YOU ARE WHAT YOU EAT: A COMPARATIVE ZOOARCHAEOLOGICAL ANALYSIS OF TWO CERAMIC AGE SITES, ANTIGUA, W.I.

A Thesis Submitted to the Committee on Graduate Studies

in Partial Fulfillment of the Requirements for the

Degree of Master of Arts

in the Faculty of Arts and Science

TRENT UNIVERSITY

Peterborough, Ontario, Canada

Anthropology M.A. Program
June 2001

National Library
of Canada

Acquisitions and
Bibliographic Services

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale
du Canada

Acquisitions et
services bibliographiques

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

Our file Notre référence

0-612-57983-2

Canada

ABSTRACT

You Are What You Eat: A Comparative Zooarchaeological Analysis of Two Ceramic Age Sites, Antigua, W.I.

David M. Cruz

The zooarchaeological assemblages from an Early Ceramic Age inland site (Royall's, JO-11) and a Late Ceramic Age coastal site (Muddy Bay, PH-14) have been examined to determine the role fauna played in the prehistoric subsistence economies of Antigua. Zooarchaeological analysis indicated that different subsistence economies were present at each site and a gradual expansion of the animal resource base occurred. At Royall's, the subsistence economy concentrated on the procurement of terrestrial fauna with a noteworthy use of molluscs (gastropods) and a minimal use of fish. At Muddy Bay, emphasis was placed on the procurement of marine fauna, especially reef fish and more molluscs were present. Results indicate that both general physiographic island features and specific geographic location may have been the determining factors for the differing subsistence economies at both sites. Other factors such as sampling procedures, preservation of faunal remains, analytical methods, population pressure, competition, environmental stress, subsistence technology, and cultural preferences may also account for the observed differences.

ACKNOWLEDGEMENTS

I would like to give a heartfelt thanks to everyone who contributed to the analysis and research of this thesis project. First, I would like to thank my supervisor Dr. Morgan J. Tamplin for his guidance, helpful advice and overall support. I would also like to thank the members of my thesis committee, Dr. Paul F. Healy and Dr. Kathlyn M. Stewart, for their endless assistance and encouragement. A great thanks to Dr. Arthur R. Murphy for providing me with the opportunity to analyze the zooarchaeological remains from the Muddy Bay (PH-14) and Royall's (JO-11) sites. His enthusiasm for Caribbean archaeology and overwhelming support and guidance throughout this pursuit of knowledge made the experience worthwhile and memorable. A special thanks to Dr. Kevin Seymour for the use of the paleo-vertebrate collection at the Royal Ontario Museum, which enabled me to identify the zooarchaeological assemblages with relative ease. Many thanks to the volunteers who helped me sort and label my data. If it were not for Susannah Lancashire, Danielle Martin, Hawley Martin, Jessica Musson, Rebecca Pickford, and Aaron Wood, I would not have been able to examine as much material as I did. I would like to express further gratitude to various faculty members in the department of Anthropology at Trent University, specifically Dr. Hermann Helmuth, and Dr. Susan Jamieson, for their financial support through various laboratory and teaching assistance positions. I wish to give a tremendous amount of thanks to former and current staff from the department of Anthropology and the Office of Graduate Studies: Sandra Carr, Virginia Keating, Janice Ecclestone, Paulette Nichols and Pat Strode, for helping graduate students as much as they possibly could and for making my days as a graduate student a comfortable and pleasurable experience. I would like to extend further

appreciation to Dr. Gyles Iannone, the late Dr. Howard Savage, Dr. Aad Versteeg, Dr. Elizabeth Wing, Dr. David Steadman, and Dr. Anne Stokes for imparting upon me knowledge regarding theoretical issues in zooarchaeology and Caribbean archaeology, and for stimulating my intellect. I wish to give the utmost thanks to friends in the program and elsewhere, and my family for their unconditional and boundless support. Thanks go to Sonja, Josalyn, Rhanj, Norbert, Scott, Cara, Kara, Joel, Charlie, Joan, Arne, Leslie, John, Felicia, Luciano, Grace, Christina, Marcello, Maria, Rebecca, and especially Mom and Dad. A sincere thanks to all of you above and to those unmentioned.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

My research examines the role fauna played in the Antiguan subsistence economies practiced by the occupants of the Early Ceramic Age inland site of Royall's (JO-11), and the Late Ceramic Age coastal site of Muddy Bay (PH-14). Using zooarchaeological analysis, I will determine whether the zooarchaeological assemblages exhibit changes in the degree and intensity of animal exploitation and whether changes occur in the resource base. I will also attempt to identify the attributes that comprise and define a subsistence economy for both sites. These two sites were used because they offer information from two distinct time periods in Antiguan prehistory and are located in two different environments, which may be ultimately responsible for determining the subsistence economies at each site. Variables considered include sampling procedures, preservation of faunal remains and zooarchaeological analysis; physiographic island features; geographic location; population pressure; environmental stress; subsistence technology; and cultural preferences. Skeletal element frequencies will also be investigated to determine food preparation and processing activities (Klein and Cruz-Uribe 1984: 63-69; Reitz and Wing 1999: 202-203). Comparison of other contemporaneous sites from the Early and Late Ceramic Age to Royall's and Muddy Bay will also be investigated to determine which subsistence economies were practiced on Antigua. These sites include Elliot's (PH-03), Indian Creek (PA-02), Winthorpe's (GE-06) and Mill Reef (PH-01). Such an inter-site zooarchaeological analysis between

Royall's and Muddy Bay may provide a clearer understanding for the subsistence economies of the Ceramic Age on Antigua, and contribute to the ongoing debate regarding settlement and subsistence patterns across the Caribbean.

For the past century, archaeologists have used faunal remains to help reconstruct past indigenous lifeways in the Caribbean. Early zooarchaeological studies were simple 'laundry lists' of identified species, such as those found in the work of Froelich Rainey and Irving Rouse in the 1930s (Brewer 1992:197; Petersen 1997; Rainey 1940; Rouse, in press). With the advent of modern scientific research, zooarchaeology began to make important contributions to Caribbean archaeology. On Antigua, zooarchaeological research began in the late 1960's at the Mill Reef site (Wing et al. 1968). Subsequent research has dealt with subsistence economies (Deagan 1996; DeFrance 1988, 1989; DeFrance et al. 1996; Dukes and Reitz 1994; Goodwin 1980; Jones 1980, 1985; 1989; Keegan 1989; Klift 1992; Morse 1989; Petersen 1997; Reitz 1994; Stokes 1991, 1999; Wing 1999; Wing et al. 1968), biogeography (Davis 1988; Watters 1989, Wing 1989; Wing and Wing 1994, in press), paleoenvironmental reconstruction (Steadman et al. 1984a, 1984b), migration (Keegan and Diamond 1987; Rouse in press), settlement patterns (Davis 1982; Keegan 1992; Murphy 1994; Petersen 1997; Stokes 1991), modes of technology (Goodwin 1982; Wing and Reitz 1982), and even issues of social complexity and ideology (Grouard 1997; Schinkel 1992).

One major zooarchaeological debate in Caribbean archaeology is the Crab-Shell dichotomy postulated by Froelich Rainey (1940; see also DeFrance 1989; Goodwin 1979; Jones 1985; Keegan 1989; Petersen 1997; Watters and Rouse 1989; Wing 1989). As part of his graduate research on archaeological sites in Puerto Rico and Hispaniola, Rainey

(1940) devised a chronological scheme based on the development of a ceramic style coinciding with changes in the concentrations of crab and shell remains in archaeological deposits. Rainey (1940:107-109) observed a shift from large concentrations of crab remains associated with the white-on-red (WOR) design on pottery (Early Ceramic Age, the Saladoid series - 500 B.C. to 600 A.D.), to later large concentrations of marine molluscs associated with coarse, crude and unpainted pottery (Late Ceramic Age, the late Saladoid and post-Saladoid series - 600 A.D. to 1492 A.D.). He defined the early deposits of crab and WOR pottery as the Crab culture, and the later deposits of crude-ware and shell, as the Shell culture.

