Life and death at precolumbian Lavoutte, Saint Lucia, Lesser Antilles

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The Caribbean archaeological record requires immediate attention and protection. Development and natural forces have impacted archaeological sites, destroying or severely damaging them. The precolumbian site of Lavoutte, located in northern Saint Lucia, has been known as a major Late Ceramic Age (A.D. 1000–1500) settlement since the 1960s, but it has been damaged over the past decades by both natural and human processes. Multidisciplinary field and laboratory methodologies were implemented during a rescue project at the site from 2009 to 2010. This paper presents the results of collaborative efforts between local and international organizations. The first goal was to demonstrate the importance of protection and rescue of endangered archaeological sites. Secondly, we aimed to show that by adopting a multidisciplinary approach including artifact analysis, bioarchaeology, paleoenvironmental reconstruction, and geochemistry, severely damaged sites can be of significant informational value.

Keywords: rescue archaeology, mortuary behavior, Lesser Antilles, precolumbian, Caribbean archaeology, bioarchaeology, human mobility

Introduction

The encroachment of tourism development on archaeological sites is a modern reality, especially in countries where local economies are dependent upon tourism. Developing land for hotels and recreational grounds such as golf courses often conflicts with the preservation of cultural heritage. In many of the Lesser Antilles and other Caribbean islands (FIG. 1), tourism represents a vital part of the islands' economies and takes precedence over other social concerns of the local community. Modifications of the landscape resulting from development projects, combined with processes of erosion exacerbated by regular hurricanes, volcanic eruptions, sea-level fluctuations, and earthquakes, often leads to the exposure, damage, or complete destruction of archaeological sites (e.g., John F. Cherry, personal communication 2011; Cooper and Peros 2010; Crock and Petersen 2001; Delpuech 2004; Fitzpatrick *et al.* 2009; Sophia Perdikaris, personal communication 2011).

In addition, the cultural and political diversity of the region, and a general lack of educational programs, along with the wants of a variety of stakeholders, has resulted in an array of unenforceable laws and regulations. An exception is the situation in the French and Dutch islands, where the Valletta Treaty or *Malta Convention on the Protection of the Archaeological Heritage of Europe* (1992), an initiative of the Council of Europe, has either been implemented or used as a guideline during the past decade (Bérard and Stouvenot 2011; Haviser and Gilmore 2011). Most other islands (especially the smaller ones) do not have sufficient resources or trained personnel to ensure that all stakeholders comply with legislation. The driving forces in heritage protection are often non-governmental organizations (NGOs) and concerned individuals, while government officials often face difficult choices concerning conservation of archaeological sites or promoting economic development (Siegel and Righter 2011). Several countries are currently addressing their regulations; the Organization of East Caribbean States recently developed a code of ethics for cultural resources management (CRM) to be applied in Jamaica, St. Kitts, Nevis, Dominica, Saint Lucia, St. Vincent and the Grenadines, and Grenada (Branford 2011).

The recent development of cultural tourism—for example, the creation of national parks on some of the islands—is expanding awareness of local histories, and at the same time is creating jobs and educational programs. In fact, many islands now explicitly promote their unique historical legacies to attract visitors from all over the globe. During the past decade, local government organizations (GOs) and NGOs, such as national trusts, archaeological

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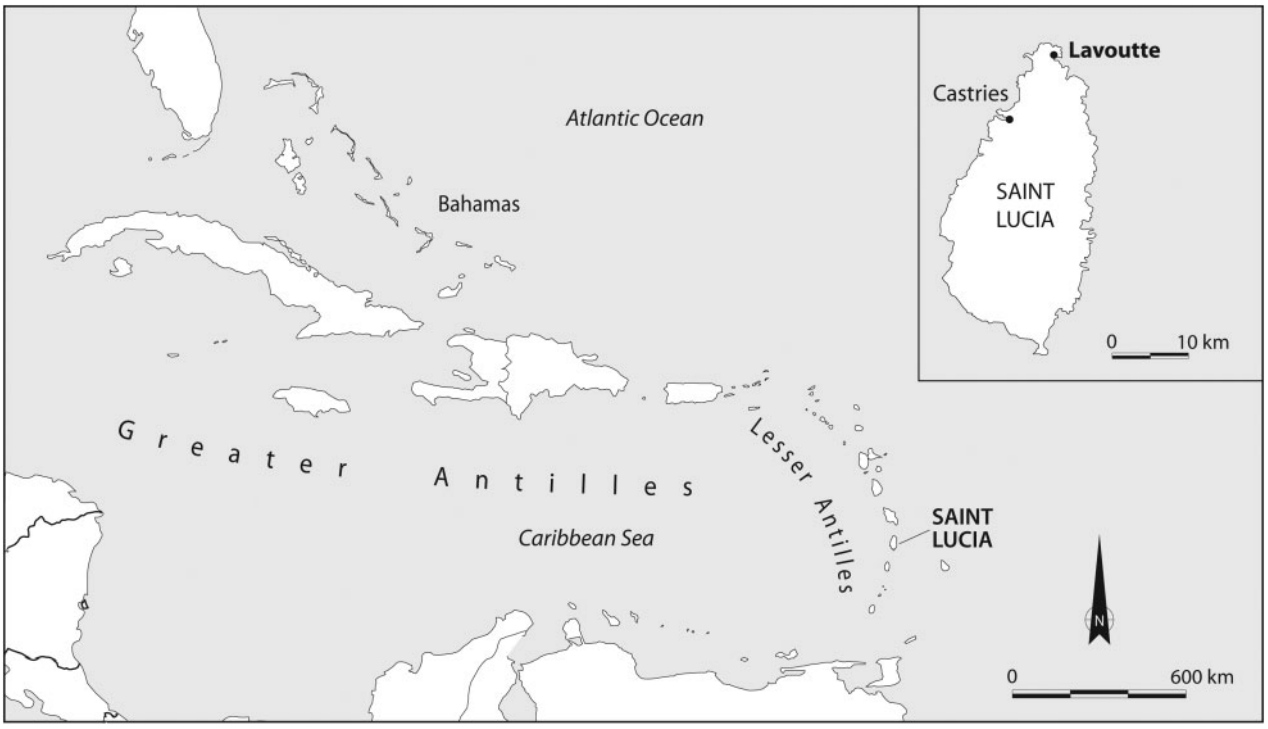

Figure 1 Map of the Caribbean with inset of Saint Lucia and the location of the site of Lavoutte.

and historical societies, various foundations and museums, as well as concerned individuals have been increasingly monitoring local archaeological and historical sites, and, when necessary, coordinating the involvement of international research groups for planned and salvage excavations. The rescue and conservation of archaeological heritage requires a high degree of flexibility in approach and field methodology. Key to such an approach is the close-knit collaboration of all interested parties. Here we describe the results of a rescue excavation at the endangered Late Ceramic Age (A.D. 1000–1500) site of Lavoutte on the island of Saint Lucia, focusing on life and death in this precolumbian community. The project was an international collaboration among the Caribbean Research Group at Leiden University, the Saint Lucia Archaeological and Historical Society (SLAHS), the Saint Lucia Government, and the Florida Museum of Natural History at Gainesville. It highlights the importance of protection and rescue of severely endangered archaeological sites and the considerable amount and quality of data that can be retrieved using a multidisciplinary approach. Through the integration of artifact analysis, paleoenvironmental reconstruction, bioarchaeology, and geochemistry at Lavoutte, crucial information has been salvaged about a poorly understood period in the precolumbian occupation of the Lesser Antilles.

