Title

First insights into the wood management for the production of lime given by the anthracological study of a 19th century lime kiln from Martinique, Lesser Antilles

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Abstract

The colonial economy of Martinique, French West Indies, has long been based on sugar cane exploitation, which started in the 17th century and decreased during the 19th century. Sugar economy led to woodland exploitation for the production of fuel. In particular, this fuelwood was needed for lime production, which was used for the purification of cane juice. As lime kilns are numerous in Martinique, their functioning implied an intense wood exploitation. To date, no archaeobotanical studies were conducted to assess how lime kiln workers used and managed wood for the production of fuel. In this study, we analyzed 207 wood charcoals fragments from a 19th century lime kiln at the Sucrerie plantation, Les Anses-d'Arlet, Martinique. This led to the identification of 50 taxa, showing that wood collection was mainly diffuse and unfocused. But the occurrence of taxa known as being used for fuelwood or charcoal production suggests that lime kiln workers were looking for wood with good fuel properties. Our results also show that the collection of wood was made locally, as revealed by the presence of a xero- to mesophilic vegetation in the anthracological record, which is in accordance with botanical and ethnological data. The presence of pioneer and heliophilic taxa also suggest that the vegetation was already impacted by wood exploitation i.e., local forest associations were largely disturbed by this time and secondary regrowth was conspicuous. Nevertheless, the high proportion of small-gauge wood charcoals fragments (36%) and the presence of edible taxa in the anthracological record suggest that saplings and pruning waste may have been preferred to preserve useful and mature trees. This study allows for the first time to assess which fuelwood was used by Antillean lime kiln workers during the colonial Period which makes it possible to better understand one of the most widespread handicrafts during the sugar exploitation in the Caribbean.

Keywords

Tropical Anthracology – Caribbean Archaeology – Colonial Landscape – Wood Charcoal – Lime kiln – Fuelwood – Sugar Economy

For several decades, the development of archaeology for the colonial period has led to an interest in the plantation dwellings of the West Indies (Moussette and Waselkov 2013; Kelly and Bérard 2014). In Martinique, the inventory of sugar refineries and distilleries (Mousnier and Caille 1990) allowed several research themes to emerge: the habitat of slaves (Kelly 2004; 2013) the production of ceramics (England 1994; 1997; Amouric et al. 2007; Amouric 2010; 2011; 2012; 2013; 2015; Thiriot et al. 2012; Cloarec-Quillon et al. 2015) and that of lime (Vidal et al. 2000; Verrand and Vidal 2004; Vaschalde et al. 2016; 2017; 2019b).

Currently, archaeobotany is developing thanks to Cultural Resources Management archaeology, but no detailed study of wood charcoal from the colonial period has ever been carried out in the Lesser Antilles. Yet, the economy of large plantations has impacted the Caribbean forested landscape. As early as 1635, new settlers had to clear the land in order to benefit from advantageous settlement conditions granted by the royal power (Blérald 1986, p25). An export economy developed rapidly, first based on tobacco cultivation, then on sugar cane (Doumenge and Monnier 1989). In 1670, large land estates appeared and enabled the French West Indies to export sugar to Europe on a massive scale. The sugar plantation was the basis of the colonial economy. It concentrates both the cultivation of cane, which implies the acquisition of land, and the means to transform it into sugar (mill, lime kiln...). For nearly two centuries, no innovation allowed production techniques to progress. The growth of the sugar economy was based solely on the increase in the slave population, the multiplication of plantations and the extension of cultivated lands (Blérald 1986, p27).

In the 18th century, sugarcane cultivation often occupied less than half of the surface area of sugar estates (Blérald 1986, p27; Bégot 2008, p51; Bonnet 2008, p167), and a large part of the estates were covered with woods and savannahs, which were essential for livestock and firewood (Bégot 2008, p50). However, the lack of management of forest resources led to a shortage of timber, which was then imported (Bégot 2008, p50). In the 19th century, profound changes affected the sugar economy: the modernization of the means of production (adoption of steam mills, shareholding), the abolition of slavery in 1848, and the competition from European beet sugar. However, the areas cultivated with cane continued to increase thanks to the development of the rum industry. Between 1855 and 1895, these areas increased by 28%, and Martinique became the first world exporter of rum (Blérald 1986, p60 and 74-79). During World War I, the number of distilleries doubled, as the production of sugar and alcohol was stopped in France because of the conflict. From the middle of the 20th century onwards, many factories closed down, and the cultivated areas decreased.

