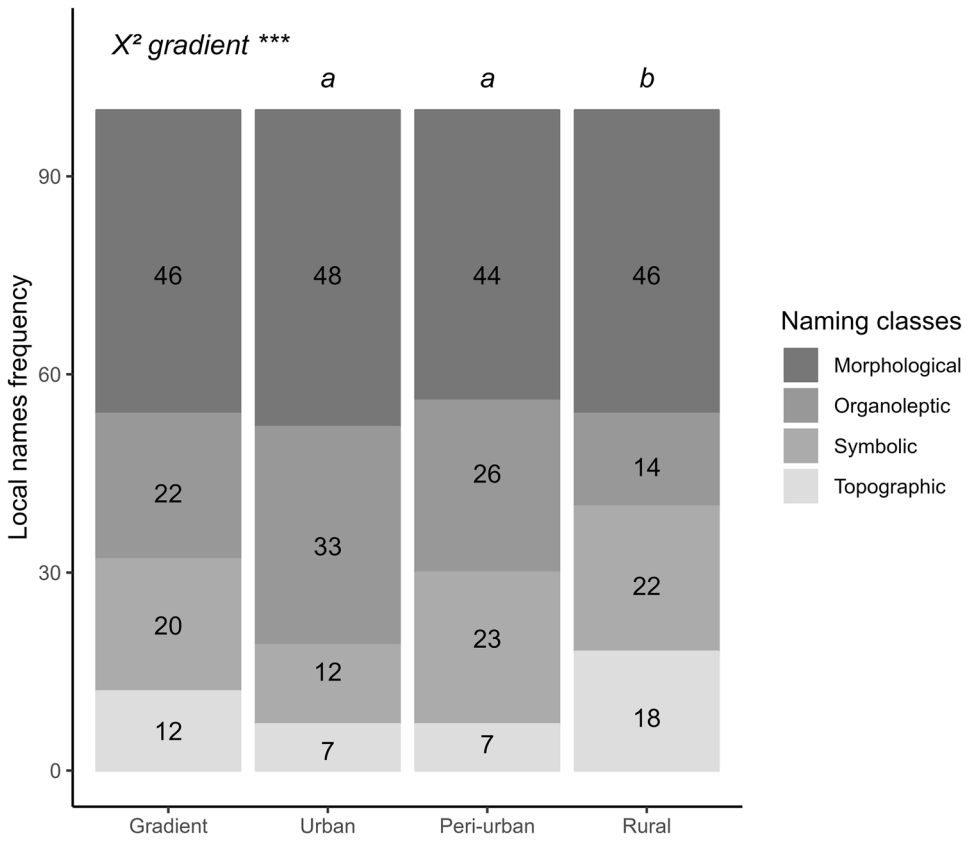

Fig. 3 Proportion of local names for the entire dataset and for each site individually. The results of the chi-squared test are represented by letters (sites sharing the same letter indicate no significant differences). $p < 0.05$ *, ** $p < 0.01$; *** $p < 0.001$. The X^2 gradient corresponds to differences in naming classes along the gradient

Naming Classes, Descriptors and Sub-Classes Along the Gradient

Significant differences were observed in the respective proportions of local names given to each naming class (morphological, organoleptic, symbolic and topographic, Fig. 3) between urban site and rural site (X^2; $p < 0.01$) and peri-urban site and rural site (X^2; $p < 0.05$). Overall, along the gradient, there was a significant difference between the different proportions of naming classes cited (X^2; $p < 0.001$).

The morphological naming class was consistently the most significant naming class along the gradient, but it was higher in the urban site (48% of varieties), than in rural and peri-urban sites (Fig. 3). Among the respondents, 46% cited at least one name that included morphological features. Some morphological features such as fruit size and skin color, which respectively had two and four sub-classes, were frequently used, accounting for 29.7% and 5.8% of all the names. Other features were less commonly used to motivate the variety names (such as pulp thickness, 1%; Table 2). Compared to the morphological naming class, the organoleptic naming class was less frequently used to motivate the variety names along the gradient (22%). Varieties' names were mainly motivated according to fruit taste (17%). The organoleptic naming class was predominantly used in the urban site, with 33% of local names construction based on organoleptic features while it was less represented in the rural site (14%) (Fig. 3). The symbolic naming class accounted for 19.7% of the listed names (Table 2). The most important symbolic sub-classes referred to names of people (13% of all the names) and to the personal history of the people interviewed (i.e., themselves, their family, or their family tree, 7% of all the names). This personal history subclass was mainly represented in the peri-urban site, with 14% of total peri-urban names, whereas it accounted for only 4% of the total in the urban site (Fig. 3). The topographic naming class corresponded to 11% of the names (Fig. 3). This naming class was mainly used in the rural site (17% of local names) while it was marginally used in the urban (7%) or peri-urban site (7%).