Essentially then, zooarchaeological studies were used to produce a chronological sequence. Rainey claimed that these differences represented separate migrations, but more recently, Caribbeanists acknowledge that although this transition does occur on some islands, it did not occur uniformly across the entire Caribbean region (Petersen 1997:123). They contend that animal resources were not suddenly replaced, instead there were gradual and variable shifts in emphasis or degree of usage over time (Petersen 1997:123-124). Some archaeologists would even argue that Early Ceramic Age migrants (Petersen 1997:123; Roe 1989:289) transplanted a 'Tropical Forest Economy' based on the cultivation of root crops and the procurement of inshore aquatic fauna, supplemented by hunting terrestrial fauna (Lathrap 1970:47; Murphy 1999:282). On the other hand, arguments have been made that subsistence and settlement patterns varied according to habitats presented to Ceramic Age colonizers inducing the adaptation of local conditions – opportunistic strategies (Siegel 1991:86). One of the main objectives of this thesis is to determine whether Royall's and Muddy Bay possess subsistence economies that were the practice of opportunistic strategies arising from local conditions on Antigua. On Antigua, these hypotheses may be identified through the analysis of zooarchaeological assemblages dating to the Ceramic Age.

Organizational Framework

This thesis begins with a review of the ecological and physical setting of the Caribbean area and Antigua, and the archaeological excavation histories of the Muddy Bay and Royall's sites in Chapter II. This chapter discusses the physical characteristics of Antigua that may have had implications for subsistence and settlement strategies. Chapter II also presents the possible range of fauna and flora that may have been used by the prehistoric occupants of Antigua. For the purposes of this research project, a brief description of the prehistory of the West Indies and Antigua is also included in this section. Emphasis will be placed on the Ceramic Age and the ceramic chronology of Antigua. The excavation history that follows, presents detailed information regarding the excavation methodology for both sites, the recovery strategies and the context of each zooarchaeological assemblage to be discussed.

Chapter III reviews the history of zooarchaeological research on Antigua and in the Caribbean region. An examination of the subdiscipline of zooarchaeology through the various archaeological research stages in the Caribbean posited by Rouse (in press) is presented. In addition, I review subsistence models throughout the Lithic, Archaic, Ceramic, and Historic Ages and illustrate the various types of zooarchaeological research conducted in the Caribbean.

In Chapter IV, I discuss my methodological approach. A detailed description of the identification procedures, methods for measuring relative frequencies: the number of identified specimens (NISP) and the minimum number of individuals (MNI) are discussed. Issues regarding the advantages and disadvantages of using NISP and MNI as measures of abundance are also reviewed. Skeletal element frequency analysis and explanations for the advantages and disadvantages for this approach will be examined, followed by a detailed description of the methodology used to determine skeletal element frequencies for the Royall's and Muddy Bay zooarchaeological assemblages.

The results of my analysis for the Muddy Bay and Royall's site zooarchaeological assemblages are discussed in Chapter V. For both sites a detailed description of the Classes of fauna and their relative abundance in various habitats are disclosed along with an analysis of the subsistence technologies identified. Results for the skeletal element frequency analysis are also presented. The procurement strategies of each site are discussed in comparison to each other and to other sites on Antigua. Finally, I examine the possible factors that could determine the identified subsistence economies identified at each site. In Chapter VI, my conclusions summarize the key ideas for this thesis in relation to my research questions.

CHAPTER II

PHYSICAL SETTING

Lesser Antilles

Geographically the Caribbean region is composed of 5 distinct island groups: the Greater Antilles; the Southern Caribbean islands; Trinidad and Tobago; the Bahamas, and the Lesser Antilles (Keegan 1994; Watts 1987; see Figure 1 and Table 1). Antigua is situated in the Lesser Antilles group. The Lesser Antilles (7,164 km^2) makes up three percent of the land area in the West Indies (Keegan 1994:259; Watts 1987:4). The Lesser Antilles consists of a double arc of islands (Keegan 1994:259; Watts 1987:11). The inner arc is formed around high volcanic cones and the outer arc is made up of limestone islands built on older volcanic or crystalline bases (Hedges 1996:165-166; Keegan 1994:259). The inner arc of islands is younger, and still volcanically active (Stokes 1991:21). The outer arc of islands has been removed from the plate boundary area due to seafloor spreading, and is no longer volcanically active (Nunn 1994:123). It must be noted that the history of volcanic activity in the Caribbean is still little known and further research in this field is required (Hedges 1996:167).

The Lesser Antilles is subdivided into the northern Leeward Islands and the southern Windward Islands (Figure 2). This subdivision arises from the designation of these island groups as British colonial units. As Keegan (1994:259) maintains, the subdivision remains useful because the Leeward Island chain is smaller at (3,207 km^2) in

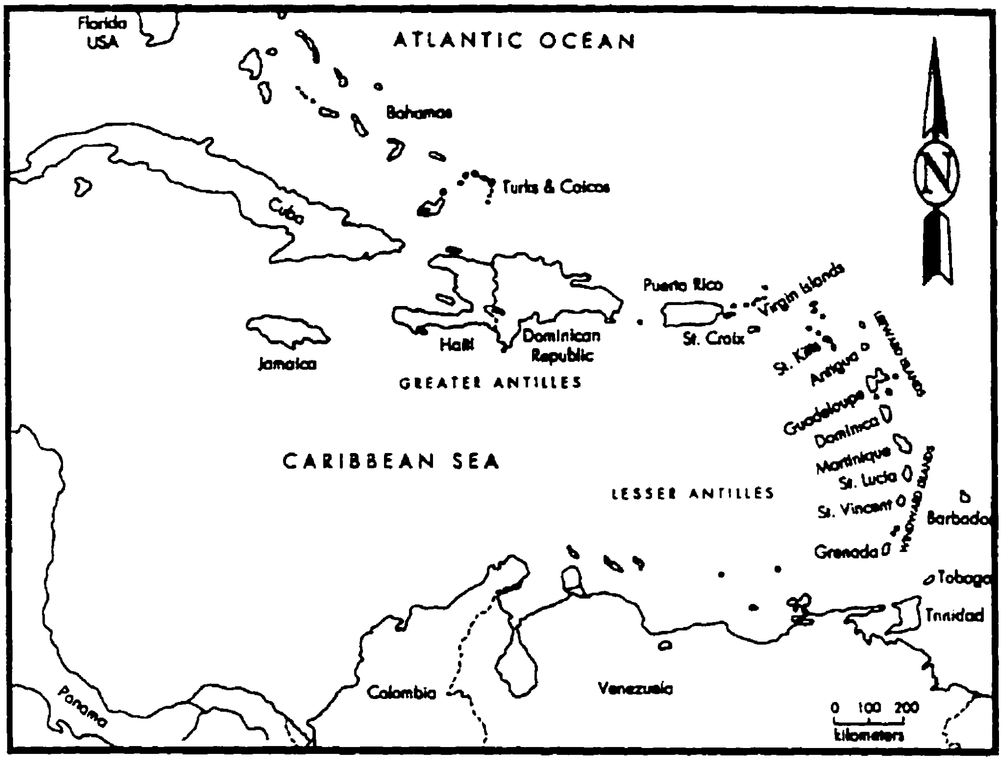


Figure 1. Map of Circum-Caribbean Area.

land area, than the Windward Islands (3,957 km^2). In addition, the Leeward-Windward division follows the prehistoric and protohistoric distribution of Caribbean indigenous societies. The Island Carib groups occupied the Windward Islands and the eastern Taínos resided in the Leeward Island chain (Allaire 1987; Keegan 1994:259-260; Rouse 1992).