Thus, between the end of the 17th and the 20th century, the slave sugar economy, then the capitalist one, led to the clearing of large areas of land. Moreover, the supply of fuel was indispensable to the West Indian economy. Before the arrival of industrial techniques and of coal at the end of the 19th century, wood and bagasse were the only fuels available. Fire was used to heat sugar boilers (Vidal 1994), potters' kilns that produced sugarloaves and molasses pots (England 1994; 1997; Thiriot et al. 2012), as well as lime kilns. Many kilns provided the lime necessary for the purification of cane juice. At the end of the 18th century, Martinique had nearly 80 lime kilns (Verrand and Vidal 2004, p41). An archaeological inventory has allowed to identify more than 130 of them on the island (Vaschalde et al. 2019b). The impact of this activity on the vegetation has thus been significant, and may have required the development of techniques for woodland management.

The colonial archives do not provide any clues on this woodland management, and only anthracology is able to enlighten us. In 2014, an archaeological excavation was carried out on a 19th lime kiln at the Sucrerie plantation, Les Anses-d'Arlet, and allowed the extraction of wood

charcoal. Anthracology in the tropics is challenging because of the scarcity of the studies compared with those from temperate or Mediterranean environments; this makes comparisons difficult. In the Neotropics, anthracological studies are most common in South America (e.g., Tardy et al. 2000; Scheel-Ybert 2001; Beauclair et al. 2009; Bianchini and Scheel-Ybert 2011; Fernandes Caromano et al. 2013; Scheel-Ybert et al. 2014; Bachelet and Scheel-Ybert 2017; Bodin et al. 2020) but are still rare in the Antilles (Newsom and Molengraaff 1999). To our knowledge, the only anthracological study conducted in Martinique is that by Christophe Tardy on the pre-Columbian site of Vivé (Tardy 2001). In this paper, we assess how lime kiln burners managed woodland to produce charcoal for the functioning of a 19th century lime kiln, in the context of the sugar cane exploitation in Martinique. Specifically, we ask these questions to better understand the fuel economy:

1. Did craftspeople favor some kind of vegetation?
2. Did they collect wood locally?

To answer these questions, we identified wood charcoals found in the remains of the lime kiln. This study, combining anthracology with an ethnoarchaeological approach, is the first one for a Caribbean colonial site.

2. Material and methods

2.1 Regional setting

The study was undertaken in Les Anses-d'Arlet (14°29'26", 61°04'50"), in Martinique, a French overseas department located in the Lesser Antilles (Fig. 1). The climate is tropical humid (Peel et al. 2007) with a mean annual rainfall of 1300 mm and a mean annual temperature of 27°C recorded in Les Anses-d'Arlet between 1951 and 1970 (Portécop 1979). The dry season extends from January to April and the rainy season occurs between June and November. In the South, the geological substratum is older and the topography lower than in the North-Western part of the island where the *Montagne Pelée* stands. The climate is also drier in the South (Portécop 1979). Martinique belongs to the Caribbean hotspot of biodiversity, which hosts more than 11,000 species of native seed plants with a species endemism rate of about 72% (Myers et al. 2000; Conservation International 2020). The most recent update of the floristic checklist counts about 3200 angiosperm species in Guadeloupe-Martinique (Fournet and Sastre 2002). In 1994, Fiard reports 396 tree species of which 20% are endemic to the Lesser Antilles. According to Portécop (1979), the flora of Martinique has a strong affinity with that of Puerto Rico and, in a lesser extent, with that of the North of South America. In Les Anses-d'Arlet area, the vegetation is xerophytic, with a *Tabebuia-Bursera* forest, a *Ceiba-Ficus* sandy-clay facies and a *Lonchocarpus-Inga* riparian forest (Portécop 1979).

