The St. Croix Archaeology Project and the Vescelius Collection: A Reexamination

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Abstract

In 1951, the Peabody Museum of Natural History at Yale University and the St. Croix Museum Commission conducted a joint archaeological survey on St. Croix, US Virgin Islands. This survey was led by Gary Vescelius, who at that time was a student at Yale University. The ceramics recovered from these investigations were used to refine the island's prehistoric chronology and for a settlement pattern analysis. This article presents the results of Vescelius' 1951 survey of St. Croix and compares his settlement pattern analysis with the results of more recent investigations. A geographic information system was created and analysis with ArcGIS® Spatial Analyst software used elevation, soil type and slope for a path distance (or least cost path) analysis. Second, the Vescelius ceramic collections, housed at the Yale Peabody Museum, were inventoried and studied. As a result, a better understanding of the island's prehistory, the potential roles of prehistoric Crucian settlements in inter-island interaction spheres, and the actions and behaviors involved in processes of settlement and social organizational change has been gained.

Keywords

Settlement patterns, St. Croix, networks, geographic information systems, ceramic style.

Introduction

This paper summarizes of the results of Gary Vescelius' 1951 archaeological survey of St. Croix, U.S. Virgin Islands (Figure 1). One outcome of this survey was an analysis of prehistoric diachronic settlement patterns for the island. Since this survey, however, there has been little application of more recent work in settlement pattern and regional analyses, such as network and social interaction theory, in the Caribbean and Greater Antilles. Second, with the exception of Gudmond Hatt's excavations in 1923, this was the first systematic archaeological study on St. Croix that did not focus solely on the collection of decorated ceramic vessels. The material culture that was collected during the field survey (some 28,000 objects) was comprised of both decorated and utilitarian ceramic wares, stone, shell and bone objects, and faunal remains. However, there was no discussion of these other kinds of objects in the final report.

Here the results of Vescelius' 1951 survey are reexamined in light of findings from more recent archaeological investigations across the island. First, a settlement pattern study was conducted by creating a geographic information system (GIS), using ArcGIS® Spatial Analyst [ESRI 2006], for all archaeological sites across the island. Using a rank-size distribution for all sites chronologically and a least-cost path–path distance analysis, a model for interisland interaction was constructed. Second, a preliminary qualitative study of collections of artifacts from "Crucian" archaeological sites concentrated on ceramic styles and decorative elements; an additional study on the presence or absence of polished stone axes, celts and semi-precious beads and ornaments was also done, but

Figure 1. The Caribbean and St. Croix, US Virgin Islands.

is not discussed here (Hardy 2008). Refined and decorated pottery, such as white-on-red (WOR) and zoned-incised-crosshatched (ZIC) wares, are considered indicative of processes of household-level specialized craft production. Through interactions both locally and regionally, a shared cultural heritage was both reinforced and generated with simultaneous innovations of unique forms of cultural identity.

Saladoid period settlers probably brought with them practices of village placement and land use, and associated conceptions of landscape. Links between communities and villages followed streams, rivers and ridge lines. The settlements themselves were located on terraces and bluffs above these waterways, at junctions with tributaries in inland areas, and at the mouths of waterways along the coast. Other communities developed between clusters of inland sites that were connecting nodes or hubs. These hubs were possibly located near resources, such as clays and stone, necessary for the production of utilitarian and prestige goods, or were involved with the transportation of goods throughout the system. Territories or polities of village groups may have been bounded within particular drainage systems; in other words, those villages and farmsteads located within a particular drainage system could constitute a socially related unit. These units would have comprised "localized interaction spheres." By examining both settlement patterns and stylistic elements, we can begin to infer cultural patterns and processes of sociopolitical organization, interaction and value.

Environmental Settings, Culture History and Crucian Chronology

The Arawakan peoples migrated and developed into Taíno culture on all the Caribbean Islands, beginning with the island of Margarita near the mouth of the Orinoco River in Venezuela and extending northwestward in a broad arc to Cuba and the Bahamas. This chain of islands has been subdivided geologically into the Greater Antilles—the four largest islands of Cuba, Hispaniola, Jamaica and Puerto Rico—and the Lesser

Antilles, which comprise the smaller and younger islands and cays.

St. Croix, sitting on the southern edge of the Greater Antillean Ridge, is geologically more similar to the islands of the Greater Antilles than the Lesser Antilles (USDA 2002; see Figure 1). The island is separated from Puerto Rico and the northern US Virgin Islands by the 4,500 m Virgin Islands Basin (Gill et al. 1989:49). The island measures roughly 32 km by 8 km, and has a dry, subtropical climate. Trade winds blow primarily from the east and northeast.

There are three main physiographic regions on the island, comprised of two mountain ranges (on the east and on the northwest ends of the island) separated by a large central valley (Whetten 1966; Hubbard et al. 1989; Nagle and Hubbard 1989). During the Cretaceous to the Tertiary periods, this valley was actually a basin or graben structure that separated two islands. As land was uplifted and sediments were deposited, eroded alluvium gradually filled the basin, becoming first a lagoon surrounded by a coral reef, then the alluvial fan-covered valley. These wide fans have, over time, continued to bury the marine sediments from Christiansted to the southwest, while recent marine terraces have been exposed in coastal areas and in the south-central and southwestern regions of the island. The mountains have been cut by streams or water flowing down guts, resulting in steep slopes and valleys.

Before Europeans stumbled on the Americas, the Antilles were inhabited by Amerindian societies, early explorers and settlers who were the ancestors of today's South American Arawakan-speaking societies. The first inhabitants of St. Croix were part of a larger migration of many groups from the middle and lower Orinoco River valley beginning around 1000 BC (Gassón 2002; Santos-Granero 2002). These peoples continued up the island chain of the Lesser Antilles, reaching the Virgin Islands and Puerto Rico around 400 BC. They were horticulturalists and made finely decorated ceramics. That they participated in complex interaction networks and political organization is evident by their hunting–fishing–farming economy, specialized craft production (if only part-time) at the household and village levels, long-distance trade for symbolically valuable objects, and designations of sacred ceremonial space. On some of these islands they encountered people whose ancestors had arrived some 2,000 years before. There is no evidence of the earliest Caribbean cultural phases—Casimiroid (about 4000 to 3500 BC) and Ortoiroid (about 2000 to 500 BC)—on St. Croix, though recent evidence for an aceramic component has been unearthed near Salt River (Carlos Solis, pers. comm. 2008). Subsequent movements of people followed similar paths, perhaps in waves, perhaps as individual voyages. Saladoid peoples may have had tribal, middle-range or ranked forms of social organization dependent on local unique historical trajectories (Siegel 1989, 1996; Curet 1996, 2003; Boomert 2000, 2001; Rodriguez Ramos 2007; Hardy 2008). Once on the islands, these peoples underwent many societal changes, interacted with their neighbors and maintained contacts with their South American homelands.