The Lavoutte Site

The northern part of Saint Lucia, north of Castries, is the most developed part of the island and the most popular with tourists. The development of the area and construction of numerous large hotels and villas has seriously affected the number and state of preservation of archaeological sites such as Choc and Pigeon Island, both located on the northwestern coast. Along the northeastern coast, there are two major archaeological sites, Lavoutte and Comerette Point. The Late Ceramic Age site of Lavoutte has been known as a major precolumbian site since the 1960s. It is located on a promontory that partly blocks the northern entrance to the bay of Cas-en-Bas. Elevation of the terrain ranges from 0 to 5 m amsl (meters above mean sea level) and the substrate consists of basalt and andesite.

The site is located on government-owned land that is made accessible to the general public. The tire tracks and scattered litter on the site demonstrate that it is frequented by visitors with cars (FIG. 2). Recent hurricane activity (e.g., Hurricane Dean in 2007), the construction of a hotel on the bay, and increased tourist activity in the area have accelerated the rate of erosion at the site, as revealed through close monitoring by the SLAHS, researchers from the Caribbean Research Group at Leiden University, the Netherlands, and the Florida Museum of Natural History during the past decade. A large number of human burials were found eroding out of the site on inspection in January 2009. As a part of the damage assessment initiated by researchers from Leiden University, an elevation map of the site was made. Comparison with a similar map, made by Eric Branford (SLAHS) in 1968 and subsequently published by Bullen and Bullen (1970) of the University of Florida, allowed for a detailed assessment of the

Figure 2 Human and natural damage at Lavoutte recorded in 2009. The white tags mark the locations of damaged burials next to tire tracks.

changes in elevation over the past 40 years. Even a rough retrodiction of erosion rates suggests that the landscape has been profoundly modified over the past 1000 years and large parts of the original settlement have probably been lost.

The results of the damage assessment indicated that recent impacts on the site have been severe and are increasing (Hofman and Branford 2011). Many of the human burials were severely damaged and exposed, and a large number have already been lost, calling for immediate intervention. A large scale rescue project was conducted in the summer of 2009 and the winter of 2010. This multidisciplinary project was designed to rescue the most vulnerable portions of the site, assess the site context, and extensively analyze the material and skeletal remains. Some aspects of the field and laboratory methods that were adapted to a rescue excavation context included: intensive collaboration with local authorities and the general public to reduce further damage; in situ analyses of the human skeletal remains to minimize further damage to the poorly preserved materials upon removal; and complete excavation of the most threatened area to provide essential contextual information on the burial ground.

The results of these investigations are fundamental to our understanding of the Late Ceramic Age occupational history of the Lesser Antilles, including specific information on settlement location, paleodemography, health and subsistence, exchange of goods and ideas, and mortuary behavior. This project demonstrates both the paramount importance of protection and rescue of endangered archaeological sites and the significant scientific value of their study.

Discovery and History of Research

The site of Lavoutte was discovered by the SLAHS in 1958. Principally, the site is known for the famous "Lavoutte statue," a unique ceramic figurine depicting a seated female that was discovered there in 1963. Subsequent visits to the site by local amateur archaeologists revealed other exceptional Taíno-influenced stone and shell artifacts. Excavations in 1968, led by the Bullens in collaboration with Branford, revealed the historical significance of the site (Bullen and Bullen 1970: 75). Based on their excavations in the midden area, the recovered Suazoid ceramics, and one radiocarbon date, the site was dated to A.D. 800–1500. The presence of numerous fragments of large figurines, including the Lavoutte statue, at the site led to the interpretation of Lavoutte as a "Carib ceremonial center" (Bullen and Bullen 1970: 75). The occurrence of "Taíno-like" artifacts at Lavoutte is thought to reflect contacts with other contemporaneous settlements in the region, connecting the Lesser Antilles to the Greater Antilles to the north (Allaire 1999). The latest investigations at the site date from the 1980s when a small scale excavation was carried out by the University of Vienna under the direction of Herwig Friesinger, which recovered three human burials, currently curated by the SLAHS (Fabrizii-Reuer and Reuer 2005).

Reconstruction of the Paleoenvironment

No macro- or microbotanical remains were found at the site during the 2009–2010 rescue excavations,

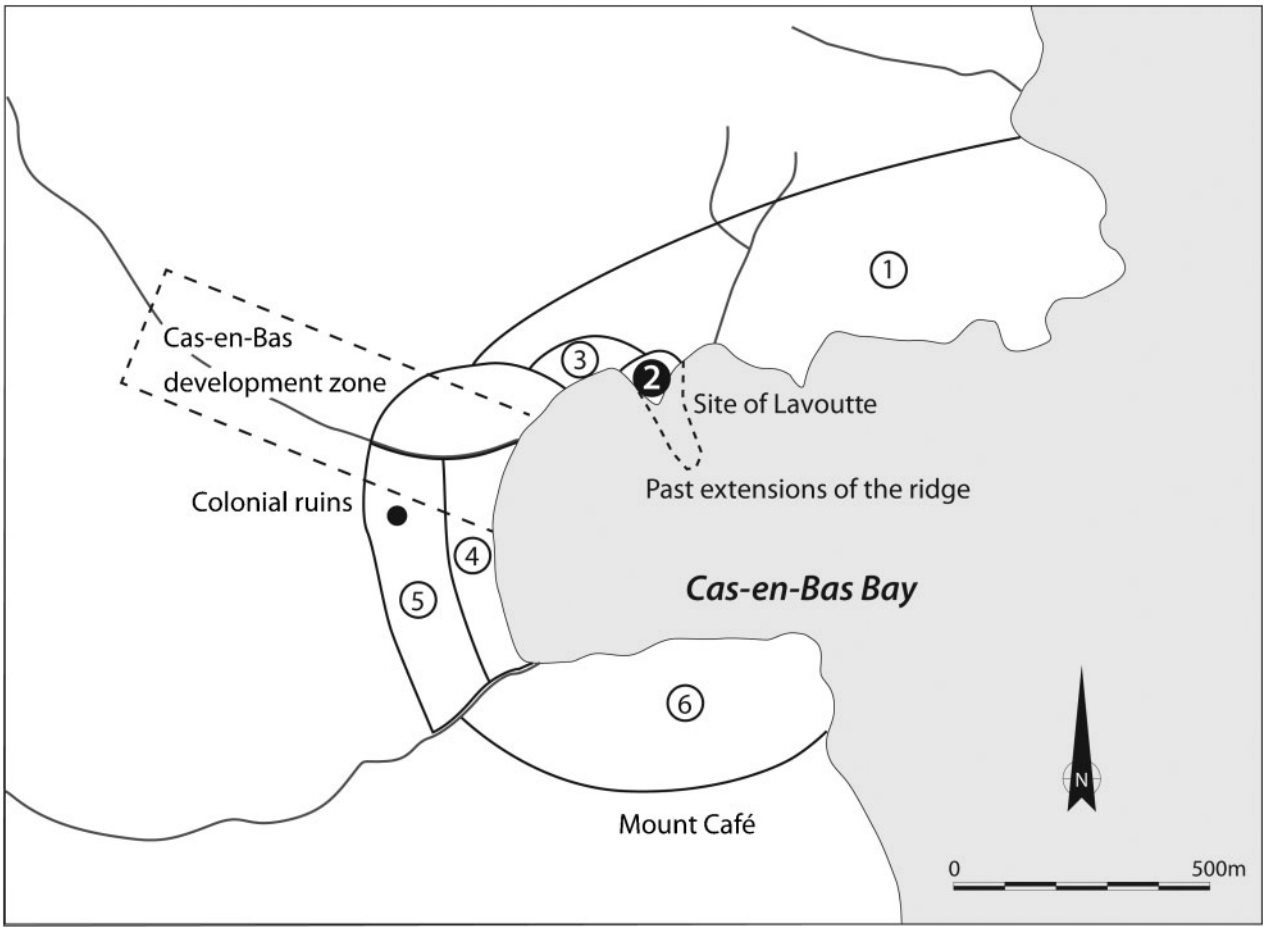

Figure 3 Paleoenvironmental reconstruction around the Lavoutte site. Numbers indicate the different vegetation zones.

except for a small number of unidentifiable charcoal fragments recovered from a hearth feature. The depositional environment and subtropical climate are not conducive to the preservation of plant material. However, the area was previously heavily vegetated and, based on our knowledge of past exploitation strategies in the region (e.g., Newsom and Wing 2004), the Lavoutte inhabitants had a good knowledge of their environment, most likely collecting fresh water from the surrounding catchments and exploiting plants for a wide variety of uses.