Antigua

Antigua is located on this outer arc of the Leeward islands between latitude 17°00'N and 17°10'N, and longitude 61°40'W and 61°55'W (Figure 2; Murphy 1996:7; Stokes 1991:21; Watters et al. 1992:15). This island is triangular with a total area

Table 1. Caribbean Archipelagos, Island Size and Maximum Elevations[a].

Island Group	**Island**	**Size (km^2)**	**Max. Elev. (m)**
Southern Caribbean (1% land area)	Margarita	1,150	920
	Bonaire	288	193
	Curaçao	443	241
	Aruba	190	167
		[2,071]	
Trinidad and Tobago (2% land area)	Trinidad	4,828	941
	Tobago	300	572
		[5,128]	
Lesser Antilles (3% land area)	Guadeloupe	1,702	1,1467
	Martinique	1,090	1,397
	Dominica	790	1,422
Windward Islands	St. Lucia	603	951
	Barbados	440	338
	St. Vincent	389	1,179
	Grenada	345	840
	Antigua	280	403
	St. Kitts	176	1,156
	British Virgin	174	518
	Barbuda	161	22
Leeward Islands	Nevis	130	1,156
	Anguilla	88	55
	Montserrat	84	742
	St. Martin	34	424
	St. Eustatius	21	549
	Saba	13	884
		[7,164]	
Greater Antilles (89% land area)	Cuba	110,922	1,972
	Hispaniola	76,484	3,175
	Jamaica	11,424	2,257
	Puerto Rico	8,897	1,065
	US Virgins	344	465
	Cayman	241	15
		[208,312]	
Bahamas (5% land area)	Bahamas	11,826	100

(a) From Keegan 1994: Table 1 and Watts 1987: Table 1.1.

of 280 km^2 (Figure 3; Keegan 1994:258; Pregill et al. 1994:15). Antigua is paired with Barbuda, a limestone island of low relief, located at 17°31'N and 17°45'N, and longitude 61°44' and 61°53' (Watters et al 1992:15). Both islands are located on the Barbuda bank,

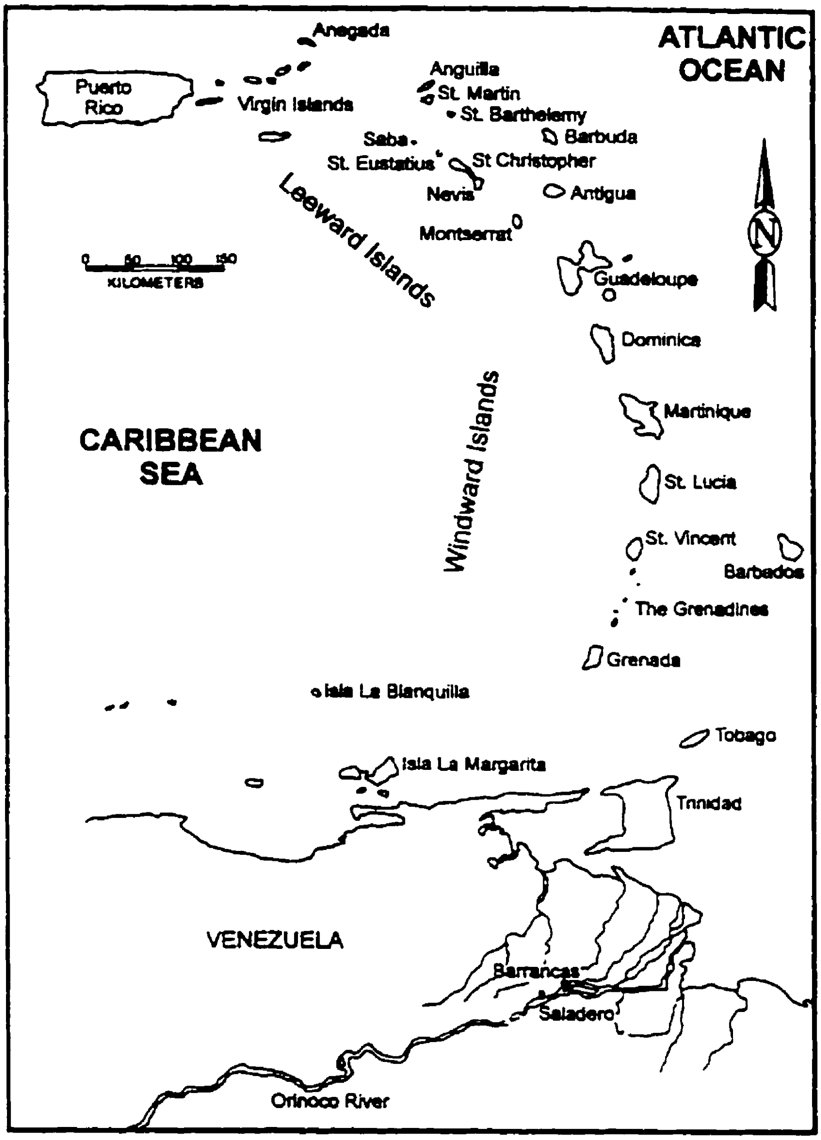


Figure 2. Lesser Antilles Group of the Caribbean Region.

a submarine platform with an estimated area of 3600 to 4000 km^2 (Figure 4; Martin Kaye 1959:263-286; Watters et al. 1992:16). The Barbuda bank is an estimated 90 km in length and varies from 24 to 51 km in width (Watters et al. 1992:16).