2.2 Historical context

During the second half of the 18th century, the Sucrierie plantation was one of the most important sugar plantation in southwest Martinique. Around 1770, the map of Moreau du Temple indicates that the domain was called "Lebrun" (Bégot et al. 1998). In 1783, the Delpech family built a sugar factory, and in 1788, the plantation was bought by Jean-François Hayot (1733-1788) (Bruneau-Latouche et al. 2002, p569; Elisabeth 2005, p1). During the 19th century, the Hayot family established itself throughout southern Martinique and diversified its economic activity (sugar, rum, pottery, building materials, etc.). It increased the extent of the Sucrierie plantation, which reached 116 ha in 1788, 177 ha in 1820, and 284 ha in 1828 (Bruneau-Latouche et al. 2002, pp569-573; Ollivier and Vaschalde 2015). Starting in the 1840s in Martinique, the creation of modern factories equipped with steam boilers disrupted the operation of the Sucrierie plantation. Around 1845, Michel Hayot (1786-1852) put an end to the pressing of sugar on the domain, and sent the cane to the new sugar factory at Pointe-Simon

(Fort-de-France). This factory was founded by Joseph Quennesson (1819-1890), which bought the plantation in 1878 (Ollivier and Vaschalde 2015). After the closure of the factory, Simon Hayot bought the Sucrierie plantation in 1899. Taking advantage of the development of the rum industry, he set up a distillery in 1918 (Louis-Alexandre 1985). In 1926, the map of the *Compagnie française aérienne* indicates that sugar cane plantations occupy large areas in the plain around the house, and that the hills are forested. The distillery closed definitively in 1950 (Mousnier and Caille 1990; Flohic et al. 1998, p29).

2.3 Remains associated to the Sucrierie plantation

The plantation is organized around a hill overlooking the *Ravine des Œillets* and the village of Les Anses-d'Arlet. The Sucrierie plantation is composed of a master's mansion probably dating from 1760-1770 AD (Charlery 2004) installed on the hilltop, and of various buildings related to its past economic activity. The only vestiges that can be linked to the sugar activity of the plantation in the 18th-19th centuries are those of the sugar mill that has been identified south of the ruins. The 20th century distillery, built on the sugar factory, stretches from east to west on the northern piedmont of the hill. It consists of a large building, restored in 2011 and containing several vats or vat supports, a steam boiler and the mechanical installation still in place, also restored. Other ruins are located to the north and west. In 2014, the archaeological excavation uncovered walls of basalt rubble bound with lime mortar and partially plastered (Fig. 2; MR 1002 and MR 1025). Dating from the second half of the 18th century, their function remains unknown.

2.4 Lime kiln structure and functioning

The lime kiln is built to the North-East of the distillery. It is a circular building measuring approximately 5 m in diameter for a preserved height of 2.20 m (Fig. 2). The external facing is built in irregular apparatus of large basalt rubble bound with a lime mortar, the whole being covered with a smooth lime plaster, like the walls previously described.

To the West is the mouth of the kiln, facing a ruined building that may have served as a "lime hut". The mouth is composed of a basalt sill and refractory stone pedestals. The lintel topping the whole has disappeared. The mouth is preceded by a large splay, which sheltered the working area, partially filled by alternating layers of lime, containing fragments of charred coral and wood mixed with ash, which testify to the activity of the kiln (US 1015). Inside the kiln, the firing chamber has a diameter of 1.50 m at the base. It has the shape of an inverted truncated cone. The floor consists of a paving laid on a bed of lime mortar and the walls are built with cut refractory stones.

To the north of the kiln, a masonry ramp allowing access to the top in order to feed it with corals has been identified despite the poor state of conservation.

The architecture of the structure indicates that it is a short-flame kiln (Vaschalde 2018, pp91-97), a process that is very widespread in Martinique (Vidal et al. 2000; Verrand and Vidal 2004; Vaschalde et al. 2016; 2017; 2019b). The raw material, composed of coral and shell fragments, is charged by forming beds alternating with fuel (wood charcoals). At the end of each firing, the lime is discharged through the mouth at the bottom of the kiln, and part of the charcoal is spread on the floor of the work area.

2.5 Dating of the lime kiln

The dating of the lime kiln is based on stratigraphy, textual sources and artifacts found during the excavation. After the walls MR 1002 and MR 1025 were levelled, the ground was backfilled

and the kiln's foundations were then dug. An inventory drawn up in 1820 does not mention the lime kiln, indicating that it was built after that date. In 1878, the lime kiln appears in the deed of sale of the estate to Joseph Quenesson (Ollivier and Vaschalde 2015). It can be assumed that it was in good condition at this time. Thereafter, it is probable that Joseph Quenesson did not have lime produced at the plantation anymore, since the canes were brought to the factory of Pointe-Simon. Finally, the excavation of the work area uncovered two fragments of glass bottle bottoms, dated to the mid-19th century. The lime kiln was therefore in operation in the mid-19th century, and seems to have been abandoned after a few decades of use.