The lack of paleobotanical remains hampers accurate reconstruction of the local environment at the time of occupation. A general environmental reconstruction by Mike Field is based on current vegetation at the site and what is known of the ecology of the plant species represented, while taking into account colonial and postcolonial activity in the area which would have impacted the composition of the vegetation (e.g., disappearance, introduction, and naturalization of plant species). At the time of occupation, human activity was likely responsible for the relatively poor vegetation cover around the settlement (FIG. 3: zone 2). Today this area is occupied by a wind-sculpted low woodland consisting of trees such as *Capparis cynophallophora*, *Capparis flexuosa*, *Coccoloba uvifera*, *Erithalis odorifera*, *Hippomane mancinella*, *Jacquinia armillaris*, and *Tabebuia heterophylla*, not all of which are native to the region.

The inhabitants of the site overlooked the bay and the slopes of Mount Café (FIG. 3: zone 6), at the time covered by a xerophytic scrub or low woodland consisting of *Agave* spp., *Bursera simaruba*, *Croton flavens*, *Lonchocarpus violaceus*, *Plumeria alba*, *Tabebuia heterophylla*, and several varieties of cacti. Similar vegetation probably existed at the time of occupation on the slopes behind the site (FIG. 3: zone 1).

The littoral vegetation exposed to the prevailing northeast trade winds in the southwestern corner of the bay (FIG. 3: zone 4) was wedge-shaped in cross section, almost certainly due to aeolian forces. From the tidal zone moving landwards there are pioneer plants such as grass species and *Ipomoea pes-caprae*, and further inland are low specimens of *Coccoloba uvifera* backed by tall *Hippomane mancinella* trees with the occasional *Cocos nucifera* palm. The flat area behind the coastal vegetation (FIG. 3: zone 5) is composed of trees that recolonized the area after a period of colonial activity.

Behind zone 5 on the surrounding slopes is a dry scrub or low woodland represented by *Haematoxylon*

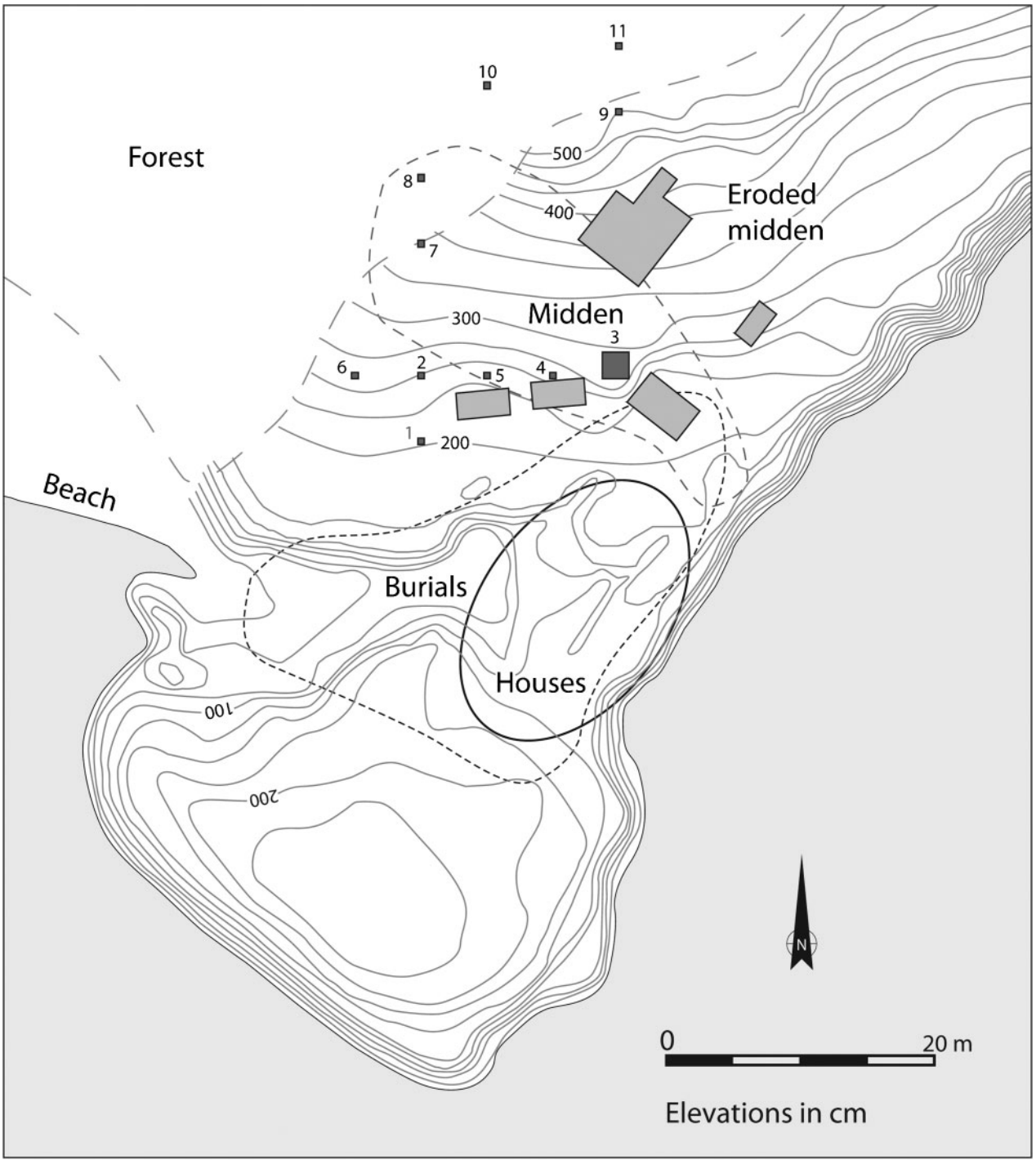

Figure 4 Map of the Lavoutte site showing the habitation, burial, and midden areas. Test pits and excavations are also shown.

campechianum and *Acacia tortuosa*. Further around the bay in the lee of the promontory on which the settlement was located (FIG. 3: zone 3) there probably existed woodland growing on a sandy beach whose canopy was not influenced by wind action. Trees that grow in this zone now may have been present at the time of occupation and include *Conocarpus erectus*, *Hippomane mancinella*, *Morinda citrifolia*, and *Thespesia populnea*.

At the time of occupation, channels flowed into the bay supplied by fresh water from the drainage catchment. Where these channels met the beach it is probable that small mangrove swamps existed with *Laguncularia racemosa* and *Rhizophora mangle* present. The root systems of these mangrove species would have produced sheltered, low energy environments where fine-grained sediments would have been deposited. Small patches of mangrove can be observed today on the margins of the freshwater channels that flow through the Cas-en-Bas development zone and into the bay at the foot of Mount Café (FIG. 3).

Field and Laboratory Methods

Rescue investigations at the site in 2009–2010 included a survey of the surroundings, open area excavation in the most damaged parts of the habitation and burial

areas, shovel tests to establish the extent of the midden area (FIG. 4), and a 2×2 m test unit in the highly disturbed midden.