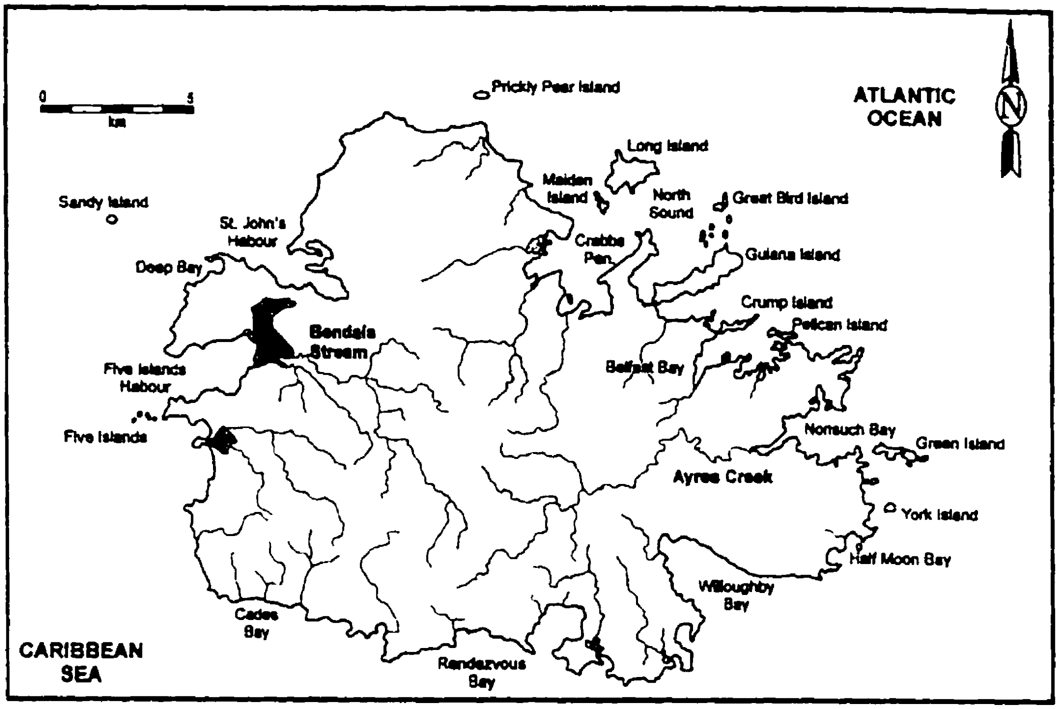


Figure 3. Map of Antigua

Geology and Soils of Antigua

Antigua's geology dates back to the early Oligocene, over 30 million years ago (Rouse and Morse 1999:5). During the initial stages of Antigua's development, volcanic activity produced peaks that rose towards the surface of the sea (Rouse and Morse 1999:5; Stokes 1991:22). Subsequently, coral reefs emerged around the islands and continued tectonic activity caused the islands to tilt. This occurrence caused the partial submergence of the volcanoes while limestone reefs were uplifted (Nicholson 1976; Rouse and Morse 1999:5; Stokes 1991:22). From this activity, a trough of tuffaceous material was formed between the volcanic area of the south and the limestone area in the

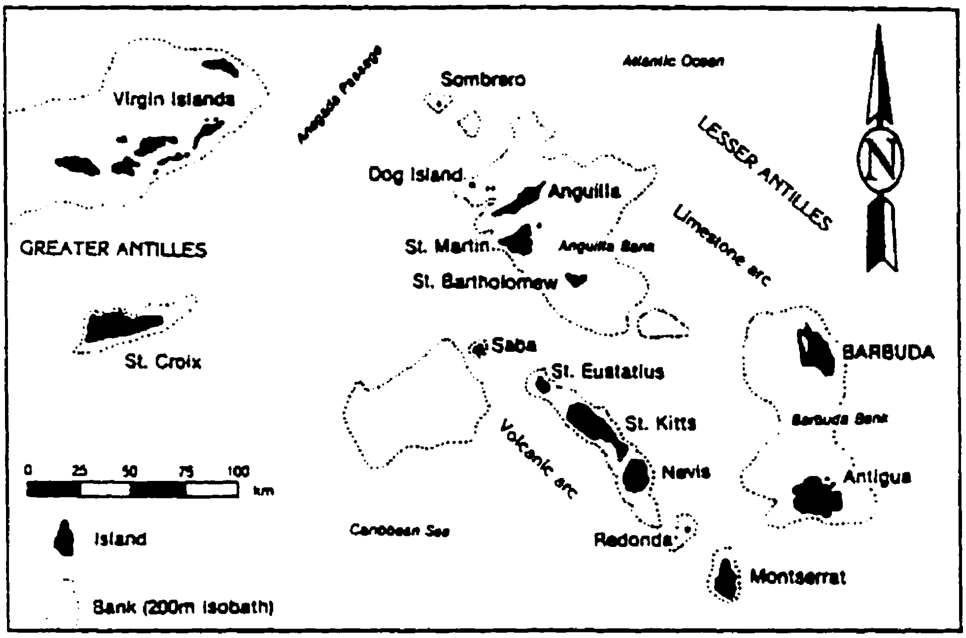


Figure 4. Antigua and Barbuda within the Environs of the Islands and Banks of the Northern Lesser Antilles (Watters et al. 1992:Figure 1).

north section of the island (Figure 5). The erosion of volcanic hills from the southern area of the island formed this middle region of Antigua (Stokes 1991:22). From this activity, there are now three geological zones and five soil types (suites) present on Antigua. The geological zones, illustrated in Figure 5, include the volcanic district, the central plain district, and the limestone district. Soil types (suites) consist of the Montero suite; Elliot suite; Gunthorpe suite; Fitches suite; and the Otto suite (Figure 6; Charter 1937; Loveless 1960:501-502; Stokes 1991:25).

Murphy (1996:10) mentions that the geological variability of Antigua can have archaeological implications for human settlement and subsistence patterns. Various regions hold either invaluable geological resources and/or ecological zones that may be beneficial for subsistence and/or settlement practices for the inhabitants or potential

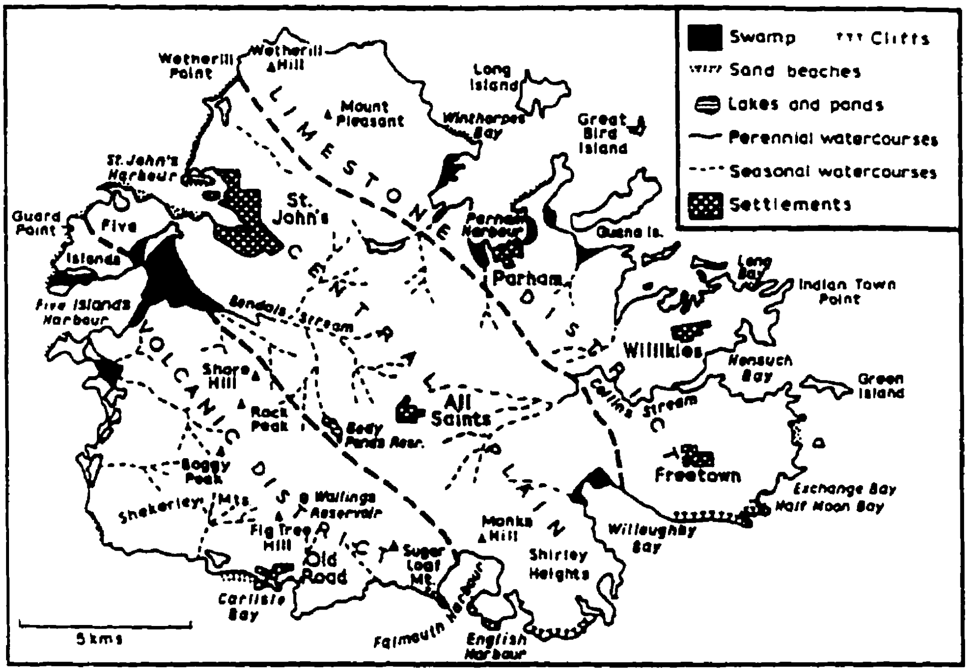


Figure 5: Geological Regions of Antigua (Harris 1965: Figure 4).

colonizers of Antigua. Soil type may have also been important in providing appropriate conditions for the production of agricultural and/or horticultural plots during the Ceramic Age on Antigua.

The volcanic district is located at the southern part of the island, and is characterized by steep sloped volcanic terrain interspersed with small alluvial valleys (Rouse and Morse 1999:5; Figure 6). The Montero soil suite (Figure 6) is present in this region, and the soils within this zone are composed of intrusive and extrusive igneous rock such as basalt, andesite, quartz diorite and ash beds and agglomerates (Murphy 1996:10; Rouse and Morse 1999:5; Stokes 1991:26). The soils in the Montero suite are neutral to slightly acidic (Stokes 1991:26). This area of the island comprises 42% of the