Redundancy of Local Names Along the Gradient

A high proportion (80%) of local names were cited only once. However, the occurrence of citations within each site varied, ranging from one to 23 citations; the highest number was recorded in the rural site for *leboack*, a morphological name meaning 'squash'(Table 3). This ethnovariety corresponded to a large and oily plum, that was reported to be particularly tasteful. Some of these local variety names were not only present in a single site but were shared between sites (7.6% of the total different local names along the gradient). Seven local variety names were shared between two sites: four were shared between the peri-urban and the rural sites, one was shared between the urban and the rural sites, two were shared between the urban and the peri-urban sites. Five ethnovarieties were named in all three sites: *leboack,* accounted for 9% of citations along the gradient, *mononone* (5.7%), *saang* (3.4%), *lebin ntomo* (2.7%) and *midjono* (1.1%).

Conceptualizing the Local Nomenclature Scheme

The naming of cultivated varieties is influenced by dynamic and contemporary social processes, involving the exchange of seeds, their names, and other associated information. Due to the nutritional value and extensive phenotypic diversity of African plums in terms of shape, color, size and taste, local nomenclature is based on various fruit morphological and organoleptic features. These criteria enable people to name

Table 3 Local names shared between two or three sites along the gradient, their naming class, translation, and percentage of citations among the set of local names collected along the gradient and translated

African plum's name	Translation	Naming class	Sites where the variety name was collected	Citation (%)
Abeng	The beauty	Organoleptic/ Morphologic	Peri-urban/Urban	1.9
Avieu levong	Red fat	Morphologic	Peri-urban/Urban	0.8
Ayap sa'a	The long plum	Morphologic	Peri-urban/Urban	0.8
Ikoum ibey	A short "ibey" tree trunk	Topographic	Rural/Urban	1.1
Itobo	The big plum	Morphologic	Peri-urban/Urban	2.3
Lebin ntomo	Sheep's testicles	Morphologic	Rural/Peri-urban/Urban	2.7
Leboack	Gourd	Morphologic	Rural/Peri-urban/Urban	9
Midjono	The tears	Organoleptic	Rural/Peri-urban/Urban	1.1
Mintongo	The long plum	Morphologic	Peri-urban/Urban	2.7
Mononome	The bird's plum	Morphologic	Rural/Peri-urban/Urban	5.7
Parla	Behind the house	Topographic	Peri-urban/Urban	0.8
Saang	The sour fruit	Organoleptic	Rural/Peri-urban/Urban	3.4