Initially, our focus was on complete excavation of the burials under immediate threat. Subsequently, both manual and backhoe clearing was undertaken at the adjacent habitation area, revealing approximately 50 features consisting of postholes and hearths. These features were cleaned horizontally, measured, and sectioned. Burial features were first defined horizontally and then excavated following the contours of the grave pits in layers according to the arrangement of bones in the pit. Preliminary assessment of the human remains was performed during the excavation; a detailed description of burial taphonomy was made in the field by Menno Hoogland. Specific attention was given to ''archaeothanatology,'' the taphonomic processes of corpse decomposition and disarticulation (Duday 2009; Duday and Masset 1987). A photographic (stereo) record was made before and after bone removal to aid in the reconstruction of the burial.

The laboratory procedures followed a multidisciplinary design. Most of the analyses took place on the island. The osteological analysis and a separate study of dentition was performed in the field laboratory by Darlene Weston and Hayley Mickleburgh. Subsequently, the human remains were handed over to the SLAHS. Human teeth were sampled for strontium isotope analysis to reconstruct patterns of human mobility. Samples of dental calculus of a small number of individuals were analyzed by Hayley Mickleburgh and Jaime Pagán-Jiménez who sought to identify ancient starch grains from plant foods trapped therein. The isotope analyses were conducted by Jason Laffoon at the Faculty of Earth and Life Sciences at the Free University of Amsterdam in cooperation with Gareth Davies.

The ceramic and lithic artifacts were studied on site by Niels Groot and Sebastiaan Knippenberg. A sample of these artifacts, some human skeletal remains, and samples for radiocarbon dating were taken to laboratories in the Netherlands for further study. Petrographic and XRF analyses were conducted to determine the composition and provenience of the ceramic and lithic materials. A sample of faunal material from the midden area is currently under study by Dennis Nieweg.

Chronology, Stratigraphy, and Features

In total, 20 samples of shell, charcoal, and human bone were submitted for radiocarbon dating at the Center for Isotope Research at the University of Groningen, the Netherlands. Based on previous carbon and nitrogen studies carried out on human bone assemblages from the Lesser Antilles (Laffoon and de Vos 2011), it is estimated that 50% of the diet consisted of marine resources. The dates suggest three main periods of deposition for the burials: CAL A.D. 1150–1300, CAL A.D. 1300–1400, and CAL A.D. 1400–1600 (TABLE 1). The site's surface area is estimated at 2000 sq m. Excavations revealed a habitation area with house posts, hearth features, and burials in the southern part of the site and a garbage dump (midden) to its north that also contained a few burials (FIG. 4).

Table 1 Radiocarbon dates from the 2009 excavations at Lavoutte, Saint Lucia.

Lab no.	Sample no.	Material	Uncalibrated B.P.	Calibrated 2 σ date*
RL-26†	–	Shell (strombus)	710 ± 100	A.D. 1431–1829
GrN-46604	F67-02	Charcoal	645 ± 35	A.D. 1280–1397
GrN-46606	F67-21	Wood	240 ± 35	A.D. 1523–1951
GrN-46607	F67-31	Bone	1000 ± 40	A.D. 1150–1287
GrN-31944	F22	Human bone	750 ± 30	A.D. 1320–1442
GrN-32314	F57-23	Human bone	740 ± 30	A.D. 1323–1446
GrN-32315	F58-23	Human bone	720 ± 35	A.D. 1325–1460
GrN-32317	F67-03	Human bone	725 ± 35	A.D. 1323–1456
GrN-32318	F67-06/1	Marine shell	680 ± 25	A.D. 1543–1680
GrN-32319	F67-11	Human bone	770 ± 35	A.D. 1312–1433
GrN-32322	F67-24	Marine shell	805 ± 30	A.D. 1446–1586
GrN-32324	F68-01	Human bone	920 ± 25	A.D. 1233–1307
GrN-32325	F68-04	Human bone	790 ± 35	A.D. 1304–1422
GrN-32326	F68-06	Human bone	865 ± 35	A.D. 1274–1393
GrN-32327	F68-11	Human bone	745 ± 30	A.D. 1321–1444
GrN-32328	F68-20	Human bone	820 ± 35	A.D. 1293–1408
GrN-32329	F69-02	Human bone	620 ± 40	A.D. 1426–1619
GrN-32330	F69-05	Human bone	960 ± 35	A.D. 1190–1295
GrN-32331	05-69-55/2	Marine shell	950 ± 25	A.D. 1337–1449
GrN-32332	05-69-55/7	Marine shell	1070 ± 25	A.D. 1270–1388

* Calibrated with CALIB 6.1.0 (Stuiver and Reimer 1993, 1999).
† Bullen and Bullen 1970.

The midden area

The horizontal extent of the garbage dump is estimated at approximately 350 sq m. The stratigraphy reveals an accumulation of classic midden material to a depth of over 40 cm, covered by a layer of large broken pots. Five stratigraphic horizons were distinguished with the upper layers containing shells and ceramic fragments of mostly Suazoid type. Bullen and Bullen (1970) had previously noted a handful of Late Saladoid and Troumassoid ceramics in some parts of the dump. These types were not recovered during the 2009–2010 excavations; however, Caliviny red-painted and polychrome pottery, also mentioned by Bullen and Bullen (1970), was found in the lower levels of the midden area. The majority of the pottery is heavy and thick. Vessels include bowls, plates, and griddles with rounded and slightly thickened rims. Oval shapes and spouted vessels are common. Footed vessels, footed griddles, and support rings are also very common. Some vessels have tabular lugs. Red slip, incision, and finger-indented rims occur as well as a fair number of *adornos* with the typical Suazoid eyebrows (Bright 2011; Hofman and Branford 2011). Other ceramic artifacts include loom weights, spindle whorls, body stamps, and fragments of figurines. Along with the pottery, artifacts of shell, coral, and stone including celts, grinders, axes, and ceremonial paraphernalia were recovered. The lithic assemblage consists of a variety of local rock types such as chalcedony, red, yellow, and green jasper, and non-local rock types such as Long Island flint and St. Martin greenstone. Long Island flint occurs only occasionally and it seems that jasper, which is locally abundant, is the main rock type used for the production of cutting, sharpening, and engraving tools (Sebastiaan Knippenberg, personal communication 2010). Preliminary observations on the marine mollusc shells and the remains of other marine animals in the midden deposits suggest that the lifestyle of the inhabitants was largely centered around the exploitation of the marine environment; they relied mostly on fishing and the capture of turtles.

The habitation area

The habitation area is distinguished by a number of features (n=50) including postholes and hearths indicating the presence of residential and auxiliary structures. The substantial diameters and depths of the posts suggest the construction of fairly large and sturdy structures, possibly for protection against the heavy Atlantic winds. The carbonized core of some posts and evidence of a burned house floor suggest that at least one of the structures was burned. The scattered distribution of the postholes resulting from the considerable damage to the site hampered the reconstruction of potential (house) structures. The close relation between the structures and the burials indicates that individuals were most likely interred in or close to the houses, as documented at many other sites in the Lesser Antilles (Hofman *et al.* 2001; Hoogland and Hofman 1999).

The burial population

Including the three graves (containing four individuals) excavated during the 1980s by the University of Vienna, 48 burial contexts were recorded at the site. As several burials contained more than one individual, the minimum number of individuals recovered to date is 53. The vast majority of the skeletons (64.2%) demonstrated poor or very poor preservation, with extreme fragmentation of the bones, particularly the crania. This is directly related to the environmental and anthropogenic erosional factors outlined above.

