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CROSSING THE BORDERS

New Methods and Techniques in the Study of
Archaeological Materials from the Caribbean



Edited by

Corinne L. Hofman, Menno L. P. Hoogland, Annelou L. van Gijn

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Crossing Disciplinary Boundaries and National Borders

New Methods and Techniques in the Study of Archaeological Materials from the Caribbean

Corinne L. Hofman, Menno L. P. Hoogland, and Annelou L. van Gijn

Introduction

During the past decades, Caribbean scholars have increasingly employed and developed new methods and techniques for the study of archaeological materials. While the aim of earlier research in the Caribbean was mainly to define typologies on the basis of pottery and lithic assemblages leading to the establishment of chronological charts for the region, it was not until the 1980s that the use of technological and functional analyses of artifacts gained interest. The 1990s saw a veritable boom in this field, introducing innovative methods and techniques for analyzing artifacts and human skeletal remains. Innovative approaches that were introduced included microscopic use-wear analysis, starch residue and phytolith analysis, stable isotope analysis, experimental research, ethnoarchaeological studies, geochemical analyses, and aDNA studies. Such studies benefited from a diverse array of experience related to the international background of the researchers constituting the archaeological community of the Caribbean. Most of these methods and techniques have long proven to be very successful in the study of archaeological materials elsewhere in the world, but in the Caribbean were less common and had not been applied systematically. The application of these approaches has shown their intrinsic value for the interpretation of the archaeological data of recently excavated sites throughout the Caribbean region and have provided new insights into the interpretation of the precolonial societies of the Caribbean, specifically regarding artifact manufacturing processes, technological systems, resource exploitation, diet, mobility, exchange, social organization, continuity, and cultural change.

The present volume forms an outcome of the symposium titled "New Methods

and Techniques in the Study of Material Culture in the Caribbean,” held at the 71st Meeting of the Society for American Archaeology in Puerto Rico in April 2006. The symposium was organized by Corinne Hofman and Annelou van Gijn, both of the Faculty of Archaeology at Leiden University, as a product of collaborative research between its Caribbean Research Group and the Laboratory of Artifacts initiated 15 years ago.

The purpose of this volume is to bring together new methods and techniques in the study of archaeological materials from the Caribbean and to assess possible avenues of mutual benefit and integration. The introduction of innovative approaches has generated new research questions for the archaeology of the Caribbean in general over the past years. The current volume comprehensively explores the advantages and disadvantages in the application of a selected number of newly emerging methods and techniques.

Each of these approaches is illustrated by a case study. A background to the study of archaeological materials in the Caribbean since the 1930s is provided in order to contextualize the latest developments in this field.

Background to the Study of Archaeological Materials in the Caribbean

The Initiators: 1930s–1980s

Typo-chronological studies have been the driving force in Caribbean archaeology since the early 1930s. Such studies were used to describe the cultural development in the Caribbean on the basis of pottery, because pottery represents a very important part of the material culture of Amerindian communities, besides artifacts made of shell, coral, and stone, and perishable materials such as wood, calabash, fibers, cotton, and feathers. The actual ratio of perishable vs. nonperishable materials in the original artifact assemblages of the Amerindian communities in the Caribbean is unknown, although it is most likely that perishable materials accounted for more than half of the material culture assemblage.

In order to establish a typo-chronological framework for the Caribbean, Irving Rouse (1972) employed the multivariate “modal” approach and advocated the classification of pottery styles as the basis for delimiting a material culture and the people behind that culture. In his view, recurrent artifact assemblages or “cultures” can be ascribed to one people and the cultural development of that people can be described on the basis of the development of style. Rouse, who followed the Mid-western Taxonomic System developed by McKern (Lyman and O’Brien 2002), defined a pottery style or complex as the entire pottery repertoire of a people during one single cultural period. This hierarchical scheme was conceived of as analogous to the biological classification system created by the eighteenth-century Swedish naturalist, Carolus Linnaeus.

Rouse emphasized each pottery style as defined by a unique set of material, shape, and/or decorative attributes, which may also be used to identify the area and period, and the people and culture responsible for its manufacture (Rouse 1972, 1989:385). Continuities and changes in modes were traced from style to style within a series or subseries in order to define and determine its origin (Rouse 1964, 1982). Style, series, and subseries names are derived from the site at which the characteristic modes were first identified. Rouse's method was subsequently adopted by McKusick (1960), Allaire (1977), Boomert (1980), and many others in the course of time. More recently, Rouse added the concept of wares to the notion of pottery styles. A ware is characterized by a set of modes for material, technology, shape, and decoration and can represent or be part of a pottery style (Rouse 1992: 81, 185).

Meanwhile, other Caribbean scholars developed alternative classification schemes. These were introduced into Caribbean archaeology by French, Spanish, North American, Antillean, and later also Dutch researchers (e.g., Barbotin 1974; Bullen 1964; Bullen and Bullen 1968; Gauthier 1973; Hoffman 1967; Mattioni and Bullen 1970; Petitjean Roget 1963, 1968, 1970; Pinchon 1952; Rainey 1940; Sears and Sullivan 1978; Winter 1978).