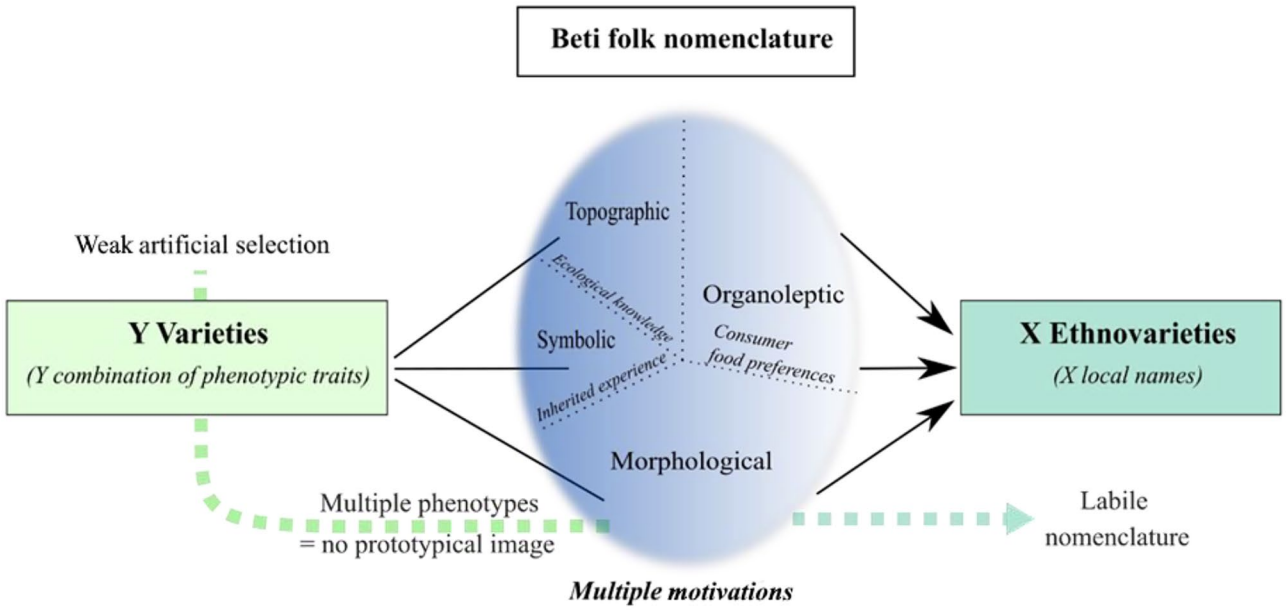

Fig. 4 General diagram (the size of each pie fraction is not scaled) illustrating the different criteria involved in naming the African plum among the Beti people and the relationship between domestication and local nomenclature. The phenotypic variation of African plums, resulting from a weak artificial selection, leads to a proliferation of names, making it challenging to establish a consensus in nomenclature

and distinguish between different types and tastes of fruit within this wide range of perceived fruit variability (Fig. 4).

The Food Preference System: Driver of African Plum Nomenclature

African Plum Varieties' Characteristics and Correspondences with Naming Classes: Fruit Quality Indicators

The MCA, used to see the links between the different morphological and organoleptic characteristics of African plums, had its first two axes representing 24.9% of the total variance (Fig. 5).

The maximum contributions for the first axis were observed for the characteristics of watery pulp texture (22.6%), bad taste (19%), red pulp color (14%) and pink skin color (6%). The first axis effectively distinguished between plums with good taste on the left and plums with bad taste on the right. Characteristics associated with bad taste included pink skin color, red flesh color, and a high-water content. For the second axis, the maximum contributions were observed for the characteristics of spherical shape (26%), small size (23%), dry pulp texture (12.7%) and large size (10%). The second axis effectively differentiated between large plums at the top and small plums at the bottom. The morphological, topographic, and symbolic naming classes were located close to each other in the center of the space. The morphological and topographic naming classes were closer to the center and characterized by good-tasting plums with blue skin color, white flesh color and medium size. Ethnovariety names related to symbolic naming class, in the center of the graph, were not associated to specific morphological or organoleptic fruit characteristics. Ethnovariety names related to organoleptic criteria appeared to be linked to large average-tasting plum with a conical shape and a violet or two-colored skin. The variety names provided characteristic information that represents the quality of the fruits which influences the decision to purchase or not.

Purchase Preferred Characteristics

Among the 16 potential predictors, the decision tree identified four descriptors and eight sub-classes as key criteria in predicting purchase behavior: fruit taste (tasty/sour), fruit size (large), skin color (blue, pink, white, black), and pulp texture (oily pulp) (Fig. 6). The CART decision tree achieved a correct prediction of purchase or rejection in 88.4% of cases in the training datasets and 87% in the test datasets (cross-validation). The decision tree determined that all interviewed individuals, except one would buy a tasty fruit. Furthermore, if the fruit was both tasty and large, ten people would purchase it. Similarly, if the fruit had skin color other than pink (white, blue or black) and was considered oily in texture, it would be purchased by 104 individuals. The three most important morphological characteristics for fruit rejection were bad taste, followed by small size and pink skin color.