Due to their poor preservation and severe damage, the vast majority of the skeletons were not very complete, with only 11 skeletons (20.8%) having more than 75% of their bones present, making it difficult to determine age, sex, stature, and morbidity patterns. Adult age was estimated based on measurements of the pubic symphyses (Katz and Suchey 1986; Todd 1921a, 1921b), the auricular surfaces of the os coxae (Lovejoy *et al.* 1985), and the sternal ends of the ribs (Işcan and Loth 1986a, 1986b). Other attributes considered were the degree of cranial suture closure (Meindl and Lovejoy 1985) and dental attrition (Brothwell 1981). For juveniles, age was estimated using degree of dental development (Smith 1991), the lengths of various long bones (Sundick 1978; Ubelaker 1989), and the degree of epiphyseal fusion (Scheuer and Black 2000). Adult and juvenile skeletons were assigned to standard age groups (cf. Buikstra and Ubelaker 1994). The sex of the Lavoutte individuals was determined based upon measurements of features of the skull (Ascádi and Nemeskéri 1970; Buikstra and Ubelaker 1994) and pelvis (Buikstra and Ubelaker 1994; Phenice 1969), and of the clavicle (Jit and Singh 1966), femur (Pearson and Bell 1917/1919; Stewart 1979), humerus (Stewart 1979), and scapula (Iordanidis 1961). Due to the enormous difficulties involved in assigning sex to juvenile remains (Scheuer and Black 2000), this was not attempted. Table 2 contains the combined age and sex data for the Lavoutte skeletal population. As the table shows, a large proportion of the burial population could not be aged or sexed, and thus it is extremely difficult to construct a meaningful demographic profile of the population. However, the age and sex profile of the burial population leans toward that of an attritional cemetery, i.e., burials accumulated naturally over time. Attritional mortality profiles characteristically exhibit a "u-shape," with a high frequency of infant deaths, a

low frequency of deaths among children and adolescents, and an increasing number of deaths through adulthood and old age (Paine 2000). Most aspects of the Lavoutte demographic profile seem to conform to the attritional profile, particularly the small number of children and the balanced sex distribution. Exceptions include the lack of infants and few deaths among those aged 46+ years.

The lack of infant skeletons at the site is a probable indication of different mortuary practices for infants. This pattern has been seen in the multi-period site of Anse à la Gourde on Guadeloupe (Hofman *et al.* 2001; Hoogland *et al.* 2010) and at the Puerto Rican site of Maisabel (Siegel 1992; Darlene A. Weston and Rachel Schats, personal communication 2010). The paucity of older adults can most likely be attributed to the difficulties associated with ageing the poorly preserved remains. It is possible that a large proportion of the individuals of indeterminate age may be 46+ years old.

Because it was not possible to undertake a complete osteological analysis of the four individuals excavated in the 1980s, these individuals were not included in the paleopathological statistics for the Lavoutte population. Sixteen of 49 individuals (32.7%) showed signs of skeletal pathology. Identified pathological conditions include non-specific inflammation/infection, degenerative joint disease, trauma, and activity-related pathology or "enthesopathy" (FIG. 5).

Relatively few of these pathologies would have contributed to mortality—the exception being one case of treponematosis (Yaws) in an adult female aged between 36–45 years (F68-20). This individual was affected by rugose periosteal lesions on the clavicles, humeri, radii, right ulna, second left metacarpal, left femur, and left tibia. The bilateral nature of these lesions coupled with the presence of nodes and superficial cavitations on the humeri and the shaft of the left femur indicate that this individual most likely suffered from treponemal disease (Hackett 1976).

Table 2 Strontium isotope values of human and faunal samples from the site of Lavoutte, and floral samples from various other locations on Saint Lucia.

Sample no.	Sample	Site	Sr ratio	2 standard error	Sex	Age
F57-17	Human enamel	Lavoutte	0.707273	0.000010	Female	36–45
F68-29	Human enamel	Lavoutte	0.707585	0.000008	Female?	18+
F67-31	Human enamel	Lavoutte	0.707611	0.000009	Male	36–45
A1	Human enamel	Lavoutte	0.707644	0.000010	Male	36–45
F67-11	Human enamel	Lavoutte	0.707678	0.000008	Unknown	18+
F67-33	Human enamel	Lavoutte	0.707704	0.000013	Male	46+
F57-11	Human enamel	Lavoutte	0.707715	0.000010	Female?	18+
F67-18	Human enamel	Lavoutte	0.707746	0.000011	Unknown	18+
F67-12	Human enamel	Lavoutte	0.707749	0.000010	Female?	18+
F68-20	Human enamel	Lavoutte	0.707830	0.000008	Female	36–45
F68-05	Human enamel	Lavoutte	0.707832	0.000008	Female	36–45
F69-02	Human enamel	Lavoutte	0.707836	0.000010	Female?	14–16
F57-03	Human enamel	Lavoutte	0.707848	0.000017	Unknown	10–12
F68-07	Human enamel	Lavoutte	0.707856	0.000009	Male	26–35
F58-23A	Human enamel	Lavoutte	0.707924	0.000010	Female	18–25
F68-01	Human enamel	Lavoutte	0.707925	0.000008	Male	26–35
A4	Human enamel	Lavoutte	0.707925	0.000008	Unknown	5–6
F69-05	Human enamel	Lavoutte	0.707942	0.000010	Unknown	35–45
F67-19	Human enamel	Lavoutte	0.707976	0.000008	Unknown	18–25
A3	Human enamel	Lavoutte	0.707995	0.000010	Female	18+
F68-11	Human enamel	Lavoutte	0.708025	0.000007	Female	46+
F68-08	Human enamel	Lavoutte	0.708033	0.000009	Unknown	4–5
F67-14	Human enamel	Lavoutte	0.708041	0.000011	Unknown	4–5
F67-13	Human enamel	Lavoutte	0.708105	0.000017	Male	36–45
F69-01	Human enamel	Lavoutte	0.708126	0.000011	Male	36–45
F67-05	Human enamel	Lavoutte	0.708148	0.000010	Female?	26–35
A2	Human enamel	Lavoutte	0.708164	0.000014	Male	46+
F57-23	Human enamel	Lavoutte	0.708176	0.000011	Female	26–35
F58-22	Human enamel	Lavoutte	0.708194	0.000014	Male	36–45
F68-04	Human enamel	Lavoutte	0.708257	0.000009	Male	26–35
F58-23B	Human enamel	Lavoutte	0.708296	0.000010	Male	26–35
F57-08	Human enamel	Lavoutte	0.708619	0.000009	Unknown	18+
SL-AL-Fa1	Snail shell	Lavoutte	0.707682	0.000005	n/a	n/a
SL-AL-Fa2	Rodent enamel	Lavoutte	0.707787	0.000011	n/a	n/a
SL-AL-Fa3	Rodent enamel	Lavoutte	0.707908	0.000009	n/a	n/a
SL-AL-Fa4	Snail shell	Lavoutte	0.708315	0.000010	n/a	n/a
4508	Grass	Point Hardy	0.707604	0.000009	n/a	n/a
4501	Grass	Caraibe Point	0.708115	0.000010	n/a	n/a
4502	Grass	Giraudy	0.708655	0.000011	n/a	n/a
4507	Grass	Haute Plantation	0.708658	0.000010	n/a	n/a
4504	Grass	Point du Caille	0.708855	0.000009	n/a	n/a
4505	Grass	Point du Caille	0.708870	0.000010	n/a	n/a
4503	Grass	Point du Caille	0.709006	0.000010	n/a	n/a