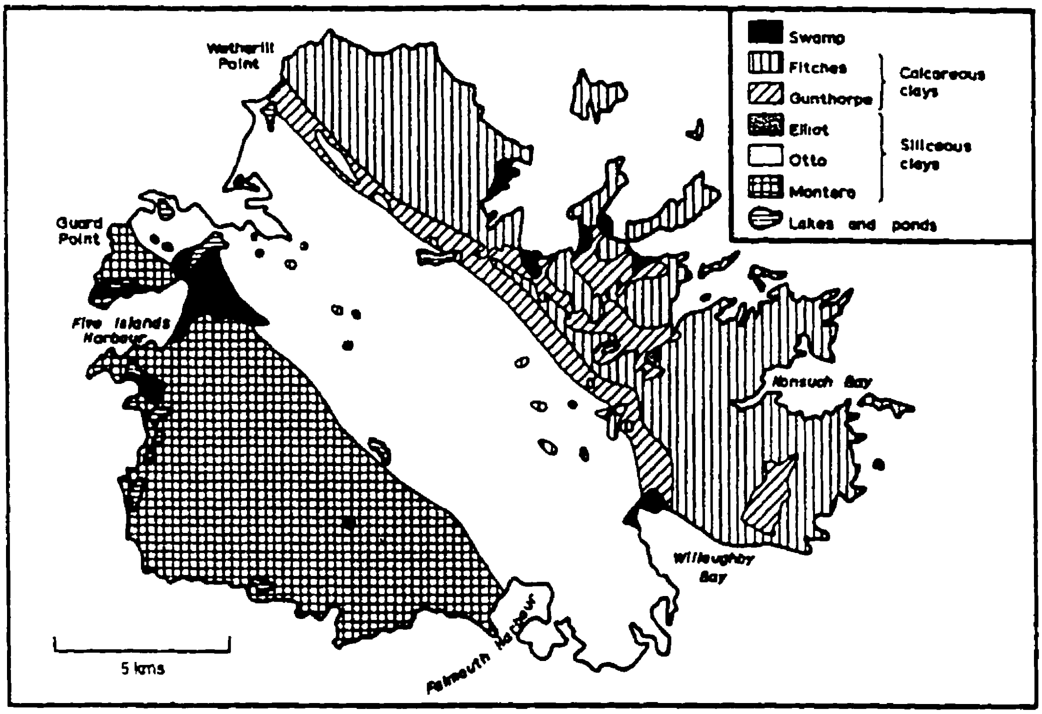


Figure 6: Soil Types on Antigua (Harris 1965: Figure 5).

land area of the island, and the highest point of the island, Boggy Peak, reaches 400 m above sea level (Multer et al. 1986).

The central plain district is an area of low rolling hills that does not rise above 17 m, running northeast to southeast (Rouse and Morse 1999:5), and represents 19% of the island's area (Figure 6). In this region, both the Otto and Gunthorpe soils are present. The Otto suite contains sedimentary rock, soft shales, indurated clays, marine and fresh water chert, indurated clays, marine and fresh water chert, limestone, conglomerates with pebbles of andesite and porphyry (Harris 1965; Loveless 1960:502; Martin-Kaye 1959; Rouse and Morse 1999:5; Murphy 1996:12; Stokes 1991:26). The soils of the Otto suite are mostly neutral to alkaline (Stokes 1991:26). The Gunthorpe suite is composed of alkaline calcareous clays (Loveless 1960:502).

The limestone district (Figure 5) is located in the northeastern uplands of Antigua and reaches 100 m above sea level from the central plain district (Rouse and Morse 1999:5). This area is comprised of a low-lying bed of limestone, a rugged coastline fringed with reefs, mangroves and offshore islands, and mature river valleys and streams that originate from the center of the island and drain in a northeast direction (Rouse and Morse 1999:5). Both the Elliott and Fitches soil suites are present within this region. The Elliott soil suite (Figure 6) consists of sandstone and is located in two small areas in the northeast and eastern part of the limestone district (Harris 1965). The Fitches soil suite is made up of calcareous clays that lie over top the limestone band. The soils within this region are highly alkaline with deposits of hard white limestone and compacted marls containing fossilized fauna (Stokes 1991:26). This area represents 39% of the island (Murphy 1996:12).

According to Stokes (1991:27), the soil types of Antigua are poorly drained and can be easily waterlogged. They dry relatively quickly producing a substantial amount of cracking. It should be considered that the combination of poorly drained soils, which harden and crack easily when watered, could have had hindered plant cultivation on Antigua (Stokes 1991:27). However, numerous Ceramic Age sites and archaeological evidence, in the form of plant grinding and cooking implements, indicate that horticultural or agricultural practices were carried out.

Climate

The climate of Antigua is warm with a mean maximum and minimum temperatures of 83°F (29°C) and 73°F (23°C) with the humidity ranging from 70% to 80%, reaching its highest near the end of the year (Rouse and Morse 1999:5). Because of Antigua's location, the climate is heavily affected by the surrounding ocean resulting in extremes "...varying between long dry spells and short, wet periods" (Rouse and Morse 1999:5). The annual average rainfall for the entire island is 1150 mm (Harris 1965:9-11; Rouse and Morse 1999:6) in which half of the rainfall results from the hurricane season lasting from August to November (Figure 7; Rouse and Morse 1999:6). The mountainous southwest region receives the highest amount rainfall per annum with an average of 1270 mm (Harris 1965:9-11; Rouse and Morse 1999:6; Figure 7). The central plain district receives 1150 mm of rain annually (Rouse and Morse 1999:6). The areas where both Muddy Bay site and the Royall's site are located receive less than 1000 mm of rain per annum (Harris 1965:9-11; Rouse and Morse 1999:6). Of importance is that the average rainfall accounted for today may have been the same during the initial occupation of these sites.

Changes in seasons on Antigua are caused primarily by the prevailing dominance of the northeast trade winds throughout the year (Rouse and Morse 1999:5; Stokes 1991:24). Daily weather fluctuations can result from smaller atmospheric disturbances caused by waves as well (Harris 1965:7). Hurricanes and tropical storms occur regularly on Antigua with hurricanes peaking in August, during the wet season. These natural disasters are caused by lows developing in wave troughs (Harris 1965:7) and, on average,

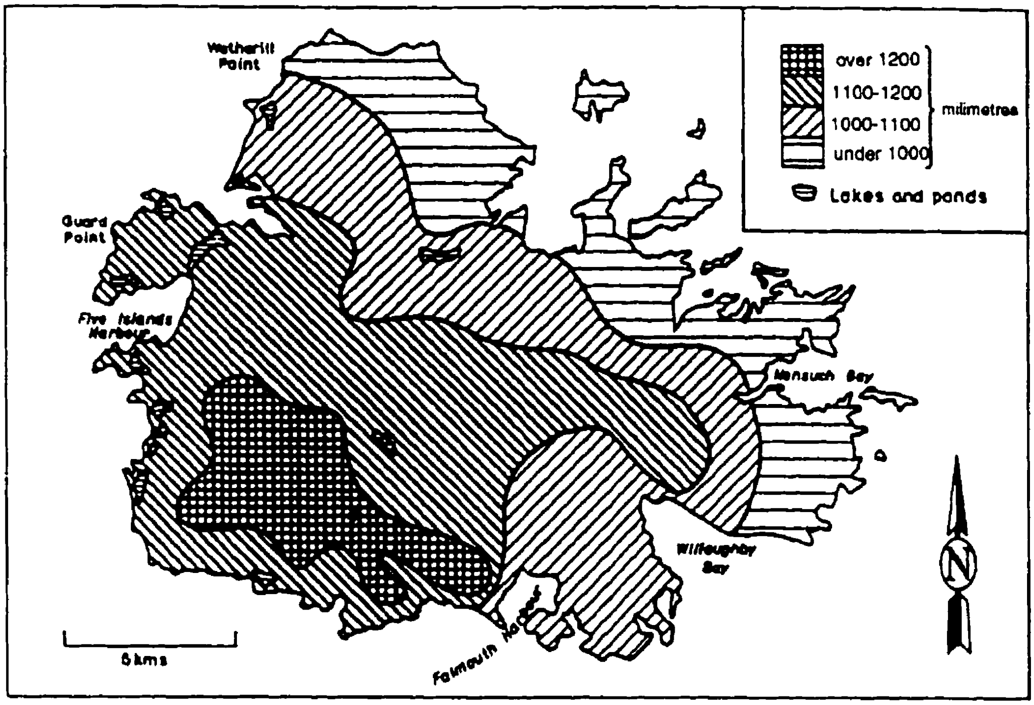


Figure 7: Annual Rainfall Distribution of Antigua (Harris 1965:Figure 2).

hurricanes will encounter an island once every twenty years. Hurricanes have devastating effects upon island environments, but also introduce foreign flora and fauna into the area. Plants and animals can be swept great distances to their new island home by wind or as flotsam (Barlow 1993:8; Hedges 1996:163; Stokes 1991:24). This occurrence can have a significant impact upon the decision by humans to reside in particular areas, and the adoption of specific or multiple subsistence economies. Alternatively, these natural disasters may have wiped out prehistoric coastal and inland settlements on Antigua, leaving little evidence for settlement and subsistence.