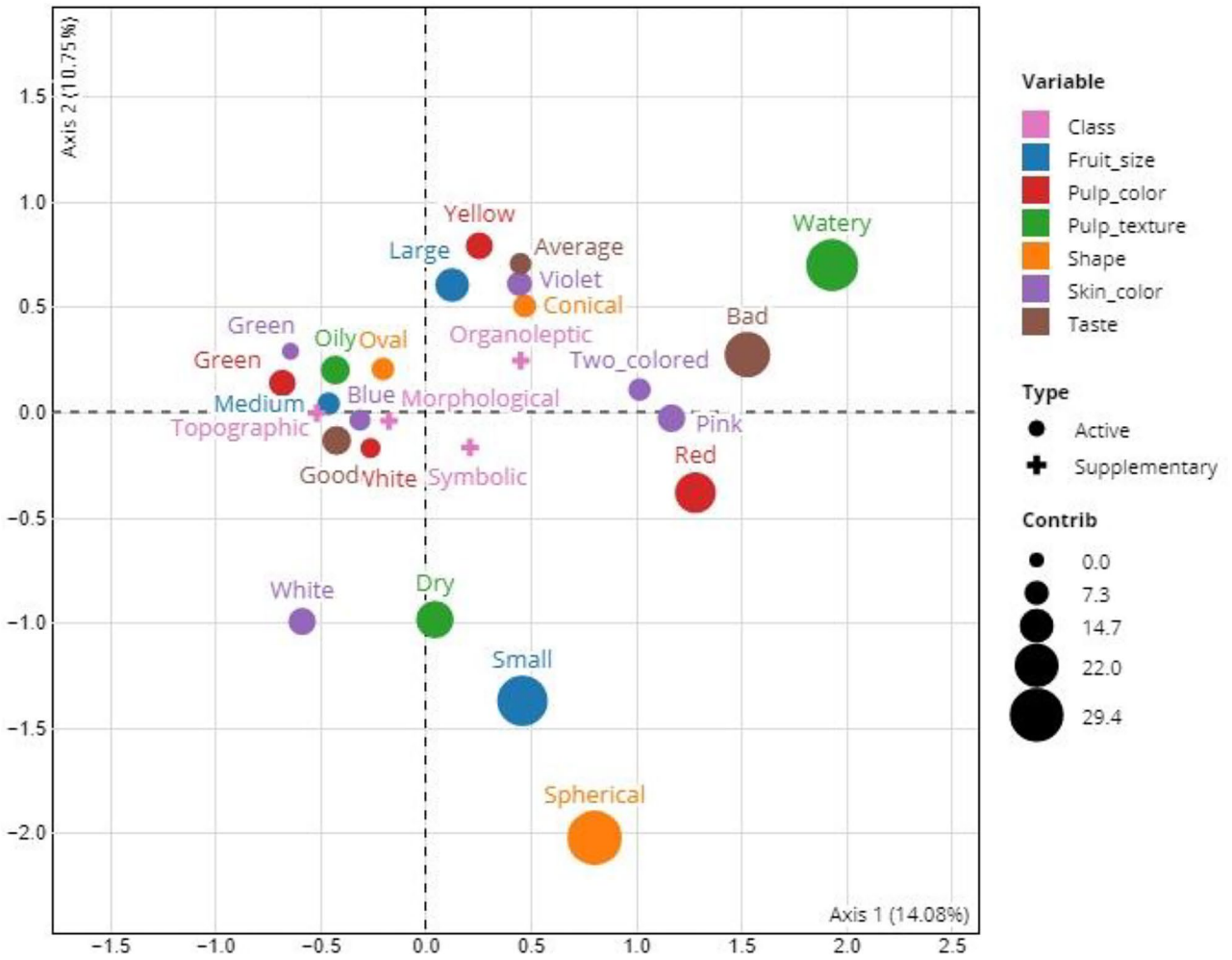

Fig. 5 Multiple correspondence analysis (MCA) based on six morphological and organoleptic characteristics of African plum varieties namely fruit size, skin color, shape, pulp color, texture and taste. The ethnovariety naming classes (morphological, organoleptic, symbolic and topographic) are represented as an additional variable (highlighted in pink color and labeled as supplementary type). The size of each circle corresponds to the contribution of the respective variable to the inertia along each axis

Discussion

In this study, through surveys of 142 Beti people along an urbanization gradient in Cameroon, we uncovered a rich local nomenclature for the African plum. After recording these numerous names, we aimed to understand the underlying logic and motivations behind its nomenclature. Our findings revealed a rich diversity of 158 ethnovarieties of African plum, identified across rural, peri-urban and urban sites. The cultural importance of this fruit tree species but also the booming demand linked to the trade and consumption of African plum have been identified as major drivers of the richness of local names and of the logic of this nomenclature. Lastly, the linguistic diversity and the phenotypic diversity of the African plum are mutually related and assessing the status of each of these diversities in relation to the others can constitute a means of evaluating the selection pressures on fruit tree.