The French priest Père Pinchon (1952) for example, divided partial to complete vessels into domestic (plain, simple decoration) and ritual (elaborate decoration) earthenware and assigned functions to them based on ethnographic examples. Jacques Petitjean Roget (1970) classified vessel types on the basis of decoration, shape, and size. Scholars of the Spanish-speaking islands and Venezuela such as Veloz Maggiolo, Sanoja, and Vargas Arenas (Sanoja 1979; Vargas Arenas 1979a, 1979b) classified ceramic assemblages from the Guianas, Dominican Republic, and Venezuela on the basis of ware and decoration, vessel shape, and size in order to create profiles corresponding to "phases." In this same vein, scholars of the American school like Bullen (1964), Hoffman (1979), and Sears and Sullivan (1978) used the Southeastern System (Ford 1954) to identify types (types, local sequences, and specimens). This approach, also called the type-variety method, was introduced into the Caribbean by Evans and Meggers (1960). Bullen (1962, 1964) used the method to classify pottery on the Windward Islands (Grenada) and the Virgin Islands (St. Thomas), Hoffman (1967, 1979) for the classification of materials from the Bahamas and Antigua, while Sears and Sullivan (1978) classified pottery from the Bahamas using this method. In order to define a type they used the name of a site in combination with the name of the style variety (for example, Pearls Incised or Palmetto Punctate).

Some of the studies made use of data from ethnohistory or ethnography in order to arrive at interpretations of vessel function (e.g., Barbotin 1974; Petitjean Roget 1963). Jacques Petitjean Roget (1963) and later Maurice Barbotin (1974: Plates V-VIII) exploited information from the Carib-French and French-Carib diction-

aries by Père Raymond Breton for his descriptions of the Island Carib pottery. These scholars made attempts to assign functions to specific vessel shapes on the basis of Breton's description of their use. Barbotin (1974) describes among others the *chamacou* and the *taolouia*, which are large wide-mouthed pots serving as containers or drinking bowls; the *tourare*, equally large but higher and used as a cooking pot for vegetables, fish, and meat; the *ialigali*, a bottomless pot for grilling fish; and the *boutalli*, the griddle. Numerous others later took up this kind of research. Ethnohistoric sources also formed the basis to discuss the use, availability, and role of metals among the indigenous peoples of the Caribbean (Alegria 1974; Guarch 1978; Oliver 2000; Szaszdi Nagy 1984).

In addition to this focus on pottery, research into lithic technology and function was also initiated (e.g., Alegria et al. 1955; Barbotin 1973; Boomert and Kroonenberg 1977; Haag 1970; Pantel 1976; Petitjean Roget 1974, 1978; Pike and Pantel 1974; Pinchon 1961; Roobol and Lee 1976; Rouse 1941; Veloz Maggiolo and Ortega 1973), besides that of shell implements and ornaments as well as coral tools (Alcolado 1976; Armstrong 1979; Bullen 1964; Clerc 1974; Coomans 1965; Goodwin and Walker 1975; Goodwin et al. 1979; Sickler Robinson 1978; Suttly 1978). This category of studies resulted in descriptions of the technological and morphological aspects of lithic, shell, and coral artifacts, which were considered supplementary to the frameworks established on the basis of pottery. Apart from establishing typologies and sequences of production, typo-technological studies were used as a relative dating method and to make inferences about exchange items (e.g., Barbotin 1970; Bullen and Bullen 1967, 1970; Harris 1978; Mattioni 1970, 1971; Mattioni and Bullen 1970; Petitjean Roget 1970; Vescelius and Robinson 1979). Finally, there are the first archaeo-metallurgical studies of Krieger, and colleagues summarized in Vega (1979), employing basic wet chemistry techniques to identify approximate chemical compositions of metal artifacts excavated from sites in Cuba and the Dominican Republic. Vega himself was the first to then develop the application of archaeometric techniques using atomic absorption spectrophotometry (AAS) for chemical analysis. He focused on a study of metal artifacts recovered from archaeological sites in Haiti and the Dominican Republic. His analyses revealed the presence of European brass in an indigenous context for the first time, citing the high zinc content of a metal sample with 84.95 percent copper and 13.13 percent zinc (Vega 1979). Vega argues that the Taíno were exploiting and working locally available gold and copper into ornaments before European contact. This metal-working tradition then adopted the use of European brass as it became available in the fifteenth and sixteenth centuries.

Chanlatte Baik investigated a metal object discovered during excavations of an indigenous burial in Guayanilla, Puerto Rico (Chanlatte Baik 1977). Chanlatte Baik then discovered a modern source of riverine gold nuggets found in the local Rio Congo by José Rodríguez, a local resident. He consequently argued that lo-

cal gold resources were being exploited and worked by basic hammering and annealing.

The New Generation: 1980s–Early Twenty-First Century

From the 1980s onward, the number of studies focusing on technological aspects of archaeological materials in the Caribbean rapidly increased. Scholars gradually initiated new approaches involving archaeometric techniques, often already tested and in use in other parts of the world, next to applying conventional technological research. With the introduction of these new approaches the typological studies of artifacts initiated during the past few decades were systematically elaborated and complemented. A wide array of characterization studies, studies on manufacturing techniques, production sequences, and functional studies, have seen light in Caribbean archaeological research during the past two decades.