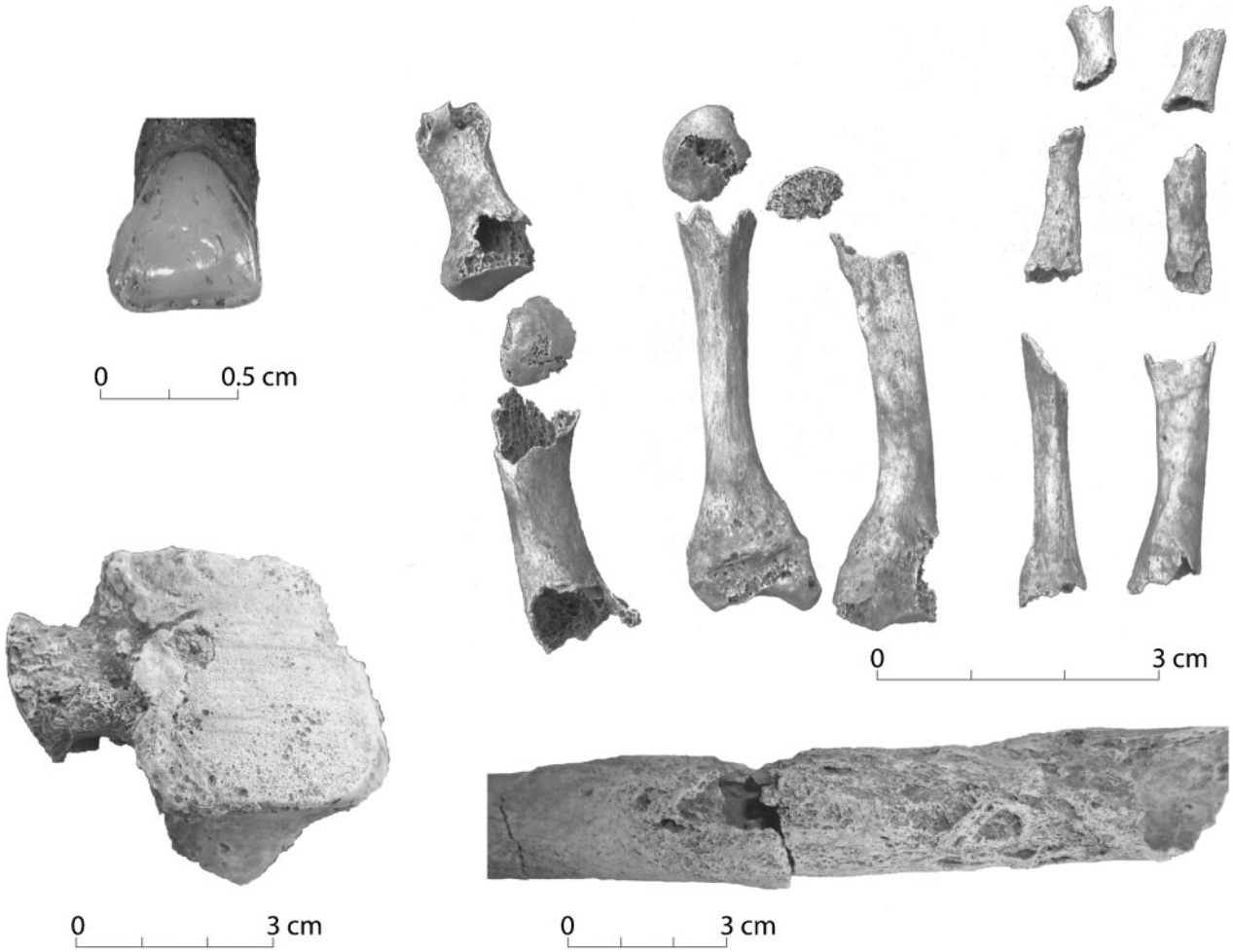

Figure 5 Upper left: non-masticatory wear (LSAMAT) in the upper left central incisor of individual (lingual view). Lower left: osteoarthritis in the ankle joint of individual F57-02. Upper right: atrophy of the fourth and fifth metacarpals of the left hand of individual F57-17 (note size difference with first to third metacarpals). Lower right: rugose periosteal lesions on the left humerus of individual F68-20.

Other than this likely case of treponematosis, most of the instances of skeletal pathology were either isolated events or had low frequency rates, e.g., non-specific inflammation/infection, trauma, and degenerative joint disease. In contrast to this was the comparatively high prevalence of enthesopathy in the humeri of the adult population (16.3%); the frequency of enthesopathy in adult males was 43%. Enthesopathies are frequently associated with trauma or overuse of various muscles (the pathology occurs to the enthesis, the site where the tendon, ligament, or joint capsule attaches to bone), though one must be careful to correct for age, as age-related degeneration can also be a factor in their formation (Cardoso and Henderson 2010). It is clear when looking at the pattern of pathologies in the Lavoutte population that the males were engaging in strenuous activities on a regular basis. Besides the relatively high frequency of humeral enthesopathies, males were affected by osteoarthritis (e.g., FIG. 5), degenerative joint disease, and activity-related trauma (e.g., compression fracture of the femoral neck, fractured lumbar vertebra).

One non-local female aged 36–45 years (F57-17) had atrophy of the fourth and fifth metacarpals and associated proximal and intermediate phalanges of the left hand (FIG. 5). There was no observable concentric remodeling on any of these finger bones. Bone atrophy can occur as a result of trauma or disuse, though posttraumatic atrophy is a relatively rare occurrence (McMaster 1937). It is difficult to determine the precise etiology of the finger atrophy, but as there appear to be no signs of trauma, disuse atrophy seems most likely. It is interesting to note that when the skeleton of this individual was excavated, a stone flake was positioned on top of the affected hand (see below).

Four instances of trauma were recorded: a fractured metacarpal shaft, a fractured radius shaft, a fractured femoral neck, and a fractured lumbar vertebra (spondylolysis). The types of injuries observed were likely the result of physical demands such as heavy lifting (Merbs 1989), with intense repeated and/or sustained stresses on the bone, although in the case of the fractured radius shaft, a direct blow or a fall is the most likely cause.

The dentition of 28 of the individuals was studied with special attention paid to the degree and type of dental wear and to any apparent dental pathology. Almost all of the adult individuals exhibited some form of dental pathology: antemortem tooth loss, caries, calculus, periodontal disease, or extreme wear. In general, the degree of wear in all individuals is high pointing to abrasive foods in the diet; however, the males showed a significantly higher mean degree of wear than did the females indicating that they consumed more of such foods. Antemortem tooth loss is very common, while conditions associated with periodontal disease are also prevalent. Calculus, mineralized plaque and a sign of poor oral hygiene, was extremely prevalent throughout the adult dental sample, with over 70% of the adults being affected. A high percentage of caries was found in both adults and juveniles indicating that they consumed a diet rich in cariogenic foods, such as carbohydrate rich plants (staple crops). The females had a significantly higher number (17.53%) of carious teeth than did the males (15.17%) suggesting that they consumed larger amounts of cariogenic foods. Research on sex differences in caries prevalence has demonstrated that in various cultures and subsistence systems females tend to be significantly more affected by caries than males (Kelley *et al.* 1991; Larsen 1997). These differences have often been explained as the result of gender-based differences in food processing and consumption. Females, who are often responsible for (staple) food production and preparation, are thought to consume more carbohydrate rich foods more frequently throughout the day, thus increasing their caries rate (Larsen 1983; Larsen *et al.* 1991; Lukacs 1992; Lukacs and Pal 1993; Walker and Hewlett 1990).

In comparison, the juveniles in the population had relatively healthy teeth. There were no examples of caries or periodontal disease. Calculus was an issue in two of the five juvenile individuals. Overall, the low frequency of dental pathology among the juveniles is symptomatic of their low numbers in the population.

Thirteen adult individuals were affected by an activity-induced pattern of dental wear known as lingual surface attrition of the maxillary anterior teeth (LSAMAT). This type of dental wear involves the loss of the lingual surface enamel of the maxillary anterior teeth (FIG. 5), and frequently occurs in other precolumbian Caribbean skeletal assemblages (e.g., Mickleburgh 2007, 2011). The enamel is often worn away entirely, leaving the dentine exposed, and the remaining structure tends to have a polished appearance (Irish and Turner 1997; Robb *et al.* 1991; Turner and Machado 1983; Turner *et al.* 1991). Of these 13 individuals, six are female, five are male, and two individuals are of unknown sex.