In general, these Saladoid societies (about 500 BC to AD 600) fished and practiced root crop horticulture, evidenced by the presence of ceramic griddles typically used by Orinocan and lowland Amazonian groups to cook prepared manioc into cassava. They also planted fruit trees and likely other plants (Newsom 1993; deFrance et al. 1996; Newsom and Wing 2004). Their ceramics were well made and high-fired, with well-executed decorative elements that included painting and incision. Villages were typically located in ecotones along watersheds and near river mouths near mangroves, estuaries, lagoons, coral reefs and soils amenable to horticulture (Morse 1989). Communities consisted of houses clustered around central ceremonial areas, with a cleared plaza surrounded by structures, further ringed by circular or U-shaped middens (Siegel 1989, 1996). They participated in long-distance interaction and communication networks, evident in both continued ceramic decorative traditions and the movement of exotic stone objects, such as jadeities used exclusively for groundstone celt production from the Motagua River Valley in Guatemala (Vescelius and Robinson 1979; Boomert 1987, 2000; Cody 1990, 1991; Rodriguez 1991; Allaire 1997; Harlow et al. 2006; Knippenberg 2006; Hardy 2008). These networks could have also included perishable goods known to have been exchanged between different cultural groups throughout the Orinoco and Amazonian regions, such as foods, feathers and baskets (Boomert 2000; Hornborg 2005).

Figure 2. Archaeological sites on St. Croix mentioned in text.

By the end of the Saladoid period and the beginning of the Ostionoid (about AD 600), hierarchical forms of organization begin to become institutionalized, evident on the landscape. Some villages remained small and may have been agricultural hamlets or activity camps, while others grew to be regional centers of power (Curet 1992, 1996; Rouse 1992; Siegel 1992, 1996). These centers, in turn, were hierarchical, some with only one plaza and others containing multiple plazas. One theory is that the dance and ball courts observed at some Chican village sites evolved out of the Saladoid settlement practice of clustering houses around the central plaza, thus alluding to a continued attribution of significance to these spaces (Alegría 1983; Rouse 1992). They were also sometimes established over Saladoid plaza cemeteries, further evidence for their continued ritual significance (Alegría 1983; Curet and Oliver 1998).

By the time of Christopher Columbus' arrival to St. Croix on November 14, 1493, the Taíno residents had, according to his guides, been recently overrun by "Island-Caribs"; scholars continue to debate who these people actually were.

In 1924, Gudmond Hatt of the Danish National Museum established the first prehistoric chronology for St. Croix and the Virgin Islands that, for the most part, has remained intact. The chronology was divided into three diachronic components, a preceramic tradition (Krum Bay) and two ceramic traditions, Coral Bay–Longford and Magens Bay–Salt River. The Coral Bay–Longford tradition consisted of ceramic traits found throughout the Lesser and Greater Antilles that are today described as Early or Cedrosan Saladoid (such as red-on-white and red-on-black painting, polychrome painting, ZIC wares, inverted "bell-shaped" vessels, and griddles), in addition to three pointer stones and beads and ornaments carved of both local and nonlocal stone. The Magens Bay–Salt River tradition consisted of ceramic traits found most notably across the Greater Antilles in midden levels above the Coral Bay–Longford ceramics, roughly equivalent with today's Late Salaoid or early Ostionoid, and continuing into the Late Ostionoid series (Elenan and Chican, or Taíno).

The prehistoric chronology for St. Croix today shows the cultural relations to Puerto Rico, eastern Dominican Republic and the rest of the Greater Antilles, and is largely based on the work by Hatt (1924) and Rouse (1992), modified locally by Morse (1995, 2004). The periods, series, subseries, styles and modes are as follows: Prosperity (about 200–100 BC to AD 400) and Coral Bay–Longford (about AD 400 to 600), phases of the Cedrosan Saladoid subseries corresponding to Rouse's periods IIa and IIb, respectively; Magens Bay–Salt River I (about AD 600 to 900) and Magens Bay–Salt River II (about AD 900 to 1200), phases of the Elenan Ostionoid subseries corre-

sponding to Rouse's periods IIIa and IIIb, respectively; and Magens Bay–Salt River III (about AD 1200 to 1500), reflecting the later infusion of Chican cultural influences into the Virgin Islands at the end of the Ostionoid period, corresponding to Rouse's Period IV.

The Yale Peabody Museum–St. Croix Museum Archaeological Survey

In 1951, Yale University's Peabody Museum of Natural History and the St. Croix Museum conducted an island-wide archaeological survey of St. Croix (Vescelius 1952). Thirty-six archaeological sites known to island residents were selected for investigation through generalized site inspection and surface collection. Twelve of these sites were excavated with test pits that measured 5 feet (1.5 m) square, dug in 6-inch (15 cm) levels. At most of these sites 10-foot by 5-foot (3 by 1.5 m) parallel trenches were excavated. The sites chosen for excavation were: Cotton Garden (Territorial Site 12VAm1-17), Cotton Grove (12VAm1-27), Cotton Valley (12VAm1-1, limited), Fountain (12VAm1-23), Great Pond (12VAm1-28), Judith's Fancy (12VAm1-5, limited), Jolly Hill (12VAm1-31), Manchenil (12VAm1-40), Milord Point (12VAm1-52), Richmond (12VAm1-4), River (12VAm1-22) and Salt River (12VAm1-6). However, only four of these sites were used for analytical units in the final report (Milord Point, Richmond, River and Salt River; Figure 2). A total of 28,447 historical and prehistoric artifacts were recovered. In this report (Vescelius 1952, also his bachelor's thesis), Vescelius only discussed decorated prehistoric ceramics; there was no analysis or discussion of shell, stone, or bone artifacts, or of undecorated ceramic wares.

Vescelius described the Milord Point site (12VAm1-52) as a shell midden comprising Analysis Units 11 and 12. Vescelius and the survey team excavated a minimum of four pits, each with two levels (A and B); Analysis Unit 11 was Pit 1, and Analysis Unit 12 was Pit 4. Pit 1, Level A, was dominated by the Santa Elena style (82% of 402 sherds), followed by Ostiones (16%), and Level B by Ostiones (78% of 85 sherds) with some Cuevas style wares (12%). Pit 4 was composed primarily of Cuevas style sherds in both levels (in Level A, 79% of 311 sherds were Cuevas, in Level B, 96% of 131 sherds), followed by Ostiones (Level A, 21%, Level B, 4%). The site has been dated to about AD 500 to 1200 on the basis of ceramic typology, or from the Late Saladoid through Ostionoid periods.