Technological Studies. Technological studies of artifacts have been undertaken to document production sequences, manufacturing techniques, and use. These studies not only include the analysis of pottery and lithics but to an increasing extent also that of shell and coral tools. Evidently, the diversity in classification methods described above was also pertinent in the way technology was approached. In this respect, mention should be made of the impact of the French school of André Leroi-Gourhan (1943) and his concept of the *chaîne opératoire* for the study of materials, which was introduced into Caribbean archaeology by archaeologists working on the French Islands (e.g., Allaire 1985; Bérard 2001; Rostain and Dacal Moure 1997; Serrand 2002). The principle of studying all sequences of the process of tool production and the pottery manufacture process, including the sourcing of the raw materials, processing, shaping, and finishing of the final product, emphasized the importance of incorporating technology into the study of Caribbean archaeological materials otherwise mainly focused on the classification of stylistic and morphological characteristics.

Other noteworthy frameworks in use in the Caribbean were based on differences between archaeological assemblages (Chanlatte Baik 1981); ecology and cultural lifeways (Goodwin 1979); or on more Marxist approaches like those by Dominican (Veloz Maggiolo 1991) and Cuban (Dacal Moure and Rivero de la Calle 1984) archaeologists. The Dominican/Cuban scheme was based on five stages of *modo de vida*, or ways of life, in which an evolutionary stage was related to a “mode of production.”

Following in the footsteps of the earlier generation of researchers, ethnohistoric and ethnographic research continued to be incorporated into technological studies in several instances in order to get grips on the relation between vessel form and function (e.g., Bloo 1997; Boomert 1986; Harris 1995; Hofman and Bright 2004; Petitjean Roget 1995; Roe 1989; Rostain 1991; Rouse 1992). Boomert (1986), for ex-

ample, made extensive use of various ethnohistoric sources in addition to ethnographic data from the Kari'na of the South American mainland in his discussion of the Cayo complex of St. Vincent. Harris (1995) used the same ethnohistoric information but also ethnographic data from the Shipibo-Conibo and the eastern Tukanoan people of the Peruvian Amazon in order to establish an ethnotypology for Antillean pottery (see below).

The study of the manufacturing process and function of pottery has revealed a wide range of techniques employed in the production of Caribbean pottery (Bloo 1997; Curet 1997; Harris 1995; Hofman et al. 1993, this volume; Jacobson 2002; Jouravleva and La Roza Corzo 2003; Roe 1989). Systematic insights were obtained in the fabrication sequences and ways of vessel shaping, decorating, and firing. In some cases it has been evidenced that several techniques were combined in the shaping of one vessel. This kind of research also enabled differentiation between pottery assemblages on the basis of technological parameters (Bonnissent 1995; Hofman 1993; Hofman, Hoogland, and Delpuech et al. 2003), rather than on exclusively stylistic and/or morphological attributes. As such, it was established that the Caribbean ceramics from the Early Ceramic Age can be clearly divided into classes in terms of fabric, shaping, decoration, and firing techniques (Hofman and Jacobs 2000/2001; Hofman et al. 2003). Roe and Harris both focused on complete vessels instead of pottery sherds in their approaches to pottery interpretation (see also Espenshade 2000). Roe (1989) adopted a "generative grammatical" approach that views the potter as selecting among pastes, decorative and functional elements, and motifs in designing and making a unique vessel. Roe built upon Rouse's modal analytic framework and aimed at reconstructing both stereotyping and innovation in archaeological pottery complexes. Harris (1995, 2001) introduced the notion of ethnotypology, focused on ethnographic reality, classifying pottery specifically by vessel types, defining Hypothetical-Vessel-Functions and Codes (ware, iconography, and form).

An interesting feature is that basketry was accidentally or purposefully used as a base for pottery manufacture as evidenced by textile impressions on ceramic sherds from Caribbean sites. As a result various weaving techniques could be documented that provide insight into Amerindian fiber work (Berman and Hutcheson 1997, 2000, 2001a, and 2001b; Hutcheson 2001, this volume; Petersen et al. 1999). The rare occurrence of basketry impressions on ceramics encountered at archaeological sites suggests that the Amerindian populations across the Caribbean region in general seem to have been making their ceramics on fiber mats only occasionally, whereas this appears to have been a common practice in the Bahamas (e.g., Chanlatte Baik 1984; Granberry and Winter 1995; Hoffman 1970; Hofman et al. 2001; Rouse and Cruxent 1963). Petersen and colleagues (1999) identified the techniques of coiling, plaiting, and twining as shown by textile impressions on ceramic sherds from Antigua and Montserrat. Twill plaiting predominates, a tech-

nique also employed most frequently in the Bahamas (Berman and Hutcheson 1997). Petersen and colleagues (1999) tentatively conclude that in the Northern Lesser Antilles at least, basketry may have been used as a base for ceramic manufacture largely, or solely, during the Early Ceramic Age.