Local African Plum Nomenclature Rooted in Cameroonian Territories and Beti Knowledge

In the Center region of Cameroon, our study revealed an exceptional richness in local nomenclature for the African plum, among the Beti people. We documented a total of 158 different local names, including both known and observed varieties (with a French translation), along the urban, peri-urban, and rural gradient. Such diversity in local names within a single ethnic group is quite remarkable, as previous studies demonstrating a such richness typically involve regions with a mix of cultural and linguistic groups (Agbo et al., 2020; Assogbadjo et al., 2008; Gwali et al., 2011; Jianchu et al., 2001; Mekbib, 2007).

This study observed that people were able to cite names of both observed and known varieties, indicating the widespread presence and cultural significance of the African

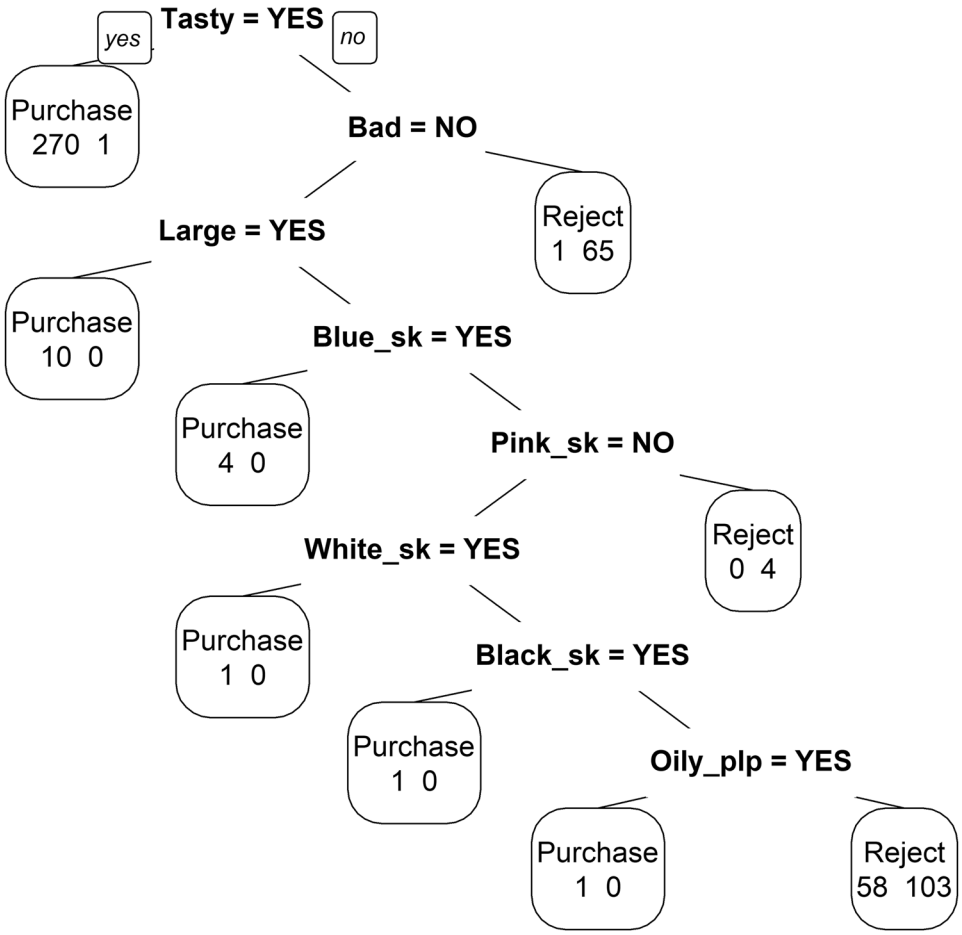

Fig. 6 Decision tree model, which displays the hierarchy of splits with eight branch nodes and nine leaf nodes based on eight characteristics. A total of 16 descriptors were used to build the tree. The label "Reject" corresponds to the rejection of fruit purchase (0), and the label "Purchase" corresponds to fruit purchase (1). Sk = skin; plp = pulp. For each label, if it is a rejection label (on the right side of the decision tree), the first number corresponds to the count for rejection and the second for non-rejection, if it is a purchase label (on the left side), the first number corresponds to the count for purchase and the second for non-purchase