Archaeological investigations were conducted at the Prosperity site (12VAm1-11) from 1976 to 1979 by Vescelius (then the Territorial Archaeologist for the US Virgin Islands) and the Virgin Islands Office of Archaeological Services, Government of the Virgin Islands. The artifacts collected during these investigations have not been completely analyzed and the results have never been published. A single paper was presented by Vescelius and Linda Robinson (1979) at the 8th International Congress of Caribbean Archaeology held in St. Kitts and Nevis; this was also never published. In it they described the recovery of several stone ornaments, in various stages of manufacture, that resembled archaeological finds from Trants, Montserrat, Sorcé, Vieques, and Tecla, Puerto Rico.

According to notes and sketches in the Vescelius Papers housed at the Yale Peabody Museum, 20 excavation units measuring 1 m by 2 m and separated by 20 cm balks were dug across the Prosperity site. Levels in each unit were dug in natural strata. Human remains were encountered in one small zone in an area near the edges of horseshoe-shaped middens. Although over 30 radiocarbon samples of shell and charcoal remains were taken during the 1976 through 1979 investigations, and estimates made of their expected findings, no radiometric dates are known to exist. The site has been dated to the Early Saladoid on the basis of ceramic attributes and styles and is regarded as the "type site" for this earliest phase on St. Croix.

Vescelius' report is the only known archaeological publication for the site Richmond site (12VAm1-4). This report describes Richmond as a cleared plaza surrounded by several middens. The Yale team excavated five test pits, two large trenches and four excavations pits (or units), designated Analysis Units 1 (Pit 2) and 2 (Trench 3) in the final report. The middens were determined to have been disturbed, but no further descriptions on the nature of the disturbance were given other than they were likely from previous excavations. Using ceramic series names from Puerto Rico, Vescelius attributed most of the ceramics to the Cuevas period, followed by Ostiones and

Santa Elena. Today these periods are referred to as Coral Bay–Longford, Magens Bay–Salt River I and Magens Bay–Salt River II, respectively. One sherd was determined to be a Palo Seco style, which is found on Trinidad and dates to the Late Cedrosan Saladoid period.

Vescelius' work at the River site (12VAm1-22) comprised Analysis Units 9 and 10 in the final report. Vescelius and his team placed a minimum of five excavation pits in a flat area between a gut and a "large cultivated canepiece"; the total number of excavation pits is unknown. Pits 4 and 5 (Analysis Unit 10) were located on the edge of a deep gut. The profile drawings of these units illustrate a likely hearth. Unfortunately, there is no description of this profile or of the hearth, and without a site map it is not known in which wall this hearth was located. Based on the profile sketches, the hearth began at roughly two feet below the ground surface and was comprised of a top layer described as "red burned earth and white ash" (Vescelius 1952:53) that was roughly 6 inches (15 cm) deep. This was underlain by "friable dark earth" that was also about one-half foot (15 cm) thick.

Most ceramics from the upper levels of Analysis Unit 9 were attributed to the Santa Elena style (76%), with Cuevas style wares increasing as excavations continued down. By Level E, Cuevas style sherds comprised about 87% of all sherds from the unit. In Pits 4 and 5, the upper levels (A through C) were mixed, likely due to plowing. Overall, the Cuevas style comprised roughly 57% of the 596 sherds that were excavated, while in Levels E they were 83% of 384 sherds, and in Level F, 99% of 78 sherds.

Vescelius' work at the Salt River site (12VAm1-6) comprised one-half (6 of 12) of the analysis units used in the final report, Analysis Units 3 through 8. The survey team conducted a surface collection and excavated 13 test pits using the methods described above. A total of 11,695 historical and prehistoric artifacts were recovered from both the excavations and the surface collection at the Salt River site; all of the historical materials were associated with Fort Salé.

Analysis Unit 3 was located just to the southwest of Fort Salé and consisted of Excavation Pits 1 and 2, both of which were comprised of three levels (A through C) reaching a depth of 18 inches (about 46 cm) below the ground surface. Excavation Pit 1 contained 765 artifacts; 384 were from Level A, 350 were from Level B, and 31 from Level C. Excavation Pit 2 contained 926 artifacts (376 from Level A, 542 from Level B, and 8 from Level C). Non-ceramic artifacts of note were a celt fragment and perforated shell, a stone pestle, a shell pendant, spindle whorl, and worked stone.

Analysis Unit 4 was located west of Fort Salé, at the northwestern base of Grieg Hill, and consisted of Excavation Pits 3 and 4. Compared to the other analysis areas, relatively few artifacts were recovered from these pits (238 and 161, respectively), despite the fact that four levels (A through D) were excavated to a depth of 24 inches (about 61 cm) below the ground surface. Historic materials recovered included a pipestem with a fleur-de-lis stamp. Prehistoric ceramics aside, notable artifacts included a coral hammerstone.

Analysis Unit 5 was comprised of Excavation Pits 7 and 8. Pit 7 consisted of five levels (A through E), and was excavated to 30 inches (about 76 cm) below the ground surface. It produced 1,415 artifacts. Pit 8 had only three levels (A through C) dug to 18 inches (about 46 cm) below surface, with a total of 1,644 artifacts. Objects of particular interest included a hammerstone, celt fragments, spindle whorls and a fragment of a stone collar.

Analysis Unit 6 consisted of Excavation Pits 9 and 10, located just to the south and west of Pits 7 and 8. Pit 9 was excavated to two levels (A and B, to 12 inches [about 31 cm] below the surface) and produced 614 artifacts. Pit 10 was dug to three levels (A through C, to 18 inches [about 46 cm] below the surface) and produced 1,125 artifacts. Notable artifacts were recovered primarily from 10-A, including zemis and a spindle whorl.

Analysis Unit 7, presumably comprised of Excavation Pits 11, 12 and 13, was near the middens at the southernmost end of the site. These three pits contained the deepest stratigraphy for the site, with eight levels dug in Pit 11 (48 inches [about 122 cm] below surface; 1,661 objects), nine levels in Pit 12 (54 inches [about 137 cm] below surface; 1,697 objects), and six levels in Pit 13 (36 inches [about 91 cm] below surface; 563 objects). Non-ceramic artifacts included a perforated shell, a shell pendant, worked stones, celt fragments and conch picks.