Turner and Machado (1983) argue that the most probable cause of LSAMAT is the use of the upper front teeth and the tongue to shred or peel abrasive plant material to extract nutrition or to use as tools. They strongly favor a masticatory (nutritional) cause, however, as they feel that the high degree of lingual attrition paired with the absence of evidence for gender-based differences must be indicative of a dietary practice. They suggest that the use of the maxillary anterior teeth and the tongue to strip the tubers of manioc or tule plants of their skin was the most likely cause of LSAMAT.

While there is some evidence for differences in dietary practices between males and females at Lavoutte (based on their degree and type of dental wear and dental pathology), the cases of LSAMAT are almost equally divided across the sexes, with no significant differences apparent. Thus, if LSAMAT was a masticatory activity, the gender-based differences in diet were not expressed through this practice. On the other hand, the fact that children are unaffected at Lavoutte may support the interpretation of LSAMAT as an activity-induced wear pattern, or in other words, the result of the use of teeth as tools in the manufacture of items made from plant materials, as the skills needed were learned throughout (adult) life, only leaving wear on the teeth after a considerable time. Despite the fact that the precise cause of LSAMAT is still unknown, its presence in the Lavoutte skeletal material is interesting as it indicates the habitual consumption and/or manufacture of plant material by a select group of the population (13 of 28 individuals).

Human Mobility

Strontium (Sr) isotope signals from the teeth of 32 humans, two rice rat teeth, and two land snail shells from the site itself and seven floral samples from various locations around the island were analyzed. A detailed description of the sampling strategy, and analytical protocols and procedures can be found elsewhere (Booden *et al.* 2008).

Saint Lucia is one of the Volcanic Caribbees, a group of islands forming a volcanic arc along the eastern edge of the Caribbean plate. The northern portion of the island, including the area around Cas-en-Bas, is primarily composed of basaltic centers and associated volcaniclastic deposits (Donovan and Jackson 1994; Maurey *et al.* 1990). Geologically young volcanic deposits tend to have relatively low, non-radiogenic Sr isotope signatures (Faure and Mensing 2005); however, coastal environments are often substantially affected by marine-derived Sr (Laffoon and Hoogland 2011; Vitousek *et al.* 1999; Whipkey *et al.* 2000). Thus, the Sr isotope range for the site of Lavoutte and the island of Saint Lucia was

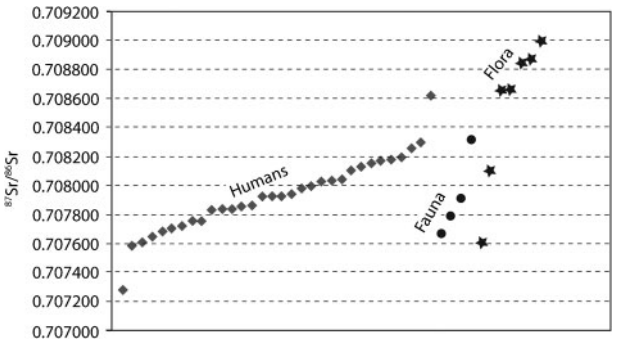

Figure 6 Range of strontium isotope values across sample categories.

expected to be intermediate between the lower values of the underlying geology and the somewhat elevated values of seawater. Floral remains from several locations across the island have $^{87}Sr/^{86}Sr$ values ranging from 0.7076 to 0.7090 (mean=0.7085, n=7). As expected, the range for the site itself was much narrower than for the island as a whole; it was estimated from the Sr signals of local faunal remains, with minimum and maximum $^{87}Sr/^{86}Sr$ values of 0.7077 and 0.7083 (mean=0.7079, n=4).

Strontium isotope signals in biological tissues reflect an average of the biologically available Sr in the local environment; those of animals with a small range are typically less variable than the total variation in the local environment (Price *et al.* 2002). As such, they are appropriate proxies for the isotopic variation among local human populations. The Sr isotope ratios from all samples from the site of Lavoutte are presented in Table 2 and displayed graphically in Figure 6. Comparisons of Sr data from faunal and human remains at the Lavoutte site bear out this premise, with most of the Sr isotope values from human remains clustering very closely with those from faunal remains. The $^{87}Sr/^{86}Sr$ values from the human sample population range from 0.7073 to 0.7086 (mean=0.7079, n=32). This mean is identical (within error) to that of the isotope data set for the faunal samples, providing independent support of our proposed local range. Statistical assessment of the human Sr isotope results identified two clear outliers (F57-08 and F57-17). We identify both of these individuals as non-locals, although they probably do not share similar geographic origins. The closest region with similar $^{87}Sr/^{86}Sr$ signatures to that obtained from the first individual, an adult female aged 36–45, is in the far south of the island of Saint Lucia. She displays a number of pathologies on her left hand as discussed above. The $^{87}Sr/^{86}Sr$ signature from the second individual, an adult of unknown age and sex, falls outside the overall range of Sr isotope values recorded for Saint Lucia, indicating a natal origin outside of the island. Identification of specific geographic origins is not possible based on Sr isotope data alone, although the $^{87}Sr/^{86}Sr$ ratio from the second individual is similar to values from a number of other islands in the Lesser Antilles (Laffoon and Hoogland 2011). Despite their varying origins, these individuals were interred in the same portion of the site in relatively close proximity to each other. No radiocarbon dates are yet available for these individuals.

Mortuary Behavior

Mortuary behavior is rather uniform, including 42 primary burials, only three single secondary depositions, and four secondary depositions of incomplete skeletons in existing primary burials. In three cases these consist of a burial of an adult individual with secondary remains of one or two other individuals. In one case, skull fragments and teeth of a juvenile (5 to 6 years old) were deposited in a primary grave of an adult male. Forty-five graves were recorded, of which three contained the remains of numerous individuals. In total, the (partial) remains of 49 individuals were excavated during the 2009–2010 rescue campaign. Twelve burials were radiocarbon dated, two of which are from the early period (CAL A.D. 1150–1300), nine are from the middle period (CAL A.D. 1300–1400), and one is from the late period (CAL A.D. 1400–1600).

There is consistency in the orientation of the burials, with approximately 90% of the individuals facing east, northeast, or southeast. The east-facing individuals with known radiocarbon dates all range between CAL A.D. 1300–1400, the middle period. Clustering is apparent in the spatial distribution of the burials in the far southeastern portion of the site. Instead of facing east, these individuals face north or south. Two of the individuals have been dated to the earlier period between CAL A.D. 1150–1300.

Most of the deceased are in very confined grave pits in seated or reclined positions with the legs tightly or semi-flexed and the arms crossed on the chest or positioned on the pelvis. An exception is one cluster of three individuals who were buried in elongated grave pits in supine positions, but still with (slightly) flexed arms and legs. Whether or not this is a diachronic difference remains to be confirmed by radiocarbon dating. In a number of cases, taphonomic processes indicate that the grave pit was left open for a certain period of time which allowed the displacement of bones outside of the body volume following the decay of the soft tissues and ligaments. There is no evidence that bones were removed from the grave after decay, as has been documented elsewhere in the Lesser Antilles (Hoogland and Hofman 1999). The confined position of some bones and visible "wall effect" indicate that some of the bodies may have been wrapped in perishable materials, such as hammocks or baskets, prior to interment

Figure 7 Individual F69-01 during excavation of the grave pit.

in very small grave pits (Duday 2009; Roksandic 2001). Grave goods are rare, but include volcanic stone flakes, shell ornaments, and bone artifacts. It is likely that grave goods may also have included perishable materials. The following descriptions of four remarkable burials illustrate some of the variation found in these assemblages.