Flora

Antigua is located within the Subtropical Dry Forest Zone, which is characterized by a seasonal rain forest with cactus–thorn and forest scrub vegetation (Stokes (1991:28; Watts 1987:26). As early as 1656 one chronicler described Antigua as one of "the best wooded of the Careeby Islands yet settled by the Christians" (Harris 1965:68). However, the deforestation of most of the island by 1789 for the cultivation of sugarcane, destroyed most of the native vegetation (Murphy 1996:13; Harris 1965:102-107; Figure 8). Furthermore, the practice of land clearing and deforestation for cultivation by indigenous peoples before European colonization could have also affected the native flora of Antigua. It must be noted that information concerning indigenous vegetation during prehistoric times is limited for Antigua. Very little paleobotanical research has been conducted on Antigua, and most information derives from historical accounts and current models for tropical vegetation (Murphy 1996:12-13; Stokes 1991:28-29; Figure 8).

In the southwestern mountainous region of Antigua, high rainfall would have permitted the growth of a mixed evergreen-deciduous forest (Stokes 1991:28). This area would extend from the mountains into the middle tuffaceous zone of Antigua (Stokes 1991:28). Stands of tree within this area may have been extremely useful for prehistoric peoples. Canoe building could have involved the use of the silk cotton tree (*Ceiba pentandra*) (Stokes 1991:29). *Ficus citirfolia* or fig plants were probably consumed and the bark of the locust tree (*Hymenaea courbaril*) was probably used for medicinal purposes and for the construction of canoes (Stokes 1991:29). Within the central

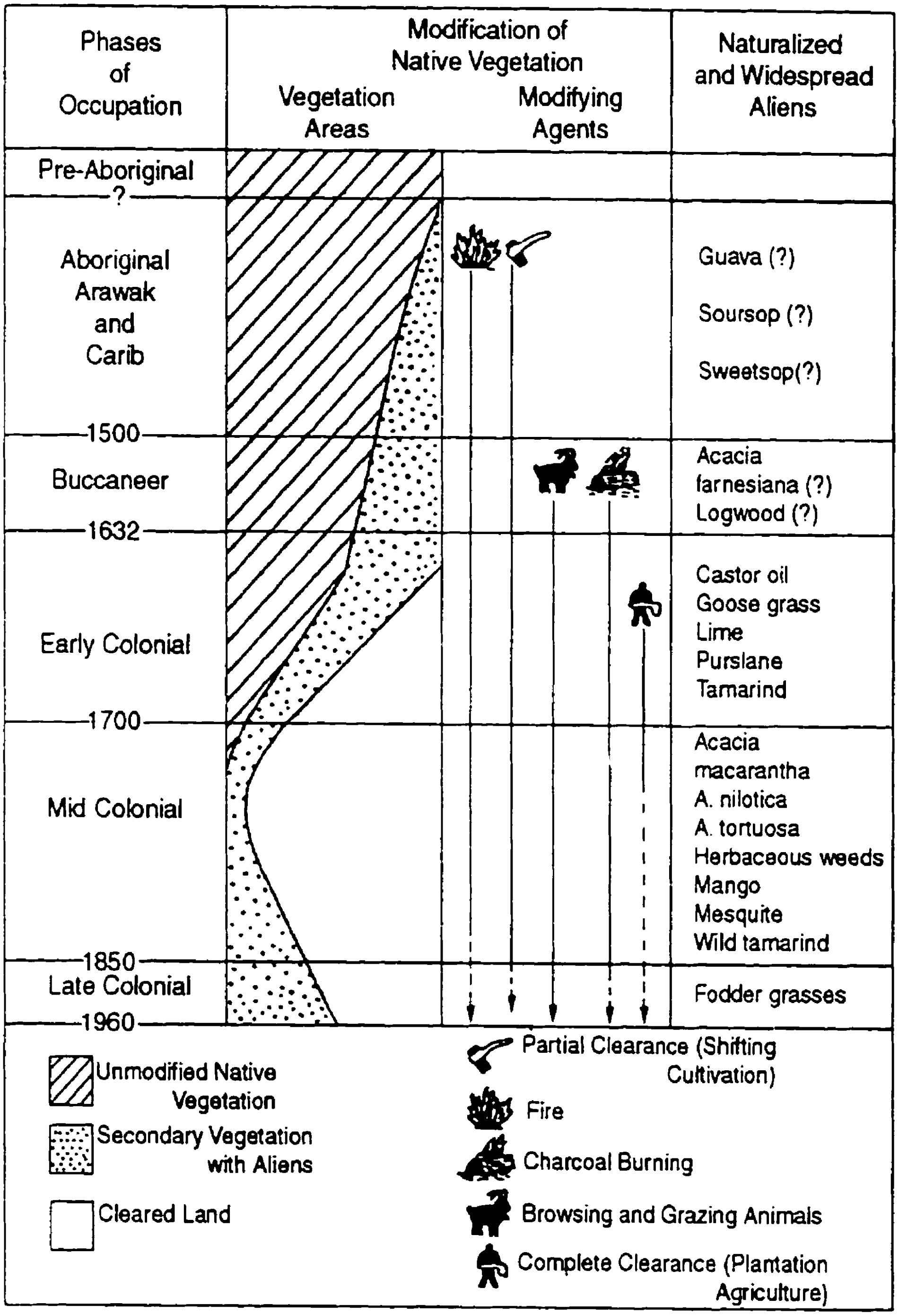


Figure 8. History of the Modifications of Native Vegetation and the Introduction of Alien Flora on Antigua (Harris 1965:Figure 14).

tuffaceous zone and eastern limestone area of Antigua, white cedar (*Tabebuia heterophylla*) and Spanish Cedar (*Cedrela odorata*) trees would have been present (Stokes 1991:30). Such trees could have also been used for the construction of residences and canoes during prehistoric times.

In the eastern region of Antigua, the vegetation is fairly sparse and stunted due to low rainfall and poor soil drainage (Loveless 1960; Stokes 1991:30). Forms of vegetation in this area are xerophytic and include thorny scrub woodland. Sources for fuel could have included whitewood (*Bucida buceras*) and boxwood (*Bumelia cuneata*) trees (Record and Hess 1943; Stokes 1991:30). Prehistoric inhabitants of Antigua (Record and Hess 1943; Stokes 1991:30) used the logwood tree (*Haematoxylum campechianum*) as a dye source. The resin from the turpentine tree (*Bursera simaruba*) was used as a sealing agent for canoes and in the production of pottery (Record and Hess 1943; Stokes 1991:30). Other plants such as sea grapes (*Coccoloba uvifera*) were possibly consumed by prehistoric Antiguans.