Finally, Analysis Unit 8 was presumably comprised of Excavation Pits 5 and 6, located nearly

due south of Fort Salé; as with Analysis Unit 7, the page with this description is missing. Compared with the other excavation pits, these pits produced relatively few artifacts (268 and 196, respectively). Unlike Analysis Unit 4, though, only one level was excavated in Pits 5 and 6. Artifacts consisted of only ceramics and unmodified shells.

The excavations revealed that the Cuevas culture from Puerto Rico was the primary component at Salt River and that it extended across the entire site. Vescelius pushed back the proposed relative date of occupation of Salt River Point to at least around AD 400, if not earlier.

Based on his analysis of topography, surface features and soils, Vescelius estimated that only 28% of the total island land area had 63% of all the prehistoric archaeological sites known at that time, and that this land was composed of alluvium. Thirty percent of the alluvial sites were in the northwest mountainous areas of the island; most arose during the Late Saladoid period and continued to be occupied throughout the Ostionoid period. Nineteen percent of all sites were on rocky shores; others were in the highlands and valleys (10%), beaches (5%) and marl areas (3%). All of the larger communities were either within the alluvial zones or at the boundary between alluvial fans and mountainous or hilly regions (or in ecotones).

Of all archaeological sites known in 1951, 46% were located in the northwestern mountainous region; others were in the eastern portion of the island (21%), isthmus (14%) and the southwestern coastal plain (12%). One-third of these sites were defined as inland communities (more than one mile [1.6 km] from the shore).

Vescelius applied the Puerto Rico chronology current at the time to St. Croix. Initially, he found that nine of the sites were affiliated with Cuevas culture, which at that time was equated with the Early Saladoid period (equivalent to today's Hacienda Grande from Puerto Rico). He noted the presence of a few ceramics at certain sites that possibly represented trade wares. During the Saladoid period (Rouse's Period IIb, or the Coral Bay–Longford period), there were ceramics of the Palo Seco style from Trinidad: 14 from Salt River, six from the Richmond site and two from the River site. Later during the Magens Bay–Salt River II and III (Periods IIIb and IV) periods, both Capá (from western Puerto Rico) and Boca Chica (from eastern Dominican Republic) style ceramics were recovered; Boca Chica style wares were recovered from the Manchenil (23), Hermitage 2 (15), Salt River (13), Cramer Park (11) and Fair Plain (6) sites, while nine Capá style sherds were found at the Manchenil site. Their presence on St. Croix could be indicative of trade or of particular exchange ties and partnerships. Those wares representative of the Magens Bay–Salt River II and III periods are possible evidence for developing interaction spheres among the Vieques Sound region that eventually became the Taíno region of influence. There is additional evidence for the presence of Santa Elena and Esperanza styles, but it could not be determined whether these decorative styles were the result of parallel development or represented actual trade wares.

Settlement Pattern Analysis and Comparison

This study is based largely on the results of Vescelius' 1951 work, which have been compared with current listings in the Virgin Islands Territorial archaeological database, site file forms, Section 106-driven projects, and conversations with archaeologists who have worked on St. Croix. Only sites with confirmed location information were defined using their cultural and chronological associations, and those with site files were used for this analysis.

Site locations, temporal and cultural affiliation, and site sizes (area) were entered into a Microsoft Access® database, then brought as event themes into ESRI ArcGIS®, v. 9.2, where they were plotted onto digitized 1958 topographic quadrant maps of the island. The 1958 quadrant maps were chosen because they showed the island's physical features as they were before the many development projects of the 1960s. Elevation and slope information came from the United States Geological Survey's National Elevation Dataset (EROS 2006), using 7.5-minute elevation data converted to the Universe Transverse Mercator (UTM) North American Datum (NAD) 1983 projection. Soils information was gathered from the United States Department of Agriculture's Natural Resources Conservation Service Soil Survey Geographic Database (USDA 2002; NRCS 2008). For the purposes of this study, coastal sites are defined as those located within 1 km of the shore, while

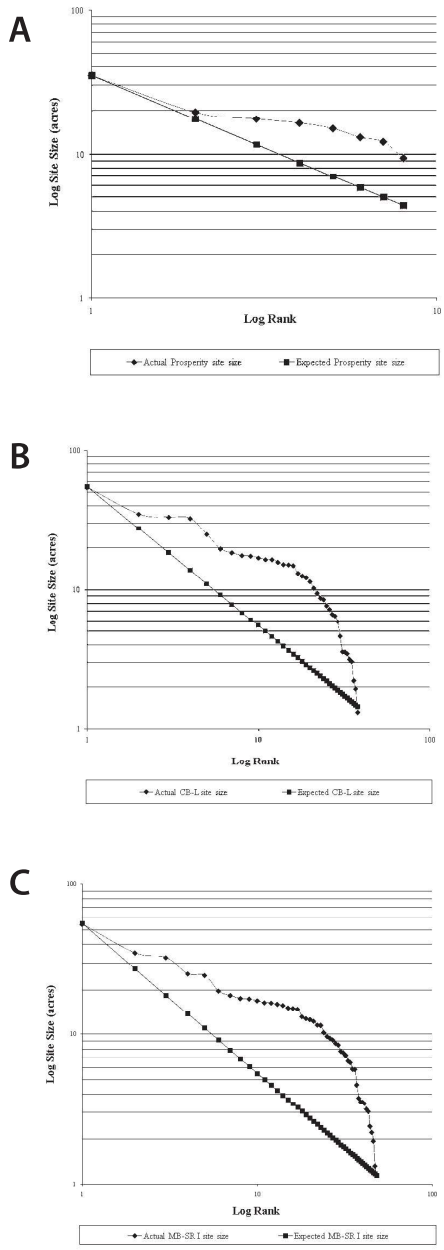

FIGURE 3. Log-log rank size distributions of sites. **A.** Prosperity phase. **B.** Coral Bay–Longford phase. **C.** Magens Bay–Salt River 1 phase.

the coastal plain is defined as more than 1 km away from the shore at an elevation between sea level and 40 m above sea level (masl).

Currently, there are nine archaeological sites with materials attributable to the Prosperity phase, and 37 sites are associated with the Coral Bay–Longford phase. The number of archaeological sites increases to 49 during Magens Bay–Salt River I, then begins to decrease to 32 in Magens Bay–Salt River II. By Magens Bay–Salt River III there are only 19 confirmed sites on the island.