The lithic technology of the precolonial peoples of the Caribbean has not been extensively studied to date. Research has predominantly been oriented toward tool and flake production and use, generating a panoply of descriptive texts on lithic reductive technology, morphology, and style (e.g., Allaire 1985; Bartone and Crock 1991; Bérard 1999a, 2001, this volume; Davis 2000, 2002; De Waal 1999a; Febles and Baena 1995; Febles et al. 1995; Harris 1983, 1991; Haviser 1999; Jérémie 1995; Knippenberg 1999a; Lewenstein 1980; Ortega and Guerrero 1985; Pantel 1991; Rodríguez Ramos 1999, 2001a, 2003; Roe et al. 1990; Rostain 1995; Stevens 2002; Vialon 2001; Walker 1980a). Many of these studies on lithic technology were aimed at detecting typo-chronological variants. Initially, the typology of Caribbean flint tools was based on the form and size of the tool in relation to similar tools in Europe and North America. The function of these tools was also transferred onto the implements found in Caribbean sites. Gus Pantel (1991:159) proposed an alternative approach emphasizing technological aspects of the Caribbean flaked stone tools based on a paradigmatic classificatory system in which dimensions and modes are described. The dimension refers to major axe variation in flaked stone assemblages, while modes represent specific individual variants. With his classification model he addressed more fundamental questions as to why cultural differences exist. Pantel is concerned with the lithic resources available to peoples in individual island biospheres and the acquisition and/or development of the technological skills necessary to exploit these environments.

Besides aiming at a better understanding of prehistoric technologies and the function of lithic tools, questions concerning typo-chronology and diachronic change within island assemblages were also addressed. Some of the Caribbean technological studies focused more specifically on axe-adze production and axe use (Berman et al. 1999; Chancerel 2003; Harris 1983; Mattioni 1990; Rostain 1994, 1995; Rostain and Wack 1987). Harris's (1983) classification, which served as a good temporal/chronological framework for axe/adzes, is based upon the shape of butts and blades. Their framework was derived from the analysis of more than 500 axes and adzes from all over the Lesser Antilles.

Another important category encompasses lapidary objects such as beads and pendants. Bead production evidences a highly refined lithic technology (e.g., Bartone and Crock 1991; Crock and Bartone 1998; De Mille 1996; De Mille et al. 1999; Haviser 1990a; Murphy et al. 2000; Watters and Scaglione 1994). While studies on the technological aspects of bead manufacture and source identification are still ongoing, most of the bead research has been focused on spatial and temporal distributions, identifying variability, and verifying centers for bead manufacture in

the islands (Boomert 1987a, 1987b, 2000:439; Cody 1991; Haviser 1999; Narganes Storde 1995a, 1995b; Rodríguez López 1991b; Watters 1997a:8, 1997b).

Typo-technological studies of shell and coral tools have been recently added to the array. Functional categories of shell tools were established on the basis of morphology, modification, and macroscopic use-wear traces, in some cases complemented with experiments (e.g., Alegría et al. 1981; Brokke 1999; Carlson 1995; Cartwright et al. 1991; Dacal Moure 1978, 1997; Dacal Moure and Croes 2001, 2004; Haviser 1990a; Izquierdo Diaz 1988, 1991; Jones O'Day and Keegan 2001; Keegan 1981, 1984; Lammers-Keijsers 2001; Lundberg 1985; Serrand 1995, 1997, 2001, 2002; Serrand et al. 1997; Van der Steen 1992; Vargas Arenas et al. 1993). Research goals involved investigation of *Strombus* axe/adze manufacture and use (Antczak 1998; Keegan 1984; Serrand 2001) and shell bead production (e.g., Carlson 1995; Dacal Moure 1989; Linville 2004; Littman and Keegan 1991). Methods for classifying shell artifacts have been presented by Dacal Moure (1978:22) and in a similar way defined by Keegan (1981:82), as departing from the fact that the morphology of the shell is the primary factor that describes tool form. Dacal Moure (1997:159) adapted his method while studying the shell artifacts of the Tanki Flip site on Aruba and put more emphasis on the relationship between artifacts and raw materials with the intention to better understand Amerindian activities. He made a division between recurrent forms, the more elaborate or highly modified (often polished) artifacts including beads and bead-blanks, and other shell material. Littmann and Keegan (1991:150) describe bead manufacture on the basis of broken beads and bead blanks from the site of Grand Turk. They distinguished two steps in bead manufacture involving flaking, chipping, and/or cutting the shell into a rounded bead blank with flat sides. According to Littman and Keegan, this was obviously the stage at which they were drilled.

Studies on the technology and function of coral tools of Caribbean sites have also continued to expand (e.g., De Waal 2002; Rostain 1997; Sipe et al. 1980; Steenvoorden 1992). Steenvoorden (1992:124–138) macroscopically identified use-wear on coral implements for the Saladoid site of Golden Rock on St. Eustatius and interpreted the fragments as grinders, polishing/rubbing tools, scalers, and bores or gimlets on the basis of their wear patterns, shapes, and worked edges in a similar way to Goodwin and Walker (1975:49), who described tools made of coral from Villa Taina in Puerto Rico.

Microscopic Use-Wear Analysis. Although there have been general attempts to relate artifact technology, morphology, and function, only very few older studies applied microscopic use-wear analysis in order to confirm hypotheses about tool function and to improve our understanding of the way artifacts were handled in the domestic activities carried out. Since the mid-1970s microscopic use-wear analysis has been a well-known method in European archaeology and elsewhere

(Van Gijn 1990), but unfortunately it has been applied only in rare cases in Caribbean archaeology (Bartone and Crock 1991; Lundberg 1985; Sears and Sullivan 1978; Walker 1980a).