In the north and east regions of Antigua scattered riparian woodlands are present. Because of the alkaline rich soil, trees in this region would have grown substantially in the past. These trees include whitewood (*Bucida buceras*) and white cedar (*Tabeluia pallida*), which can be found within the vicinity of Ayres Creek and near brackish water (Stokes 1991:29). In the fresh/brackish water areas mangrove and manchineel (*Hippomane mancinella*) plants flourish. Historic accounts indicate that the poison from the manchineel tree was placed on arrowheads for hunting (Little and Wadsworth 1964; Stokes 1991:29). Of other interest is the fine clayey silt used in the manufacture of pottery, which is created by the filtering effect of mangrove roots within this region as well (Stokes 1991:29).

Fauna

As with most of the islands in the Lesser Antilles the fauna on Antigua are from Central and South America (Hedges 1996; Watts 1987:37; Woods 1986:654). Because of the numerous conditions encountered by fauna during the migration and colonization process, island fauna often differ from the fauna of nearby continental areas, especially on islands most distant from the mainland source. This suggests that much of the fauna from Antigua was left to develop initially in isolation reducing species variation. As a result, the geographical setting, isolation and physical uniformity of Antigua suggests the existence of a small number of native species unique to that island (Harris 1965:60; Stokes 1991:43). However, human intervention has also played a large part in the present composition of fauna on Antigua. Overhunting and the introduction of new animals have altered the island's faunal composition and diversity (Harris 1965:60; Pregill et al. 1994; Steadman et al. 1984*a*).

The distinct nature of an island's ecosystem can indicate the presence of two ecozones, terrestrial and aquatic (Murphy 1996:108). On Antigua, both are present (Figure 9) within the limestone district in the northeastern uplands of Antigua. The terrestrial ecozone includes animals that can be classified either as endemic or introduced. Animals in this ecozone reside in woodland and open lowland areas (Wing 1999:53). Within the aquatic ecozone lie three zones: Inshore Estuarine and Tidal Flats;

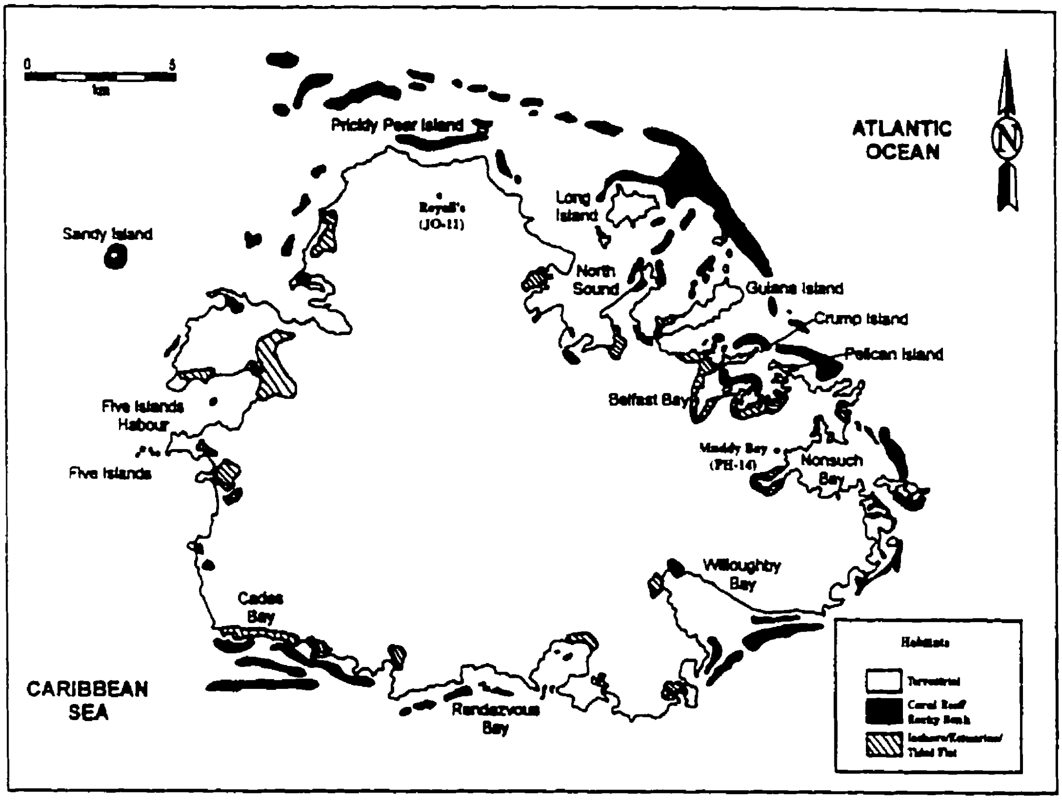
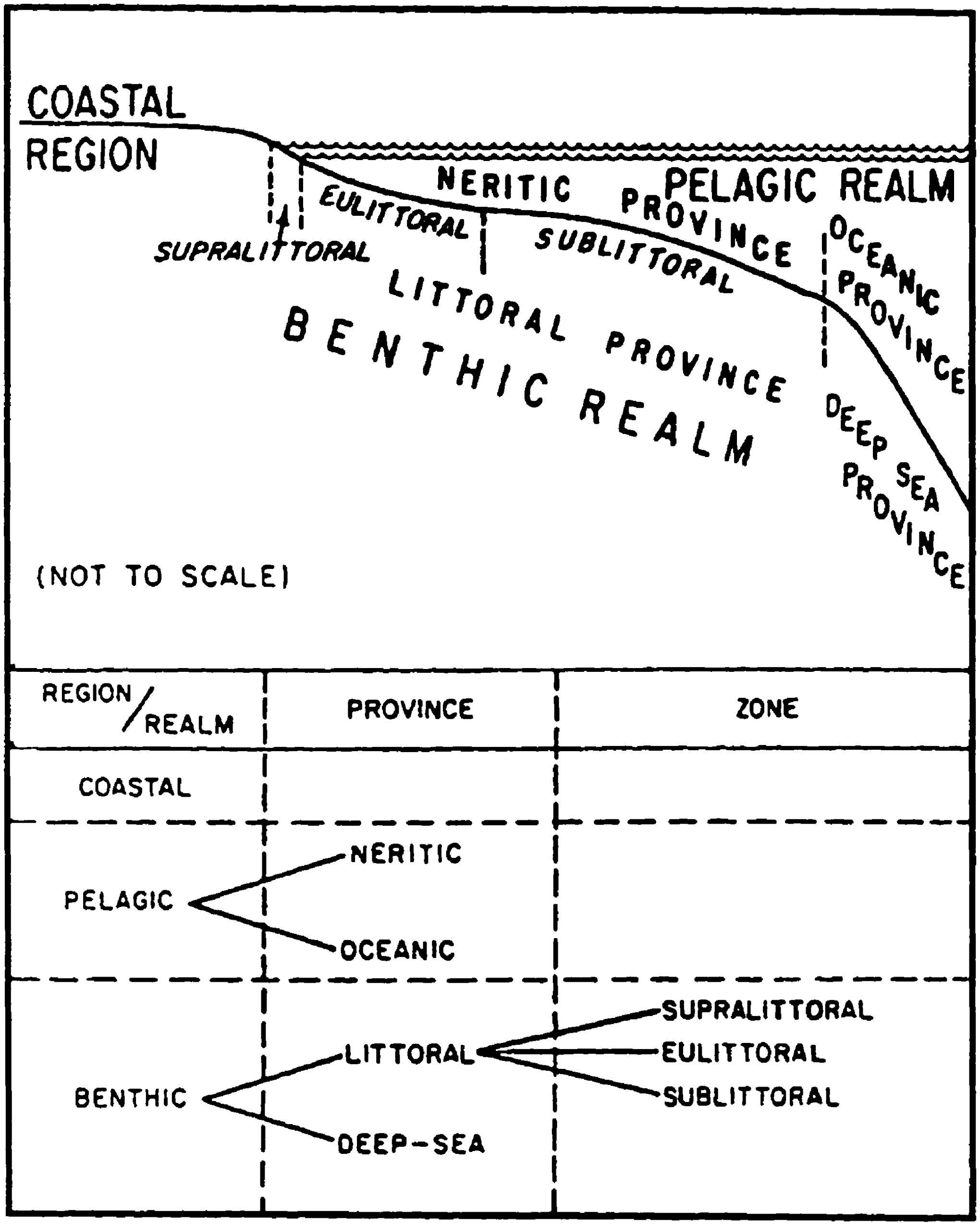


Figure 9: Habitats of Antigua (Murphy 1999:Figure 13).