Of the total of eight identified Prosperity phase archaeological sites (or settlements), all but one were located on the coast or in the coastal plain; of the 37 Coral Bay–Longford phase sites, six were in the inland–mountainous region, 22 were on the coast, and eight were in the coastal plain. A total of 18 sites were near the mouths of streams and watersheds throughout the Saladoid period (4 for Prosperity, 14 for Coral Bay–Longford), while a total of 15 (4 for Prosperity, 11 for Coral Bay–Longford) sites were near junctures of smaller tributaries that feed into the larger drainage system.

During the Magens Bay–Salt River I phase there were 23 settlements on the coast, 10 in the coastal plain and 14 in the interior hills and mountainous region, all within 500 m of a drainage or stream. Six of these sites were located at the boundary between 0 to 40 masl and 40 to 94 masl, as defined by the GIS. Many of these coastal sites may not represent actual villages, but could have been lookout points, fishing locales for inland settlements, or isolated one-house locations. These settlements largely remained occupied through Magens Bay–Salt River II; 13 sites were all apparently abandoned during this period. By the Magens Bay–Salt River III period, there were only two inland, 11 coastal and six coastal plain communities.

As described by both Vescelius (1952) and Morse (1989), the earliest Saladoid period sites were located on alluvial soils. This study showed that most sites, regardless of chronological period, were located on Glynn soils; this is not unexpected, as these soils are found along drainages, waterways, alluvial fans and terraces. These are followed by settlements on Glynn border soils, or on boundaries between Glynn series and other soil series. The Annaberg–Cramer and Victory-Southgate series soils are roughly equivalent in preference; the Annaberg–Cramer series are in the northwestern mountainous region, while the Victory–Southgate series is on the hilltops and slopes of the Salt River and the eastern hilly and mountain regions. By the Magens Bay–Salt River

III phase, settlements are preferentially located on Glynn and Victory–Southgate series soils, while the Glynn border soils are infrequently occupied. Settlements are only located on Hesselberg series soils during the Coral Bay–Longford through Magens Bay–Salt River I phases, while Arawak series soils have occupations during the Magens Bay–Salt River I and II phases.

The increase in the number of sites during the Coral Bay–Longford and Magens Bay–Salt River I phases seems at first glance to occur in two main patterns: as pairs, possibly the result of increasing populations and village fissioning, and along watersheds, where several sites cluster near potential headwaters. New settlements established both at the mouths of streams and at either the headwaters of these same streams or at the junction of these streams and tributaries could be indicative of the establishment of garden plots by coastal groups that, over time, could have turned into separate villages.

To determine relationships between the chronological distribution of prehistoric settlements across the landscape and their sizes with importance, a rank-size analysis was done for all sites on the island with confirmed locations, with estimates of site size based on surface survey and subsurface testing (when available). The rank-size rule (Zipf's Law [1949], or the log-normal rule) simply states that the second largest settlement is roughly one-half the size of the first, the third largest is one-third the size of the first, and so on, until the *n*th-sized settlement will be 1/*n*th the size of the first, expressed as follows (Falconer and Savage 1995):

$$P(n) = \frac{P(1)}{n}$$

When plotted, this rule illustrates a power law distribution with an exponential distance decay and when scaled with a logarithmic transformation a rank-size distribution plots as a straight line descending from the upper left down to the right. In archaeological contexts, log-normal distributions represent the expected distribution of a regional settlement system in which larger urban areas are "well integrated with their subordinate communities" (Falconer and Savage 1995:40). However, there are special cases to the rank-size rule when applied to preindustrial (and prehistoric) systems, in which variations from a log-normal distribution are frequent. There are four main types of variance to the log-normal distribution curve: primate, primo-convex, convex and double-convex distributions. The Rank-Size Program, v. 3.2.2 (Savage 2003) was used to run Monte Carlo simulations and a Kolomogorov–Smirnov one-sample goodness-of-fit test (K-S test), which evaluates the observed rank-size plots and compares them to an expected, log-normal distribution (Savage 1997:235). A least-squares regression was run on the rank-size plot.

The rank-size analysis shows several incarnations of convex and double-convex curve variations to the rank-size rule (Figure 3). During the Prosperity phase of the Early Saladoid period, there was likely little hierarchical organization of settlements, with the possible exception of the Glynn and Windsor sites; this phase shows a convex curve variation as defined by Savage (1997). All the cultural phases after Prosperity have a double-convex curve variation to the log-normal rule. This is interpreted as the likely presence of two or more forms of settlement systems existing in the same area, or that a central-place-like system was beginning to develop; a classic central-place settlement system will have a stair-step distribution (Savage 1997). During the Coral Bay–Longford phase, settlements seem to be organizing hierarchically, with most between 10 and 20 acres in size. This pattern continues into the Magens Bay–Salt River I and II phases.

To shed further light on the nature of possible intersite relations, a path distance analysis was then conducted for all sites on the basis of their chronological affiliation, using ESRI's Spatial Analyst program for ArcGIS® v. 9.2 (ESRI 2006). In short, the path distance calculates the minimum accumulative costs to travel across a surface from one point to another, while compensating for the actual surface distance and horizontal and vertical factors (slope). First, hydrology, basins and regions were determined using slope information. Drainages were defined using regions of streams. Even though today there is no running water on St. Croix, Salt River was a perennially running stream until 50 years ago, and Spanish and French maps dating to the middle of the 17th century depict at least three "rivers." It was therefore assumed that before the removal of the island's forests by European settlers there were many small rivers, streams and brooks that were both perennial and

A

B

C

D

E

Figure 4. Path distance analysis for sites, with drainages and basins. **A.** Prosperity phase. **B.** Coral Bay–Longford phase. **C.** Magens Bay–Salt River 1 phase. **D.** Magens Bay–Salt River II phase. **E.** Magens Bay–Salt River III phase.

rain-fed. Slope and elevation were the most weighted variables for site selection and location. Another assumption was that regular lines of communication and interaction between communities (nodes) will follow the shortest paths of least resistance (links) and, in this case, generally follow the hydrology along streams and watershed networks.

During the Prosperity phase, one settlement was established in each drainage system; four settlements were established at the mouths of streams and guts, while four were placed in the coastal plain (Figure 4A). In the Salt River drainage, the Salt River and Glynn–Windsor sites, located along the same waterway, were likely related. Five of these settlements could have been linked by overland routes that would have been of low travel cost, even though these paths would have cut across drainage systems. Coastal settlements would have been accessible by canoe along the coastline.