plum across rural to urban sites. The Beti nomenclature encompassed a wealth of known varieties collected in this study (150 in total), that represented both theoretical and practical knowledge acquired over time (Reyes-García et al., 2007). Respondents spontaneously described known varieties that came from their village and that held special significance in their childhood, or possessed distinct and remarkable characteristics, such as highly sour, delicious, large, dark and shiny fruits. These aspects were reflected for instance by the ethnovariety *modza*, translated by the "village chief", which had a distinct shape, and evoked specific childhood memories in the respondent. Local names have persisted in the individual and collective memory, demonstrating their long-lasting nature.

In our study, the urban site had the highest number of known varieties, despite the limited availability of land for planting within the city. African plum trees still found a place in family compounds, with city dwellers planting a few trees, that held great significance as they represented "a piece of the village that they keep close to them". This connection between rural and urban environments in Cameroon (Mainet, 2017) facilitated the transmission and perpetuation of traditional ecological knowledge and practices.

The overall richness of ethnovarieties was significant across the entire gradient, but it was the greatest in the rural site, especially concerning observed varieties. Although the rural site is more isolated, virilocality, a social rule of marriage among the Eton, leads to the mandatory establishment of women in their husband's native village. As their move to their husband's village, women bring both their own knowledge on fruit growing practices, but also African plum names and varieties they are familiar with. For example, Mrs. M. C. shared that "when she came in marriage, she told her husband that she wanted to eat *leboack*, her father's plum in the village". This indicates that women may therefore be one of the drivers of the known and observed varietal diversity of the rural site, as observed for other crops in Central Africa (Delêtre et al., 2011).

Variety exchanges also allow names and information about their characteristics to be exchanged. In Cameroon, seeds from African plums are disseminated through four main channels: gifting between individuals; purchasing at markets or in nurseries; transporting varieties during family visits to

villages; spontaneous propagation (Schreckenberg et al., 2002). Seed exchange is one of the drivers of the diversity of local names of our sites, as was also observed in other studies in France or Kenya (Labeyrie et al., 2019; Thomas et al., 2011), and contributes to the genetic diversity of the species, enriching the genetic pool in Yaoundé (Rimlinger, Avana, et al., 2021). Seed circulation systems operate openly within and between sites, which likely accounts for the widespread dissemination of names in both urban and rural sites. In fact, seed commercial circulation further accentuates this process, as each of our sites is connected to the African plum trade.

Respondents from the rural site named more ethnovarieties compared to other sites along the gradient. This can be attributed to the strong interest to the cultivation of African plum trees among rural dwellers in Centre Cameroon. Species cultivation and the richness of its nomenclature can thus be positively linked, as shown for other tree species (Adan et al., 2016). However, there seems to be a tipping point in this relationship: in our study, the peri-urban site had the highest proportion of unnamed varieties accounting for 52% of the total, in contrast to 20% in the rural site. This site, characterized as a secondary city experiencing rapid population growth and serving as an important hub for African plum production, exemplifies how the dynamic development of economic rationality can trigger significant cultural and symbolic changes. Interestingly, only in the peri-urban site did people explain that they saw no purpose in naming their trees, and instead, children were the ones assigning names.

Overall, the "known and observed" diversity of varietal names for the African plum reflects the collective contributions of individuals who assign names based on the fruits they grow, remember, bring, or exchange. While people acquire knowledge of variety names from others, it is not uncommon for names to be reassigned. This occurs when farmers observe significant phenotypic differences that are distinctive enough to warrant a separate name for a given morphotype. The complexity of the nomenclature is further influenced by the fact that the same phenotypic difference may carry different weight or significance for different farmers (Sambatti et al., 2001). The multitude of names reflects the diverse perception of fruit morphotypes and other characteristics associated with the species (Boster, 1985). Regarding economic integration and urbanization, they have been shown to have adverse effects on traditional knowledge (Gandolfo & Hanazaki, 2014). However, in the case of African plum, the exchange of varieties helps counterbalance these effects, contributing to the maintenance and preservation of traditional knowledge despite economic and urban influences (Agbo et al., 2020; Assogbadjo et al., 2008; Godoy et al., 2005; Nuijten & Almekinders, 2008; Sogbohossou et al., 2014).