In 1980 Walker was the first to apply the Low Power microscopic approach to a Ceramic Age flint assemblage, that from Sugar Factory Pier on St. Kitts (Walker 1980a, 1980b, 1983). During the last couple of years, Low Power techniques have been supplemented by the High Power approach, and both have been increasingly applied to flint assemblages from the Caribbean (Briels 2004; Lammers-Keijzers 2007). Until about five years ago the majority of use-wear research worldwide was directed at flint tools. Recently, tools made of pottery, shell, bone, antler, or coral have been examined as well (i.e., Barton and White 1993; López Varela et al. 2002; Maigrot 1997, 2001; Oversteegen et al. 2001; Van Gijn 2005; Van Gijn and Hofman in press). Some of these studies were done on Caribbean artifacts (Kelly 2001, 2003, 2004; Kelly and Van Gijn this volume; Lammers-Keijzers 1999; Van Gijn et al. this volume).

In a similar vein, Christy de Mille and Tamara Varney (2003, this volume) used scanning electron microscopy (SEM) on molds of stone beads from Saladoid sites on Antigua to examine traces of manufacture. This research addresses questions as to the manufacturing techniques, organization of production, and intra- and intersite variability in order to get a better understanding of Saladoid lapidary technology as a whole, in which technology is viewed as socially meaningful and mediated.

In the process, use-wear analysis has also provided information on organic materials worked by the Caribbean Amerindians, otherwise lost in the archaeological matrix but which play a crucial role in comprehending past subsistence and craft activities (Briels 2004; Kelly 2003, 2004; Lammers-Keijzers 2007; Nieuwenhuis 2002; Van Gijn et al. this volume).

Recently, starch and phytolith analysis on stone tools and ceramics has proven to be a potentially valuable source of information on what plant species were processed with these tools in Caribbean archaeological sites (Lundberg 1989; Nieuwenhuis this volume; Pagán Jiménez and Oliver this volume; Pagán Jiménez et al. 2005; Rodríguez Suárez 2004; Rodríguez Suárez and Pagán Jiménez this volume). This kind of research may also be an aid to paleobotanical investigation in defining plant species (Newsom this volume; Newsom and Wing 2004; Pagán Jiménez and Oliver this volume; Pagán Jiménez et al. 2005).

Only in rare cases has the entire toolkit of Caribbean sites been studied, involving the technological and functional analysis of shell, coral, and stone tools and the interaction of these tools in particular activities (Kelly 2004; Rostain 2001; Rostain and Dacal Moure 1997; Van Gijn et al. this volume). This type of research starts from the premise that technology is a cultural phenomenon that plays an active role in the reproduction of society and in processes of change (Appadurai

1986; Dobres and Hoffman 1994; Lemonnier 1986, 1993a, 1993b; Van Gijn in press). People make choices that are in harmony with the existing technological system. Microscopic use-wear analysis makes it possible to track the more hidden technological choices. Central to this research is the comparison of the function of each tool category and the determination of the choice of raw materials for specific activities. Were these choices related to cultural or technological parameters and does the picture change through time?

Rostain and Dacal Moure's (1997:265–278) study focused on shell, coral, stone, and bone implements from the Tanki Flip site on Aruba. In order to compare tools made of different raw materials they focused on the manner in which these materials had been modified by the Amerindians using the classification scheme of Leroi-Gourhan (1943) based on type of modification (type of movement and working edge). They distinguished between three types of movement (impact, pressure, and pressure with hammer) and three types of working edges (cutting edge, point, and flat side). Rostain and Dacal Moure conclude that the manufacturing techniques for stone, shell, coral, and bone comprised flaking (freehand and bipolar percussion), hammering, pecking, abrading, polishing, incising, and drilling and concluded that the Amerindians at Tanki Flip had the ability to apply the majority of the techniques to various hard raw materials, without striving to an aesthetically high level, however.

Experimental Archaeological Analysis and Ethnoarchaeology. Technological and functional studies of archaeological materials in the Caribbean have benefited from experimental archaeology and ethnoarchaeology. Replicas have been made to enhance the understanding of certain techniques, and experiments have been used to carry out specific activities (e.g., Bérard 2001; Bonnissent 1995; Briels 2004; Dacal Moure et al. 2004; Hofman and Jacobs 2000/2001, 2004; Hofman et al. 1993, this volume; Keegan 1981; Kelly 2001, 2003, 2004; Lammers-Keijzers 1999, 2001; Lundberg 1985; Petitjean Roget 1990; Rostain 1991; Van der Steen 1992; Vialon 2001; Walker 1980a). Jeff Walker (1980a) studied the manufacturing techniques and functions of the lithic artifacts found at the Sugar Factory Pier site on St. Kitts by incorporating data from ethnography and experimental archaeology into his archaeological analysis. Walker replicated flint tools and employed them for peeling and grating tubers, sawing, whittling and planting wood, and engraving shell. He also used data from ethnography and ethnohistory, which provided additional data on the use of stone tools. The combination of the different data sets has generated new insights in site activities, subsistence patterns, and potential trade networks (Walker 1980a:73).

Ethnoarchaeological studies from northern South America have also enhanced our understanding of the various sequences of the manufacturing process and use of artifacts in precolonial Caribbean assemblages as well as that of the sociocul-

tural parameters and choices involved in the actions (e.g., Cornette 1991, 1992; Duin 2000/2001; Hofman and Jacobs 2000/2001; Van den Bel 1995; Vredenburg 2004). In recent years, a number of anthropologists and archaeologists worldwide have made clear that technological behavior is social, political, and symbolic/cognitive, and as such it is embedded in the behavior, ideas, and value systems of a society (Lemonnier 1993a; Stark 1998).