By the Coral Bay–Longford phase, additional

settlements were established at the mouths of streams, while interior settlements were located upstream, one near the headwaters and one farther downstream at the conjunction of the primary stream and a tributary (Figure 4B). These streams constituted the least-cost paths between settlements. Most new interior settlements were established in two drainage systems: the northwest mountainous region and the Salt River system. These settlements were likely linked by overland routes that met at strategic locales, namely the St. Georges and River sites. New coastal villages were established in the previously unoccupied northeast drainage, while three new settlements were established within the Great Pond system. The overland least-cost paths established during the Prosperity phase remain, while most of the new coastal sites were likely connected to each other by water routes that followed the coast. The cays began to be used.

There were few new settlements established during the Magens Bay–Salt River I phase and these appeared along the projected least-cost paths connecting northern and southern settlements (Figure 4C). Settlements continued to be concentrated in two drainage systems, the northwestern drainage and the Salt River drainage, which were still connected by two inland hubs. The eastern half of the island's coast continued to see growth; these settlements seem to be connected along linear paths following the coast, and the cays continue to be used.

During the Magens Bay–Salt River II phase the number of settlements decreased, while a new hub (the Fair Plain site) developed at the confluence of Bethlehem and River guts (Figure 4D). The "gap" that existed between the northwestern and Salt River settlement groups seemed to infill with new, small settlements that may have been nodes connecting these two regions, and the growing Fair Plain settlement may have been this region's central hub. The Prosperity settlement was abandoned, possibly replaced by Sprat Hall (12VAm1-12) as the node connecting the northwestern communities. The eastern settlements continued to be occupied, all having only two or three links to other communities.

Finally, the decrease in the number of settlements during the Magens Bay–Salt River III phase could have been the result of village centralization or nucleation, or of people moving to better-connected communities like Fair Plain, Sprat Hall and Salt River (Figure 4E). While the island's eastern communities were still occupied and linked to each other linearly, the other drainages, once filled with both inland and coastal settlements, now had only one or two communities each. The Salt River system retains three ridgetop sites, but their roles as either upland villages, lookout posts or some other function remains unknown. There is no longer evidence of the cays being used, but this evidence could have been erased by erosion, storms or cultural actions.

To investigate the potential development of small-worlds, nodes were connected to their nearest, most cost-efficient neighbors, as determined by the path distance analysis. Some nodes were connected to only one other node, while others were connected to several. While these connections were made using Euclidean distance, the paths chosen were the shortest measurable lengths within the corridors determined by the path distance analysis.

The numbers of connections for each node are defined as follows: nodes with one or two connections are individual actors within a small interaction sphere; nodes with three connections are potentially small hubs within particular spheres; nodes with four or more connections are larger hubs linking the smaller nodes (and their networks) to a larger network, and quite possibly with external networks that would represent long-distance relations (in other words, they are the strong links between the more weakly connected developing small-worlds). These better-connected nodes are the most likely locales for evidence of long-distance trade, the presence of valuable goods, and possibly scenes of sacred and ceremonial ritual. They could also represent the locations of specialized production of particular goods. In comparison, nodes with only one or two connections could be special use sites, like stone quarries, garden plots or even lookout posts.

Most settlements in all time periods have two connections, with the exception of Magens Bay–Salt River III communities, in which most settlements have three low-cost links. For all time periods, the most connected nodes in the system, those with four or more links, are the fewest in number but not necessarily the largest in site size. Until the Magens Bay–Salt River II phase, the most connected sites were also the largest sites.

Based on this analysis, the Prosperity phase settlements do not seem to be connected to each other through terrestrial links. These communities are potentially connected to only one other settlement, and it is possible that most of these settlements' ties were likely directed toward off-island settlements. However, by the Coral Bay–Longford phase not only are these settlements linked to each other, but they seem to have been developing into hubs connecting small sites with emerging intra-island networks, primarily in the Salt River, north central, and northwest regions of the island.

This pattern continued into Magens Bay–Salt River I, where most nodes have two and three links. It is during this time that the Salt River site joined the other hubs in the number of potential connections. During the Magens Bay–Salt River II phase there was a drop in how many communities had three low-cost links and an increase of those with only two. However, the Fair Plain site became a large hub, potentially connecting nearly every drainage system across the island. The Salt River site continued to be well connected, and could have been a "jumping off point" for inter-island communication and interaction. The number of well-connected nodes decreased, while the number of smaller, less-connected nodes increased. Finally, there was an apparent breakdown in the network during the Magens Bay–Salt River III phase, in which only the Salt River and Fair Plain settlements had more than three possible links, perhaps indicating the division of the island's population into two political regions centered at these communities, one to the north, the other to the south. Both of these archaeological sites have produced either fragments or complete stone collars and ceramic wares with decorative elements similar to the Boca Chica and Capá styles of the Dominican Republic and Puerto Rico.

As stated earlier, the climate for St. Croix today is dry and subtropical, and for the last 50 years there have been no perennial streams or rivers on the island. Observations by French settlers and cartographers during the 17th century noted the presence of at least three, and most likely four, rivers or major streams on St. Croix, all located in the Northside Range: Creque Gut, Mint Gut, Caledonia Gut and Salt River. Today these four major streams flow only intermittently during periods of heavy rainfall. We do not know whether the other smaller streams and tributaries would have been primarily rain-fed or perennial; regardless, even during periods of drought a dry streambed would be easy to traverse between communities. That being said, most cross-country least-cost paths were in the coastal plain, with little variance in elevation. The small size of the island—roughly 32 km long by 8 km wide—reduces the effect of size and distance when considering cross-country links to various nodes; on the other hand, the island's high relief is a determining factor for efficiency.

In comparison, there are three basic forms of settlement patterns known to have been used throughout lowland Amazonia: single dwellings, circular villages and linear villages (Boomert 2000:283). These settlements are most often semi-permanent or long-term occupations located on high bluffs and along the sides of valleys above active river channels, while the floodplain is often used for farming and gardens. Many villages are found along small rivers and perennial streams, above falls or rapids, and at the junctions of tributaries and rivers or where bluffs extend into the river, often on *terra preta* soils (Denevan 1996: 665). In the Orinoco Valley itself during the Early Saladoid period, the assumed "homeland" of the Saladoid people and culture, people occupied high, forested levees and terraces near rivers, tributaries, and at the mouths of seasonal streams (Boomert 2000:255).