This study reveals that the number of named African plum varieties is consistent across different socio-economic categories of respondents, irrespective of age or gender. This finding underscores the shared cultural significance of the tree within the community. Despite the influence of urbanization and other factors, the local nomenclature remains deeply ingrained in Cameroonian territories, including among the younger generation. It is worth noting that the Beti nomenclature does not revolve around specific local names for African plum ethnovarieties but rather follows a consensus-based nomenclatural rationale embraced by the respondents.

Local African Plum Nomenclature Scheme

Local nomenclatures are often based on culinary, medicinal or agronomic uses (growth, resistance to climatic conditions, cultivation), as well as domestication or selection practices (Appa Rao et al., 2002), and on origin/site characteristics where species or varieties developed (Loko et al., 2018; Sathya, 2014). When it comes to African plum, no names specifically referring to fruit uses, tree care or growth patterns were found. Interestingly, a significant proportion of African plum names, particularly in the rural site, consisted of toponyms associated with the site's history and environmental criteria. These toponyms serve the purpose of distinguishing male trees or common/average African plums, which typically exhibit traits such as a blue color, medium size, and good taste. These toponyms reflecting ecological, agronomic, and historical knowledge of the cultivators can also be replaced, after fruit production, by a name related to morphological or organoleptic characteristics after the fruits have been produced.

Local nomenclature is also influenced by cultural criteria (Appa Rao et al., 2002; Nuijten & Almekinders, 2008). In the rural site, the naming of African plums' trees reflects memorial and symbolic values. Cultivators have the option to name a tree after themselves or after significant individuals as a way to honor and remember them. For instance, a tree named '*avita sia*' translated as "the uprooted who has risen again" symbolically represents a woman's triumph over a serious illness during the time she planted the plum tree. "Symbolic" nomenclature, involving the names of individuals, is more commonly used for known varieties, while observed varieties tend to be associated with memories of a person's life, leading for instance to a higher prevalence of names related to topography.

Symbolic names often highlight remarkable size, color and/or shape descriptors, such as the white-skinned plums, which are described as "rare", "not sold on the market", "prestigious", "for family". Other symbolic references are found for African plum nomenclature. For instance, the '*ntongo benui*' tree ("food for orphans") refers to the very large quantities of fruit produced by this variety which can be shared with the community. These "symbolic" nicknames effectively convey fruit or tree characteristics through shared

analogies or metaphors connected to the community's history and everyday life experiences.

Overall, the local names of African plums bear witness to the multiple interactions between tree owners and their trees. They manifest how, over time, biological and cultural diversity have become linked: the diversity of African plums is now encoded by Beti values, practices, and memories.

Market Impact on African Plum Nomenclature

The naming diversity of African plums is indicative of people's fruit perceptions, but also preferences, as observed in other African tree species (Assogbadjo et al., 2008; Ekué et al., 2010). As individual preferences for fruits can vary depending on whether the fruit is intended for self-consumption or the market, varietal names also aid in recognizing preferred fruits and subsequently influence decisions related to harvesting or purchasing. This might explain the high number of local names related to organoleptic features in the urban site, where individuals primarily act as consumers. When purchasing plums from the market, fruit taste appears to be the most significant criterion. The proportion of oil or water in the fruit pulp is also a notable characteristic that is identifiable and named, as it is of interest to consumers. Size and color, which can serve as indicators of fruit quality, are informative visual and naming criteria. Market consumers tend to gravitate towards large, oily, dark, and blue-to-black fruits, while disregarding pink-colored watery plums. While taste remains the primary criterion, size become less important if the plum is small but flavorful. On the other hand, large plums with average (slightly acidic) or even very sour taste still attract consumers. Size, taste and color (as a proxy for taste), which are criteria of interest for sale, significantly impact the price of plums (Anegbeh et al., 2005). Thus, local nomenclature is closely connected to management practices, cultivation techniques, and tree selection that align with both self-consumption and consumer food preferences.