Most of the Caribbean ethnoarchaeological studies deal with the manufacturing process of pottery. Cornette (1991, 1992) adopted a morpho-stylistical and technological approach to the pottery of the Galibi (Kari'na) of coastal French Guiana. He used archaeological and ethnographic data and conducted research among the Galibi on the fabrication process. His study resulted in a very useful overview of the rapidly disappearing Kari'na pottery tradition. Vredenburg (2004) similarly made a study of the closely related pottery manufacturing traditions of the Kari'na of the lower Maroni River in Suriname. She studied the raw materials, manufacturing process, and function of the pottery vessels with the notion that it was permeated with the animistic and mythological worldview of the people who produced the ceramics.

Petrographic Analysis. Low-tech microscopic analysis of the fabrics and high-tech petrographic analysis has been used to explore the source of origin(s) of clay and nonplastic inclusions (temper). The outcome of these studies on pottery provided insight into the differential use of clay sources through time and between pottery styles (Curet 1997; Faupl 1986; Goodwin 1979; Goodwin and Thall 1983; Hofman and Jacobs 2000/2001, 2004; Hofman et al. this volume; Mann 1986; Walter 1991:13, 45); the procurement at local sources if the needed raw materials were available (Arts 1999; Bloo 1997; Van As and Jacobs 1992); the subsequent use of different clay sources on one island (Belhache et al. 1991; Cox O'Connor and Smith 2001); the selective choice of clay sources and within clay sources (Hofman et al. 1993); and the procurement of raw materials or finished pottery products on neighboring islands or on the mainland of South America (Boomert 1986; Crock 2000; Donahue et al. 1990:229; Fuess 2000; Fuess et al. 1991; Hofman et al. 2005; Petersen and Watters 1991b:355). As such, it was evidenced that in the Leeward Islands of the Lesser Antilles, the islands of volcanic origin served as sources for raw materials of finished ceramic products for the limestone islands of Barbuda and Anguilla (Crock 2000; Donahue et al. 1990:229; Petersen and Watters 1991b:355). In the southern Lesser Antilles, on St. Vincent, part of the Cayo pottery assemblage was found to be tempered with *caraipé*, the burned bark of the *kwepi* tree of the *Licania* genus. This is not a species indigenous to these islands and must have come from the mainland of South America or Trinidad where this tree species is endemic (Boomert 1986). Contacts between the islands and the South American mainland during the Late Ceramic Age have therefore been postulated.

Similarly, petrographic analysis has been used to identify the nature of greenstone artifacts found at the site of Hope Estate, St. Martin, and to establish the source area of this material (Van Tooren and Haviser 1995). It was identified as radiolarite or tephrite and its local origin at Hope Hill was confirmed. The identification of this source area presented important opportunities for later research on inter-island contacts (Crock 2000; Crock and Petersen 2004; Knippenberg 2004, 2006). Rock types from the site of Tanki Flip, Aruba, were identified by petrographic analysis in order to discriminate foreign origins (Rostain 1995, 1997a). As no chert deposits occur on Aruba, the Tanki Flip occupants would have traveled to quarries on other islands or the mainland, either to exchange the chert with people living near these quarries or people having access to them.

Archaeometric Techniques. Neutron Activation Analysis (NAA), neutron radiography, X-ray fluorescence (XRF), infrared absorption, emission spectrophotometry, trace element analysis using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICAPAES), and Thermal Ionization Mass Spectrography (TIMS), among others have been gradually added to the array of conventional archaeometric methods and techniques and have been employed in conjunction with them in order to determine the chemical composition of the mineral constituents of pottery or lithics and the geological signature of raw materials. The introduction of these innovative methods and techniques to the study of Caribbean pottery and lithic assemblages has yielded fruitful results over the past few years.

From the late 1980s onward, these techniques have been used in addition to petrographic analysis to determine variations in chemical composition of pottery to infer chronological variation or continuity in ceramic production processes and/or to determine local or exotic provenance (e.g., Carini 1991; Cox O'Connor 1997; Cox O'Connor and Smith 2001, 2003; Gustave et al. 1991; Lundberg et al. 2002; Ortiz 1996; Walter 1991; Winter and Gilstrap 1991).

Over the years these techniques have been refined to enable more precise pinpointing of the source areas of pottery, lithic, and also metal raw materials. They also permitted new inferences on the distribution patterns of certain raw materials across the Caribbean islands (Fandrich 1991; Hofman et al. 2005, this volume; Isendoorn et al. 2005; Knippenberg 2004, 2006, this volume). Reg Murphy and others (2000) conducted an exceptionally interesting study on the identification of sources for semiprecious raw materials used for the manufacture of the gems and ornamental materials from Early Ceramic Age Antigua combining typotechnological analysis with archaeometric techniques.

Murphy and colleagues studied the morphological and physical properties of the shell and rock specimens and categorized them as finished products, blanks, three-pointed stones, or raw materials. Representative samples were selected from each category for detailed mineralogical and petrographic analysis. These analyses

included microscopic examination, measurement of gravity by the hydrostatic method, and qualitative analysis of the chemical composition for sodium and heavier elements by energy-dispersive X-ray spectrometry using a Cambridge Model 250 scanning electronic microscope (SEM-EDS) and Laser Raman microspectrometry (Murphy et al. 2000:238). In addition, a number of samples were submitted to X-ray diffraction (XRD), and thin sections to petrographic analysis. From these analyses they conclude that only 2 percent of the specimens are of non-local origin, and these concern only finished objects (Murphy et al. 2000:242).