The Vescelius Ceramic Collection

The second portion of this study was an endeavor funded by the United States National Park Service to inventory all known collections of artifacts recovered from archaeological sites now under the stewardship of the National Park Service, namely, the Salt River and Judith's Fancy sites. Salt River Bay National Historic Site and Ecological Preserve was established in 1992, and the well-known and often investigated Salt River site is within the National Park Service boundary; however, the Government of the Virgin Islands Department of Planning and Natural Resources maintains jurisdiction over the five-acre Columbus' Landing site.

These collections were studied between 2002 and 2006 at the following institutions: the Smithsonian's Institution's National Museum of Natural History and National Museum of the American

Figure 5. "Chalky wares." YPM 190103. Salt River site. Vescelius Collection. Courtesy of the Division of Anthropology, Peabody Museum of Natural History, Yale University.

Indian in Washington, DC, USA; the Peabody Museum of Natural History at Yale University in New Haven, Connecticut, USA; The National Museum of Denmark in Copenhagen; and Christiansted National Historic Site in Christiansted, St. Croix, US Virgin Islands. This project concentrated primarily on ceramic series, styles and decorative elements, the presence or absence of polished stone axes and celts, and semi-precious beads, amulets and ornaments; however, the focus of this article is only on the ceramic components.

Style is "both a component of human activity" and indicative of variation in material culture, identified systematically through the tracking of attributes (Hegmon 1992:519). Similarities in decorative and stylistic elements are not necessarily only indicative of common physical origins, or of movements or migrations across a landscape, but also of shared symbolic value and heritage through a variety of means of communication of ideas and knowledge. These identities, in turn, are not necessarily defined by kinship, but can crosscut blood ties through economic and "fictive" relations (Rice 2006:255). In other words, stylistic variability is representative of social interaction and reveals the creation, development and maintenance of social boundaries (Parkinson 2006). The influence of social networks on the production of goods and symbolic significance are imbued in their shape, use and symbolic design motifs. Additionally, the processes of pottery production itself, such as clay and temper selection, the relations necessary to obtain materials and the maintenance of styles over time through the interaction of teaching and learning are just as informative about the active roles people play as the communicative roles of the selected style.

Several ceramic attributes were noted, including thickness, methods of manufacture and decoration, mineral constituency, general composition of paste and temper, texture, color and weight. All available provenience information not included in the original 1952 report was gathered from the Vescelius Collection. Digital photographs were taken of all sherds selected for analysis. Additionally, the Yale Department Geology of Geology and Geophysics confirmed the identification of stone artifacts.

The value of studying such collections must be emphasized. First, because of the speed of housing and resort development in the Caribbean, especially in the Virgin Islands, many sites have

FIGURE 6. Brushed flange wares. YPM 190331. River site. Vescelius Collection. Courtesy of the Division of Anthropology, Peabody Museum of Natural History, Yale University.

been destroyed. In some cases older collections represent the only archaeological work conducted at a site, much of it, unfortunately, unscientific and not controlled. In other cases, such as with the St. Croix Archaeological Project, field collection during the excavations gathered not only pretty, decorated ceramic sherds and carved shell and stone, but also included faunal remains and undecorated vessel fragments.

This study of the Vescelius ceramics centered on utilitarian wares not typically discussed in the literature, at least for Crucian sites, and not included in the 1952 report. First among these was a pale yellow to white chalky ware (Figure 5). Eight sherds of this type were identified: from the Salt River site, Pit 7, Levels C, D and E, 12 to 30 inches (about 30 to 76 cm) below surface, Pit 12, Level D, 18 to 24 inches (about 46 to 61 cm) below surface, and Level I, 48 to 54 inches (about 122 to 137 cm) below surface; from the Sprat Hall site ("surface"); and from the River site, Pit 4, Level E, 24 to 30 inches (about 61 to 76 cm) below surface. They are thinner than other vessels (3.6 to 3.8 mm and 4 to 6 mm) and seem to have been confined to incurving vessels, some carinated. Studies of other collections of St. Croix material culture, especially the Hatt Collection at the National Museum of Denmark and those housed at the National Museum of the American Indian, have found other examples of these wares. Materials in the Hatt Collection were found near the ball court and plaza. Light buff-colored to white paste, thin-walled wares with burnishing are typically attributed to the Earliest Saladoid populations. However, the stratigraphic locations of these chalky wares chronologically places them with the Coral Bay–Longford, and possibly Magens—Bay Salt River I, phases. Finally, these wares were also encountered at the Judith's Fancy site during National Park Service investigations in 2005, and preliminary analysis of thin sections of these sherds indicates that they contain primarily calcite and calcium carbonate.

A second find was a group of ceramics with a burnished buff slip; in some cases these were heavily burnished. These wares were typically observed in Levels C to G at the Salt River, Sprat Hall and River sites and on the surface at Prosperity. Some of these buff burnished wares from the Salt River site (Pit 7, Level E, 24 to 30 inches [61 to 76 cm] below surface) and River site (Pit 3, Levels C and D, 12 to 24 inches [30 to 61 cm] below sur-

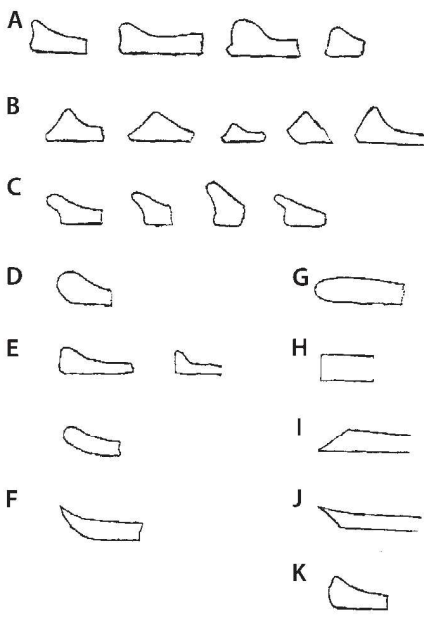

FIGURE 7. Griddle rim types. **A.** Concave raised rim. **B.** Triangular raised rim. **C.** Overhanging raised rim. **D.** Rounded raised rim. **E.** Perpendicular raised rim. **F.** Sharply edged upcurving raised rim. **G.** Not raised/rounded edge rim. **H.** Not raised/perpendicular edge rim. **I.** Not raised/inward bevel rim. **J.** Not raised/outward bevel raised rim. **K.** Raised convex rim. Not to scale.

face) showed evidence of "criss-crossed" brushing on the upper interior flanges of vessel necks (Figure 6). They averaged 5 to 7 mm in thickness, had a fine sand temper, and were found only in association with pale chalky wares (described above). Brushing could be representative of a distinctive ware type used for particular functions, an outward symbol of membership in a particular house, or the manufacturing style of an individual potter. Of course, without further work this is all speculative.