2.6 Charcoal sampling and identification

Sampling was done in a deposit of mixed charcoal, coral and stone fragments in front of the opening of the kiln from a single layer, the stratigraphic unit 1015 (Fig. 2), which probably corresponds to the last firing. The 2-liters deposit was collected in clods with a trowel to avoid charcoal breaking. It was then water-sieved in 4 and 2 mm meshes to retrieve charcoal fragments. Charcoal fragments were then dried away from the direct sunlight to prevent them from bursting.

Only fragments > 4 mm were considered for anthracological analysis (Chabal et al. 1999; Scheel-Ybert 2001). Below this size, the identification is harder because fewer anatomical features are visible. This is especially true for the tropical material where there is a strong anatomical homogeneity. Charcoals were observed under a reflected light microscope with dark and bright field, at x100, x200, x500 and x1000 magnifications. In the absence of a reference collection of charred wood from the Lesser Antilles at the *Institut des Sciences de l'Evolution de Montpellier*, identification was performed with the help of the charcoal reference collection from French Guiana (Scheel-Ybert 2016), as many taxa are common between the two regions. Specific literature (Détienne and Jacquet 1983; Cirad 1990; Rollet et al. 2010) and identification tools (InsideWood 2004-onwards; Bodin et al. 2019) were also used to complement the comparisons with the reference collection. Many tropical woods are characterized by a homogeneous anatomy, making them difficult to distinguish, especially within the same family. Identification at the genus level is possible in the case of a monogeneric family or when genera present distinguishable anatomical features. Similarly, identification at the species level is only possible in the case of a monospecific genus or when species are anatomically heterogeneous. Poor preservation of charcoal masking diagnostic features or the presence of features common to several taxa led to the designation of morphological types (e.g., type *Lonchocarpus* or Leguminosae type *Lonchocarpus*). A quasi-secured identification is preceded by "cf." for *confer* (e.g., cf. *Spondias* or *Spondias* cf. *mombin*). When a taxon has an anatomical affinity with another taxon but differs from it in major aspects, it is preceded by the mention "aff." for *affinis*. Finally, when two species may match with the observed features, they are both mentioned (e.g., *Spondias dulcis/mombin*). The nomenclature used follows that of the Angiosperm Phylogeny Group (2016) and that of the Legume Phylogeny Working Group (2017) for the Legume family.

3. Results

The anthracological analysis resulted in the identification of 183 charcoal fragments out of 207, distributed in 50 taxa including 16 morphological types and 7 indeterminate (Fig. 3). Among the 207 charcoal pieces, 24 were indeterminable due to a very poor preservation (e.g., vitrification) or because of a distorted anatomical structure (knots). The anthracological assemblage contains an important proportion of Leguminosae (45%) distributed in 19 types of which 6 are assigned to genera or species which have a close anatomy. Among the 207 analyzed charcoal fragments, 29% come from twigs and 6% come from knots.

4. Discussion

4.1 Palaeological significance: a firewood collected locally

The high number of types in our anthracological spectrum reflects the need of a specific reference collection for study areas with peculiar vegetation composition: even if the reference collection of charred woods from French Guiana helped through the identification process, many taxa are endemic to the Lesser Antilles or simply do not occur in French Guiana. However, building a reference collection is a long process which is not compatible with short projects. This is an issue that was previously underlined during a pioneering research in New Caledonia, another tropical region where anthracological studies are still scarce (Dotte-Sarout 2011). Hence, due to the high number of morphological types, the following interpretation relies on a reduced list of taxa that may shed light on the collect of wood used as fuel for the lime kiln. This short list already makes it possible to formulate hypotheses.

First, some taxa found in the anthracological assemblage may indicate that wood collection was made in a xerophilic forest. These are *Spondias mombin*, cf. *Zygia latifolia*, an Apocynaceae resembling *Plumeria* sp. and the types *Acacia macracantha* and *Senna bicapsularis*. To this list can be added the types *Psidium guajava* and *Citharexylum* which have xero-mesophilic affinities and *Coccoloba*/Sapindaceae which may also correspond to a xerophilic facies (Rollet et al. 2010). It is noteworthy that the porknut *Acacia macracantha*, which was the most abundant taxon in the charcoal assemblage, and the golden apple *Spondias dulcis*, an introduced species from Oceania, are used as firewood and for the production of charcoal (Rollet et al. 2010). Some species of the genera *Citharexylum*, *Coccoloba* and *Plumeria* are also used as firewood and to produce charcoal in the French West Indies, such as the fiddlewood *Citharexylum spinosum*, the seagrape *Coccoloba uvifera* and the frangipani *Plumeria alba* (Rollet et al. 2010; ONF 2015).