New methods and techniques in archaeometallurgical studies have been recently applied in South and Central America (Gordus and Shimada 1995; La Niece and Meeks 2000; Lechtman 1988; Merkel et al. 1995; Siegel and Severin 1993; Whitehead 1990). Bray (1993, 1997, 2003) has worked extensively with assemblages from Colombia using XRF techniques to study surface enrichment processes. These studies have acted as a useful example of how microanalytical techniques can be used to enable better interpretation of metal assemblages from indigenous contexts in the Caribbean. Siegel and Severin used energy dispersive spectrometry on a microprobe to analyze the chemical composition of one gold artifact excavated from the Maisabel site in Puerto Rico (Siegel and Severin 1993). This study was restricted to the surface of the object only. They dated the archaeological context to A.D. 70–374 leading to the conclusion that *guanín* had a long history of use among the indigenous peoples of the Caribbean before European arrival and that this was the earliest gold/copper alloy to be reported from an archaeological context in the West Indies (Siegel and Severin 1993).

Most recently, archaeometric methods and techniques have been introduced to the study of human skeletal remains of precolonial populations in the Caribbean. These studies have enabled the formulation of new questions about Amerindian mobility, marital rules, as well as life and health conditions. These questions can now be tackled by state-of-the-art methods and techniques such as stable isotopes used for exploring the contribution of different types of resources to the diet of precolonial populations (Keegan and DeNiro 1988; Norr 2002; Stokes 1995, 1998, 2005; Van Klinken 1991). After Keegan and DeNiro (1988:326) had mapped the distribution of nitrogen and stable carbon isotopes in the food chains in the Bahamian archipelago, they were able to reconstruct two trends in the diet of a sample of 17 Lucayan Taíno individuals. The marine component of the diet varied from predominantly mollusk oriented to more pelagic fish oriented. For other individuals a distinction could be made between sea grass and shallow water reef environments and other oceanic environments. Stokes (1998) determined carbon and nitrogen isotope signatures of bone collagen and apatite carbonate of 102 human bone samples from 19 sites located in the Greater Antilles and the Leeward islands of the Lesser Antilles. The combination of bone collagen being a sign of the source of protein and the apatite reflecting the source of protein and carbohy-

drates provide detailed insight in the diets in relation to the different environmental settings during Saladoid and Ostionoid times.

During a recent project on Puerto Rican burial assemblages, stable isotope analysis was combined with trace element analysis (Curet personal communication 2005), intended to show human migration in the region. Trace element analysis was also performed on skeletal remains from the Tutu site on St. Thomas (Farnum and Sandford 2002). Strontium isotopic analysis, another method to determine provenance, was recently employed on human skeletal remains from Saba and Guadeloupe (Booden et al. this volume; De Jong 2003; Hoogland and Hofman in press). Such analyses have been successfully applied in other parts of the world to trace migration and mobility patterns (e.g., Price et al. 2002; Wright 2005).

Finally, analysis of mitochondrial aDNA has been carried out and is ongoing on precolonial populations from several islands of the Greater Antilles. This research is aimed at determining place of origin, affiliation, and migratory routes of people and more generally to identify the ancestors of the Taínos and other indigenous Caribbean peoples, as well as their routes of migration and settlement (Curet personal communication 2005; Lalueza-Fox et al. 2001, 2003; Luna Calderón 2002; Martínez-Cruzado et al. 2001). Important results in this field indicate that the Taínos from the site of La Caleta in the southeastern Dominican Republic had a substantially reduced mtDNA diversity, which is indicative of an important founder effect during the colonization of the Caribbean Islands. This is assumed to have been a linear migratory movement from mainland South America following the chain configuration of the Antilles (Lalueza-Fox et al. 2001). In this same light, migration studies have also focused on DNA of the present-day population. Martínez-Cruzado and colleagues (2001) drew a genetic portrait of the present-day population of Puerto Rico to obtain information about the history and origins of its present population.

Outline of the Volume

This volume is divided into three parts, encompassing (1) provenance studies, (2) functional analysis, and (3) new trends and new directions in paleobotanical and paleo-osteological studies.

The first section includes provenance studies examining pottery, metal, and lithics using conventional archaeological and archaeometric techniques. The chapters on the functional analysis of artifacts involve typo-technological and microscopic approaches, while the studies on paleoethnobotany and paleo-osteology also display the use of a diverse array of new methods and techniques.

Provenance Studies

During the past few years, provenance studies have revealed new information using archaeometric techniques and interdisciplinary research. Recently, two major proj-

ects have been initiated for the provenance study of pottery in the Caribbean. One of these is the program directed by Christophe Descantes and was the main focus of the SAA symposium, titled "An Exploratory Study into Chemical Characterization of Caribbean Ceramics. In Memory of J. B. Petersen."