The Labile African Plum Names: Domestication Processes Underway

African plum local nomenclature naming is a dynamic and evolving process which results from weak breeding selection and domestication practices. Farmers have engaged in the selection of trees and seeds over generations (Youmbi et al., 2010), choosing seedlings from their own home gardens, and eliminating unproductive trees (in terms of quantity and quality of fruit) but also by sowing seeds with desirable features (Leakey et al., 2009). The modification of selected traits, driven by humans intervention, is a key factor in the domestication process of a species such as the African plum (Mboujda et al., 2022). However, the predominantly allogamous nature of African plum trees and the rare use of vegetative propagation methods, along with environmental conditions, contributes to the maintenance of interindividual variability. Despite an ongoing domestication process, African plums still exhibit a significant phenotypic diversity, in terms of shapes, colors, tastes and sizes supported by observed local nomenclature diversity. This calls for more systematic research on the intraspecific diversity of cultivated perennial species, seen through the lenses of biocultural diversity.

The remarkable finding of our study is the diversity of local names that are rarely shared among respondents, both within each site and along the gradient. Although only five names were shared across all study sites, but many synonyms (African plums that do not have the same name can correspond to very similar fruit features) were observed. For instance, the ethnovarieties *'feumeu'*, and *'apouma'* both designate the same good white plum with green flesh in the Eton language. Synonyms were recurrently observed within local nomenclature systems even when species are clonally reproduced (Dansi et al., 2013; Delêtre, 2009; Mekbib, 2007). In the case of African plum, the naming process exhibits a low level of consistency (the degree of representativeness of the names compared to the actual batch of existing varieties), with unstable meanings. Significant simultaneous exchanges of varieties (African plums as well as names) in Central Cameroon (Rimlinger, Avana, et al., 2021; Rimlinger, Duminil, et al., 2021), particularly through the value chain, can lead to confusion in names. Despite cross-varietal synonyms, the observed local names' diversity can also be attributed to the balance between two selection models: blind selection and intentional selection (Boster, 1984). Cameroonian cultivators employ a differentiated management strategy (Aguirre-Dugua et al., 2012), wherein they maintain desired and cultivated varieties while tolerating unwanted trees that grow spontaneously in the crop fields (Carrière, 2002). This blind or unanticipated selection preserves the entire pool of varieties instead of completely eliminating less appreciated ones (Campbell, 1965), since the cost of maintaining a variety is low compared to the cost of abandoning it. Blind selection goes hand in hand with the intentional selection model based on perceptual distinctiveness, which involves selecting of easily distinguishable characteristics in order to enhance discrimination between diverse cultivars (Boster, 1985). In conclusion, the local nomenclature, which mirrors variation of fruit traits, can also reflect an existing artificial selection, indicating an ongoing process of domestication (Fig. 4). The study of local nomenclature, rooted in collective social-ecological memory, is therefore relevant in the context of agrobiodiversity conservation (Rodríguez Valencia et al., 2019).

Conclusion

The interaction between Beti cultivators and their African plum has resulted in the recognition and naming of a large number of varieties. The local nomenclature of the African plum among the Beti community is rich and motivated based on morphological, organoleptic, topographic, and symbolic features. However, the nomenclature of African plum nomenclature primarily relies on the lexicon, with names reflecting the fruit's morphology or taste, directly influenced by consumer dietary preferences and commercial considerations. External factors, such as seed circulation through regional trade, exchanges, and donations between urban and rural dwellers, as well as among villages, contribute to the diversity of local names along the urban–rural gradient.

The African plum's spontaneous propagation through seed planting allows for weak artificial selection. We posit that this non-intensive artificial selection plays a significant role in the proliferation of local names associated with African plum. In conclusion, recognizing cultivators' knowledge and preferences regarding the varieties they maintain in their fields is crucial for understanding the possible loss of germplasm diversity in agricultural systems and implementing effective in situ conservation measures.

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Availability of Data and Materials The data sets supporting the conclusions of this article are available in the following OSF repository: https://osf.io/gs6t3/?view_only=41a5e8f5f53b4bbda6cee441f3f350f4.

Declarations

Ethics Approval and Consent to Participate For each study site, local traditional authorities were visited to obtain their agreement to conduct interviews in the area under their authority. Prior to conduct interviews, participants were informed orally of the research intentions and of their right to participate or decline. A written format indicating that participants agreed that the interview followed the principle of prior informed consent was signed after interview completion.

Competing Interests The authors have no competing interests to declare that are relevant to the content of this article.

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