There are also taxa corresponding to a mesophilic vegetation, which suggest that wood collection was not restricted to the xerophilic forest. These are the breadfruit *Artocarpus altilis*, the amarillon *Lonchocarpus* cf. *heptaphyllus*, which is used as firewood in the Lesser Antilles (Rollet et al. 2010; ONF 2015) and Melastomatoideae. To these taxa can be added the type *Cassipourea guianensis* and two *Inga* morphotypes.

Second, other taxa may indicate a pioneer and/or heliophilic vegetation such as *Spondias dulcis/mombin*, Melastomatoideae, Salicaceae, cf. *Zygia latifolia*, *Coccoloba*/Sapindaceae and the type *Acacia macracantha*. This suggests that the fuelwood was collected in a secondary forest or in disturbed areas. Three morphological types found in the anthracological assemblage might support the hypothesis of a collection from a secondary forest association. These are the types *Citharexylum*, *Cordia* and *Psidium guajava*. The species of the genus *Citharexylum* are heliophilic, the common guava *P. guajava* is a pioneer and some *Cordia* species are short-lived pioneers, such as *C. alliodora* (Rollet et al. 2010). Interestingly, some *Cordia* species are also used as firewood in the French Antilles, such as the white manjack *C. sulcata* (Rollet et al. 2010; ONF 2015). The presence of pioneer and heliophilic taxa may be the result of an intense landscape exploitation.

Third, the presence of possible riparian taxa, such as the amarillon *Lonchocarpus* cf. *heptaphyllus*, cf. *Zygia latifolia*, *Spondias mombin* and the type *Senna bicapsularis*, may also suggest that some woods were collected near water courses (Guppy 1917; Portécop 1979; Rollet et al. 2010; ONF 2015).

Obviously, the uncertainty of some identifications (e.g., morphological types) requires caution in interpreting their presence. Nevertheless, the presence of xero- to mesophilic, secondary forest and riparian taxa in the anthracological record is coherent with the present-day flora

found near the Sucrerie plantation. This suggests that the craftspeople collected the firewood in the vicinity of the plantation, and, given the high number of taxa represented in the anthracological record (50 potential taxa) without any preferential collection of certain species for fuel use. However, it is possible that the craftspeople favored woods with good fuel properties, as suggested by the presence of several taxa known to be used as firewood or for charcoal production.

The fact that the wood was collected in the near environment of the lime kiln is consistent with ethnological data from another lime kiln site in Martinique. In Le Lamentin, near Fort-de-France, a retired craftsman told that he used the wood of different mangrove tree species (Vaschalde et al. 2019b). In the bay of Fort-de-France, the mangrove vegetation is abundant, especially near Le Lamentin, which reinforces the idea of local supply. According to the craftsmen of Le Lamentin, mangrove wood was appreciated by the lime kiln workers. In Guadeloupe, this use is attested since the 19th century (Archives de Médecine Navale 1869). In Les Anses-d'Arlet, the mangrove is absent, and no mangrove charcoal was found in the lime kiln. As in Le Lamentin, artisans have harvested wood around the site, and have adapted their practices to local taxa.

4.2 On the most abundant taxa: a reflect of the palaeoenvironment or a differential preservation?

The most abundant taxa of the anthracological record are the type *Acacia macracantha*, *Lonchocarpus* cf. *heptaphyllus* and the type *Psidium guajava* which count respectively for 14%, 10% and 8.2% of the total number of charcoal fragments, representing together 32.2% of the anthracological record. As there is a large amount of other taxa represented, reaching a total of 50, it is unlikely that these three taxa were preferred as fuelwood and specifically selected by the craftspeople. The dominance of these taxa in the anthracological record may simply reflect their abundance in the environment rather than a wood preference. Similar observations have been made in Europe for potters and lime kiln workers from the historical period (Chabal 1997; Vaschalde 2018). Another explanation for their dominance could be a differential preservation leading to an over-fragmentation of charcoals. Several studies have shown that post-depositional processes affect charcoal preservation and can induce a bias in the proportions between taxa (Lancelotti et al. 2010; Théry-Parisot et al. 2010; Chrzazvez et al. 2014; Dussol et al. 2017; Henry et al. 2020). To assess the likelihood of the hypothesis of a differential preservation, we would need this kind of data for each of our taxa, which would require time-consuming experiments. Furthermore, this would be applicable only for those which have been securely identified, not for the morphological types. Testing this hypothesis is therefore very difficult.