Burial F69-01 is an adult male found in a seated position, with the lower arms flexed and resting on the abdominal cavity (FIG. 7). The legs are tightly flexed and are in a vertical position. The upper part of the torso including the cranium and the knee joints are missing, probably due to vehicle traffic and erosion. It is not possible to establish whether the cranium was removed intentionally. This burial was particularly rich in grave goods. Two tools (one of stone and one of coral) with clear use marks were found on both sides of the body close to the pelvis. Furthermore, a fragment of a very weathered manatee rib was found on the right tibia. This object resembles the Taíno vomiting sticks known from the Greater Antilles (McGinnis 2001). Other artifacts of manatee bone such as snuff-inhalers have been recovered from similar contexts elsewhere in the Lesser Antilles (Hoogland and Hofman 1999).

Burial F67-11 is a young adult individual dated to CAL A.D. 1312–1433 (FIG. 8). The burial was located in a severely disturbed part of the site and was damaged by vehicle traffic and erosion. The cranium and right arm were missing. Body parts such as the arm, leg, and pelvic bones belonging to two additional adults of indeterminate sex were deposited on a bed of soil covering the primary individual. This may indicate a later depositional event or that the deposition was simultaneous and these bones were separated on purpose. A large amount of charcoal was found inside of the grave pit as well as burned clay. This burial was located adjacent to two postholes.

Individual F68-06, an adult of indeterminate age and sex dated to CAL A.D. 1274–1393, was heavily damaged and eroded due to its proximity to deep tire tracks (FIG. 9). The cranium is oriented to the southwest. The precise depositional context of this individual is unclear, but it seems to be a primary interment of a single individual whose body may have been desiccated and tightly flexed before interment. The good articulation of a number of bones and the highly flexed position of the remains as a whole support this interpretation. Two shell ornaments

Figure 8 Individual F67-11 during excavation of the grave pit.

Figure 9 Left: individual F68-06 during excavation of the grave pit. Right: note the "Taíno-like" incised, wing-shaped shell ornament positioned on the long bones of the lower limbs.

were also recovered: a large perforated cowry shell found underneath some cranial fragments, and an incised "Taíno-like" wing-shaped shell ornament positioned on top of the leg bones.

Of particular interest is the composite burial F58-23 dated to CAL A.D. 1325–1460, which was partly destroyed by deep tire tracks traversing this part of the site (FIG. 10). The lower body of the primary individual was completely missing, however, some fragments of the pelvis remained. The deposit consists of a primary burial of a young adult female aged 18–25, in supine and extended position, and the secondary burial of a cranium of an adult male aged 26–35. The male's cranium was probably removed from the corpse before complete decomposition of the soft tissues as the mandible was tightly articulated and the upper and lower dentition was in occlusion (the jaw was closed). This cranium was deposited simultaneously with the corpse of the female and it was placed on her upper right humerus, facing her thorax. The grave pit was filled in immediately after deposition as indicated by the strict anatomical articulation of the female skeleton. Both individuals are isotopically local based on their Sr signatures.

Figure 10 Composite burial F58-23 during excavation of the grave pit.

Discussion

Despite the poor preservation, fragmentation, and loss of human skeletal remains at Lavoutte, our project uncovered a wealth of information on the lifeways and burial practices of a small Caribbean community in a dynamic coastal landscape. Beginning around A.D. 1000, the Lavoutte community established a village on the bay and exploited the marine and littoral resources of the surrounding area. The settlement comprised a habitation area on the coast probably with multiple wooden post-built houses, a cemetery, and a midden area behind the settlement to the north.

The demographic profile of the buried population at Lavoutte indicates that the cemetery accumulated over an extended period of time, as is also supported by the radiocarbon dates. It is noteworthy that the demographic profile at Lavoutte is predominantly an adult population; children are virtually absent, suggesting that they received a different treatment at death. The presence of an individual with clear evidence of treponematosis (Yaws) underlines previous indications that this disease was present in the region prior to European contact. Yaws is one of the four diseases caused by bacteria from the genus *Treponema*, and is believed to have been endemic to the Caribbean prior to the arrival of Columbus (Guerra 1978). It was also particularly prevalent in Saint Lucia, at least in the 20th century when 2800 cases were recorded between 1950 and 1953 (St. John 1985). It is tempting to ascribe the lesions observed on individual F68-20 to Yaws as well; however, while Yaws has been identified in many other Caribbean skeletal assemblages, caution must still be applied (e.g., Crespo-Torres 2005; Hoogland and Panhuysen 2001; Luna-Calderón 1983; Sandford *et al.* 2005; Vento and Gonzalez 1996; Schats 2011).

The poor condition of the dentition of many of the individuals suggests a heavy reliance on plant carbohydrates in addition to marine proteins, the latter being well represented in midden deposits. There are clear indications of gender differentiation in labor activities. Male individuals show evidence of involvement in physically strenuous activities perhaps including canoe paddling, whereas females show pathological signs of a more cariogenic diet. Mortuary behavior mostly consists of primary inhumations in small round or oval pits with a clear preference for cardinal orientation. The low frequency of grave goods suggests that a certain degree of social differentiation was marked in death. Furthermore, social relationships among the Lavoutte individuals are expressed through spatial clustering of the burials within the settlement and also through the sequential interment of two or more individuals within one grave. Hammocks or other perishable materials (e.g., baskets) were probably used as burial containers and in some cases burial pits were left open for a period of time after deposition. Similar practices are known from contemporaneous sites in the region, e.g., Anse à la Gourde on Guadeloupe (Hoogland *et al.* 2001; Hoogland *et al.* 2010), however, at Lavoutte practices seem to be more uniform and less complex. Manipulation of the grave and bones after interment, for example, is far less common. All but two of the individuals are locally born pointing to low rates of immigration to the site despite other evidence for the existence and maintenance of regional social ties. This contrasts with estimated rates of immigration at other sites in the region. At Anse à la Gourde, for example, around 28% of the population are non-locals based on their Sr signatures (Booden *et al.* 2008; Laffoon and Hoogland 2011; Laffoon and de Vos 2011). A range of domestic ceramics for cooking and food preparation, flake tools of local stone, as well as artifacts of non-local stone varieties, and pottery figurines show a full range of quotidian and ritual activities occurring at the site, illustrating that the community was tied into local subsistence and wider social networks.

The layout of the Lavoutte settlement, spatial distribution of burials, mortuary behavior, and the nature of the material culture remains reveal a picture of a small scale community in which a close relationship between the living and the dead persisted over time. The veneration of ancestors was an important aspect of the worldview of these insular communities, reflected in the continuous use of the combined habitation and cemetery area, the rebuilding of structures, and the deposition of kin on ancestral grounds in the context of the household, be it within or outside the house structure. Data from contemporary sites in the region show that this was common practice and demonstrate a recurrent pattern of village life, shared worldview, and exchange of goods and ideas throughout large parts of the archipelago (Hofman and Hoogland 2004, 2011; Fitzpatrick *et al.* 2009; Morsink 2011; van den Bel and Romon 2010). The presence of non-local pottery and lithic materials and artifacts in the region accentuates the integration of the Late Ceramic Age communities into millennia-old regional social networks in which people, goods, and ideas, as well as cultural and social practices amalgamated over time (Hofman and Hoogland 2011; Hofman *et al.* 2007; Hofman *et al.* 2011). The presence of "Taíno-style" ceremonial paraphernalia at Lavoutte reflects the geographical extent of this network incorporating the Greater and Lesser Antilles.

Conclusions

The Lavoutte rescue excavations represent an example of cooperation among all interested parties. More than 2000 Saint Lucians visited the site, presentations

were made at a number of schools, and an awareness campaign was enacted through the local media.

Lavoutte, however, is only one example of many sites in the Caribbean subject to severe natural and human transformations. These transformations are responsible for the rapid change of the insular landscape and destruction of the archaeological record. It is vital that research agendas are adapted to this development. Currently, archaeological heritage management in the many countries of the Caribbean is in a state of transition. While Caribbean nations and territories have now developed some form of heritage legislation following national and international standards, the complexities and conflicts of implementing these laws need to be dealt with at a local level in order to preserve, document, and interpret the rich archaeological record of the islands.

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