The second project, also presented at the aforementioned symposium, represents the one initiated at Leiden University, The Netherlands, in which both pottery sherds and clay samples from the different islands along the Antillean chain have been submitted to a combination of archaeometric techniques encompassing conventional archaeological methods and geochemical analysis. In addition, ethnoarchaeological research is used to contextualize clay-sourcing practices in traditional Amerindian communities in northern South America in order to get a better understanding of clay procurement strategies. Corinne Hofman, Daan Isendoorn, Mathijs Booden, and Loe Jacobs present their combined approach in Chapter 2 and illustrate it with a case study from the island of Saba in the northern Lesser Antilles.

Jago Cooper, Marcos Martín-Torres, and Roberto Valcárcel Rojas present an archaeometallurgical study for tracing the provenance of metal ornaments from the cemetery of El Chorro de Maíta and some nearby sites in Cuba (Chapter 3). The methods used are ED-XRF, optical microscopy, and SEM-EDS. Emphasis is put on the manufacture, composition, and origin of the different alloys identified. The results of this study offer insights into the relationships between the Europeans and the indigenous populations, their trade systems, and the influence by the colonizers on local customs and values.

In Chapter 4 Sebastiaan Knippenberg and Hans Zijlstra present a case study on the methodologies employed in the characterization of flint and chert sources in the northern Lesser Antilles with the aim of provenancing artifacts. Using multiple approaches, this study does not only aim at characterizing sources, but also at explaining the differences between the sources. Trace element composition is being discussed as well as the effects of chemical weathering.

Functional Studies of Artifacts

Functional studies of artifacts concentrate on organic and inorganic materials using macroscopic and microscopic techniques.

Charlene Dixon Hutcheson discusses a new method for studying past weaving techniques using dental alginate molds on ceramics from the Bahamas (Chapter 5).

Christy de Mille, Tamara Varney, and Michael Turney present new methods for investigating stone bead drilling techniques using molds and scanning electron microscopy in Chapter 6. They illustrate their case with beads from Saladoid sites on Antigua.

In Chapter 7, Benoît Bérard, who has built up his experience in the European Paleolithic, stresses the importance of studying lithic technology for the under-

standing of Caribbean cultural traditions and change. He illustrates his case by comparing the *chaîne opératoire* of lithic *débitage* of two sites on Guadeloupe and Martinique belonging to the Huecan and Cedrosan Saladoid subseries.

Microscopic analysis of tools has led to a better understanding of the way tools were manufactured and used during prehistory and provides insight into the domestic activities carried out at a given site. Annelou van Gijn, Yvonne Lammers-Keijsers, and Iris Briels (Chapter 8) stress the importance of studying use-wear analysis on different categories of artifacts, including ceramic and lithic, shell and coral artifacts, in order to reconstruct the technological system of a site. In this chapter the authors focus on the technical and functional relationships among these materials in a study of artifacts from the sites of Plum Piece on Saba and Morel and Anse à la Gourde on Guadeloupe.

Together with Harold Kelly, Annelou van Gijn tackles the study of coral tools from the site of Anse à la Gourde combining use-wear analysis and experimental archaeology in Chapter 9. The coral tools are categorized as tools on the basis of their modified shapes, residue, and use-wear traces. Experiments with replicated coral tools were carried out with shell, clay, bone, wood, seeds, and plant materials.

Phytolith and starch residue analysis has lately received new impetus in the Caribbean. They yield detailed information on the function of specific tools and pottery and the importance of plant processing for dietary purposes. Channah Nieuwenhuis stresses the significance of phytolith and starch residue analysis in combination with use-wear analysis illustrating her case with Archaic Age stone tools from the island of Saba (Chapter 10).

Jaime Pagán Jiménez and José Oliver present a case study of starch residue analysis on seven lithic artifacts from two sites on Puerto Rico, namely Cueva de Los Muertos and Vega de Nelo Vargas (Chapter 11). The information obtained reveals that phyto-cultural dynamics in central Puerto Rico are sufficiently varied to suggest the presence of different agricultural production scenarios coexisting in the intra- and interisland spectra.

Roberto Rodríguez and Jaime Pagán Jiménez show the importance of starch residue analysis in the interpretation of the use of ceramic griddles from the site of Macambo II in Cuba in Chapter 12. A multifunctional use for these griddles is put forward.

New Trends in Paleobotanical and Paleo-Osteological Research

After more than two decades of established paleobotanical research in the Caribbean, Lee Newsom explores new methods and techniques in the study of plant macroremains, including utilizing wood collections for their dendrochronological records, efforts to recover information on plant use through chemical residues, the potential of wetland sites, and the significance of ancient germplasm collections as a record of biodiversity and species dynamics (Chapter 13).

Paleo-osteological research presented in this volume concentrates on analysis carried out recently on the human skeletal assemblages from the Lesser and Greater Antilles. Alfredo Coppa and colleagues investigate biological relationships, using dental morphology to explain migration dynamics (Chapter 14). Their results demonstrate that the biological data from dental morphology support the hypothesis of at least two migratory waves in the peopling of the Caribbean islands.

Mathijs Booden, Raphaël Panhuysen, Menno Hoogland, Hylke de Jong, Gareth Davies, and Corinne Hofman use $^{87}\text{Sr}/^{86}\text{Sr}$ on teeth and bone samples to determine the origin of the population at the Troumassoid site of Anse à la Gourde on Guadeloupe (Chapter 15).

The volume is concluded by an epilogue by William Keegan (Chapter 16) in which he discusses the new insights that can be obtained by means of the innovative methods and techniques illustrated in the previous chapters.

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