4.3 Collection of cultivated and/or edible species as fuelwood

As pointed above, the large amount of potential taxa (*i.e.* including the morphological types) found in charcoals suggest that there was no selection of a specific taxon for fuel use. Even edible species were collected: the breadfruit *Artocarpus altilis*, a species introduced in the late 18th century (Leakey 1977), and the hog plum or the golden apple (*Spondias mombin* or *S. dulcis*), also both introduced – probably much earlier concerning the hog plum, by natural seed dispersion (Guppy 1917). To these taxa might be added the common guava *Psidium guajava*. The use of edible species as fuel for lime kilns in Martinique has already been reported by Father Labat in the late 17th – early 18th century with the orange tree *Citrus* sp., introduced in the 16th century (Labat 1724; Le Bellec and Le Bellec 2004), and more recently by Vidal *et al.* (2000) with the mango tree *Mangifera indica*, introduced in the 18th century (Le Bellec and Le Bellec 2004). Therefore, it is not surprising to find edible species in the wood used for the functioning of lime kilns. The charcoal from the lime kilns can thus testify to the taxa exploited

and/or cultivated within an exploitation specialized in sugar production. In Europe, the presence of exploited/cultivated taxa in anthracological assemblages results from the pruning of fruit trees, as it is the case with vine for example (Ros and Vaschalde, in press). At the Sucrierie plantation, pruning waste from *Spondias dulcis/mombin*, *Artocarpus altilis* and *Psidium guajava* could thus have been harvested for fuel use.

4.4 On the presence of charcoals of twigs in the fuel

About 30% of the charcoal fragments came from twigs, as revealed by the non-parallel arrangement of the rays in the transverse section. If we consider that the knots also come from twigs or branches, this percentage reaches 36%. It is therefore likely that small-gauge wood was favored by the craftspeople. Several reasons could explain this. First, the abundance of small-gauge wood in the environment, such as in a semi-open forest with small trees and shrubs as suggested by the presence of pioneer and heliophilic taxa (see above). This type of vegetation would be in agreement with the intensive land exploitation by the sugar economy of the 19th century. This has been observed with Mediterranean lime kilns fueled by wood from the *garrigue* or the *maquis* (Vaschalde et al. 2008; 2019a; Vaschalde 2018). Second, this could be due to wood management practices. The managers of the plantation could have wanted to preserve the useful parts of the trees (trunks, main branches) by forbidding them to be cut down. Artisans would have used only small branches, dead wood, or brushwood. This type of practice is attested in the south of France during the modern period (Vaschalde 2018), and would be in agreement with the recovery of supposed pruning waste from fruit trees found in the lime kiln of the Sucrierie plantation.

5. Conclusion

The study of wood charcoals from the lime kiln of the Sucrierie plantation is one of the firsts from the colonial period in the West Indies. It shows that the lime burners used wood harvested from local vegetation composed of a great diversity of species. This vegetation was open to semi-open, and appears to have been highly impacted by the exploitation of resources. However, tree management practices may have been applied, explaining the important use of small-gauge wood. This management would notably concern cultivated and/or exploited trees and food crops in the plantation. Anthracology makes it thus possible to address issues that cannot be dealt with on the basis of a study of the archives. Thanks to this archaeobotanical approach, we get a better understanding on how lime burners managed woody vegetation during the colonial period. Further research is however needed on this kind of activity in the Antilles, and it is necessary to study a greater number and diversity of archaeological sites from the colonial period to able comparisons between practices used in other islands of the archipelago. Finally, it is also necessary to carry out floristic surveys of the current vegetation around the sites in order to highlight the impact of the colonial sugar economy on the present-day environment.

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SB, CV and DO wrote the manuscript. **CV** did fieldwork (charcoal extraction and sieving), **DO** led the archaeological excavation and **SB** did charcoal identification.

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Caption Figure 1: a. Location of Martinique in the Lesser Antilles. b. Location of Les Anses-d'Arlet in Martinique, where the Sucrierie homestead and its lime kiln are situated, and main vegetation types of the island. Origin of the data: IGN OCS GE 2017, ESRI World Light Gray Base, DEM SRTM 1 and viewfinderpanoramas.org.