Griddle rims were also examined (Figure 7) and compared with a style guide for ceramic forms and decorative styles established by Kenneth Wild (Virgin Islands National Park) and Emily Lundberg (modified for this study). In general, griddle rims from the Ostionoid period tend to all have some form of upward or raised rim, while those from the Saladoid period reflect a mix of flat and raised edges. In the Vescelius Collection at Yale, most of the griddles from lower levels at all sites (Levels E through H, 24 to 60 inches [61 to 152 cm] below surface, roughly equated with the Prosperity and Coral Bay–Longford phases) had rims as in Figure 7E, G, H, I, J and L. Those from upper levels (Levels A through D, 0 to 24 inches [61 cm] below surface; roughly equated with the Magens Bay–Salt River I and II phases) had rims as in Figure 7A, B and E. Whether this diachronic shift in style preference is indicative of greater uniformity in production style over time is unknown. Possibly there were more potters during Early Saladoid times, located at each village or even in each household, creating their own unique stamps on standard utilitarian vessels. Over time fewer individuals could have been responsible for making pottery wares, possibly resulting in a standardization of rim elements on these vessels. At the same time, the emphasis on the production of well-decorated pottery vessels (WOR and ZIC wares) during Saladoid times devolved during the Ostionoid period. This shift is seen as evidence for greater changes in tribal ranking to more hierarchical forms, as symbolic (and likely cultural) values were no longer realized through pottery production, but through other mediums, such as stone carving and patterns of village settlement and layout.

Conclusions

The reexamination of Vescelius' settlement pattern analysis with a GIS-based analysis can be interpreted in the following way. St. Croix's prehistoric communities were strategically established along paths of transportation and communication. Over time, and as village populations grew, hilltop residences were established that were quite possibly defensive locales, especially on the hills above Salt River Bay. The initial settlements on St. Croix were founded in areas where lowland Amazonian and Orinoquian lifeways could be continued; that is, horticulture and gardening, with easy access to the seashore for fish, crabs and other marine resources. These settlements also likely included a territory that encompassed an entire drainage system, the only exception being those in the Salt River system where both coastal and inland communities were established. These drainage systems could have acted as political boundaries, and particular villages located in key locales could have risen in importance and devel-

oped into new hubs of interaction in growing localized interaction spheres (or small-worlds). Eventually new villages developed, possibly at interior garden plot locations. The initial places of settlement, however, remained important as centers that fostered the continuation of Saladoid-era beliefs and practices, indicating membership within the Arawakan interaction sphere. On the basis of the above analyses, the greatest changes apparently occurred at the end of the Prosperity phase, when links that had been focused on interisland and long-distance relations likely began to transition toward intraisland interactions. New nodes or settlements were established within each drainage.

Relationships developed between settlements along watersheds and drainages where those at the shoreline or at watershed entrances (in the alluvial fan) seem to be older than those farther inland, with the exception of the Salt River drainage. Interestingly, this pattern follows, in many ways, Vance's Mercantile Model (Vance 1970; Hardy 2008). This is supported by both the rank-size distribution and the GIS analysis, which show that, with the exception of the Prosperity phase, there were likely two or more forms of settlement occurring across the island simultaneously. By the Coral Bay–Longford phase, there were a wide variety of villages, ranging from small to large in size, and a settlement hierarchy was developing during the Magens Bay–Salt River I phase, with relations between "parent" and "satellite" communities. By the Magens Bay–Salt River II phase, a central-place system was beginning to develop around the Fair Plain site. Nearly every ecological setting contained small- and middle-sized communities, with marked preferences for lee shore beaches and hilltops adjacent to fertile bottomlands. Finally, during Magens Bay–Salt River III there were large villages at the seashore and fewer small, isolated communities, possibly representing greater nucleation of populations at growing villages.

With a model derived from theories of practice and complexity and Complex Adaptive Systems (CAS) (Watts and Strogatz 1998; Barabási and Albert 1999; Bentley 2003), the GIS analysis can be interpreted in the following way. Small-worlds began to form, in which local links of shorter distances were established between clusters in the newly developing regional network of the northern Lesser Antilles (Leewards)–Puerto Rico–Eastern Hispaniola region. The CAS eventually evolved to a critical state through multiple dynamic interactions. The initial Crucian settlements in each drainage developed into small hubs, connecting these newer communities into the larger system. A pattern of relations between better connected villages, located near the mouths of rivers and junctions with smaller streams, and lesser connected communities at the headwaters could also be explained in local interaction networks within the developing scale-free networks of small-worlds, where many smaller agents are connected to each other through a few higher ranked communities.

Stylistic changes in Crucian ceramics (and throughout the Virgin Islands) are indicative of interactions with communities in eastern Puerto Rico and eastern Hispaniola (Dominican Republic). Morse (1989, 1995, 2004) and Lundberg and Righter (1999) have found that many of these style attributes are illustrative of contacts with emerging Ostionoid hierarchical societies. As the regional and macroregional societies began to diversify and create small-worlds on local and regional scales, the once more rigid stylistic boundaries defining Saladoid and non-Saladoid identity became increasingly permeable. Localized and regional stylistic variability increased, continuing along this path well into the Ostionoid period. However, the presence of particular stylistic elements across regions, such as Ostiones, Esperanza, Capá, Chican and Boca Chica, are illustrative of interactions between individual communities. These potential contacts have been substantiated with a neutron activation analysis of ceramic sherds and clays from St. Croix (Ferguson and Glascock 2006; Hardy 2008). There is chemical evidence that Hacienda Grande pottery from Puerto Rico made its way to the St. Georges site on St. Croix, while at the same time Crucian pottery was transported to several sites on eastern Hispaniola and the Maisabel site on Puerto Rico.

This study has also revealed that reexamination of existing archaeological collections, in light of more recent finds and studies, could be a productive means of gathering data about the daily lives of societies long gone. In today's climate of reduced funding for survey and excavation, not to mention management and housing of new collec-

tions, reexamination of old collections can yet be useful for providing insight into past exchange and communication relations, forms and methods of settlement, and resource use and selection. The Vescelius Collection is remarkable for its provenience information, the discussion and presentation of its final report, and its analysis of settlement pattern and site distribution. This collection has yet to reveal all its secrets and has the potential to provide insight into the daily activities, practices and beliefs of ancient island cultures in general, beyond the terrestrial bounds of St. Croix.

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