Coral Reefs and Rocky Banks; and the Offshore Pelagic (Wing and Reitz 1982:21-23; Wing 1989:142-143). The Inshore Estuarine and Tidal Flats include mangrove swamps, protected lagoons river deltas, shallow inshore waters, beaches, and rocky outcrops (Wing and Reitz 1982:21-23; Wing 1989:143). The Inshore Estuarine and Tidal Flats habitat can also fall into the terrestrial zone division when dealing with certain fauna that reside within both the terrestrial and aquatic zones, such as marine turtles and some crabs. The Inshore Estuarine and Tidal Flats habitat can be further subdivided into Littoral (intertidal zone), Eulittoral (zone in between intertidal zone and low tide mark), Sublittoral (between low tide mark and the open ocean), and Supralittoral (splash zone above low tide mark) zones where most molluscs reside (Davis 2000:15; Stokes 1991:47-49; Figure 10). The Coral Reefs and Rocky Bank habitat contains a diverse number of vertebrate and invertebrate taxa (Wing 1989:142). Coral reefs are characterized by reefs in clear, shallow warm water with live coral in fringing or barrier form, and Rocky Banks are composed of deep dead coral or rock ledges (Wing and Reitz 1982:22). The Offshore Pelagic contains taxa that reside in an open ocean habitat (Stoke 1991:50; Wing and Reitz 1982:22). The classification of this habitat is applicable to areas on the island where the continental shelf is narrow and deep water is within the immediate vicinity (Wing 1989:143). Thus, such divisions may provide insight into procurement strategies adopted by the prehistoric inhabitants of Antigua. The following discussion will focus upon the genera of fauna that were most likely consumed and/or utilized for other non-food purposes by the prehistoric inhabitants of Antigua.

Terrestrial Zone Fauna (Endemic and Introduced)

Mammals. The terrestrial mammals of Antigua consist of endemic/native and introduced species. All of the native species are extinct, and most of these extinctions and extirpations have been brought about by human impact (Pregill et al. 1994:15; Steadman et al. 1984*a*:4451; Table 2). Such mammals include the Antillean fruit-eating bat (*Brachyphylla* cf. *caveranrum*), the Moustache bat (*Pteronotus parnellii*), the Leaf-chinned bat (*Mormoops blainvillei*), Extinct bat (*Phylloncyteris* cf. *P. major*) and Velvety free-tailed bat (*Molossus molossus*) and the Rice Rat (Oryzomyine sp.) (Pregill et al.



REGION/REALM	PROVINCE	ZONE
COASTAL		
PELAGIC	NERITIC OCEANIC	
BENTHIC	LITTORAL	SUPRALITTORAL EULITTORAL SUBLITTORAL
	DEEP-SEA	

Figure 10. Marine Habitats (Watters 1983:Figure 2).

Table 2. Extinct Vertebrates from Antigua[a].

Taxa Extinct on Antigua	**Burma Quarry**	**Indian Creek**	**Mill Reef**	**Historic Record or Specimen**
Reptiles				
Leiocephalus cuneus (Curly-tailed lizard)[b]	x			
Ameiva griswoldi (Ground lizard)	x		x	x
Alsophis antillensis (Ground snake)	x		x	x
cf. *Boa constrictor* (Boa Constrictor)		x		
cf. Boidae, genus uncertain (unknown boid snake)*	x			
Birds				
Puffinus lherminieri (Audubon's Shearwater)	x	x	x	
Porzana flaviventer (Yellow-breasted Crake)	x			
Porphyrula martinica (Purple Gallinule)		x	x	
Phoenicopterus ruber (Greater Flamingo)			x	
Amazona sp. (?)[b] (Parrot)		x	x	
Athene cunicularia (Burrowing owl)	x			x
Cinclocerthia ruficauda (Trembler)	x			
Mammals				
Pteronotus parnellii (bat)	x			
Mormoops blainvillei (bat)	x			
Phyllonycteris major (bat)[b]	x			
Oryzomyine sp. (Rice Rat)[b]	x	x	x	
Trichechus manatus (manatee)			x[c]	

(a) From Steadman et al. 1984a:Table 2

(b) Totally extinct taxon.

(c) Taxon identified from Hawkes Bill Bay site, not Mill Reef.

1994:15–16, 47-48; Steadman et al. 1984*a*; Wing et al. 1968; Woods 1986:654; Table 2). Bat remains are commonly found within the earlier levels of archaeological deposits, implying that they became extinct at an early date (Stokes 1991:44; Wing et al. 1968). Furthermore, bat remains may also represent natural deposits, considering both their relative absence in most archaeological sites, and their small nutritional contribution. Archaeological evidence on Antigua and throughout the Lesser Antilles indicates that the endemic Rice Rat was an important contribution to the Caribbean diet (Murphy 1996:112; Stokes 1991:45; Wing 1999, 1989, 1993, 1994; Wing et al. 1968).

Prehispanic introduced mammals include the Agouti (*Dasyprocta aguti* or *Dasyprocta leporina*), guinea pig (*Cavia porcellus*), and the domestic dog (*Canis familiaris*). These animals can be described as domestic or tame and were introduced by early colonizers from South America (Harris 1965:61; Morgan and Woods 1986; Olson 1982; Roe 1994:157; Steadman et al. 1984a:4450; Wing 1993:247). Their absence within the fossil record of Antigua further implies that they were not native to Antigua (Morgan and Woods 1986; Olson 1982; Wing 1989: 140, 1993: 247). Reasons for their introduction could have resulted from the absence of land fauna on Antigua and the maintenance of contact with familiar animals from the mainland.

Remains of the domestic dog, *Canis familiaris*, have been found at numerous sites throughout the Caribbean (see Wing 1989), and sometimes within significant social contexts such as human burials, suggesting that the dog played an important role in these societies (Roe 1994; Wing 1989:140-141). On Antigua, dog remains have been found within midden contexts at the Indian Creek and Royall's sites, suggesting that dogs could have been consumed as well (Healy et al. 1999; Wing 1999).

Guinea pigs, *Cavia porcellus*, have a long history of domestication within the Andean area and have been identified at sites across the Caribbean (Wing et al. 1968; Wing 1989:141). Their importance in Andean culture as a food source and during certain feasts may be applied to the Caribbean as well (Bruhns 1994:67). On Antigua, guinea pig remains have been uncovered at the Mill Reef and Indian Creek sites (Wing et al. 1968; Wing 1999).

The Agouti, *Dasyprocta* sp., has been recorded at a number of sites across the Caribbean. Agouti remains have been uncovered on Antigua at the Mill Reef, Muddy Bay, Royall's, and Indian Creek sites (Cruz and LaRose 1995; Healy et al. 1999; Murphy 1996; Wing 1989,1999; Wing et al. 1968). It has been suggested that the Agouti was an important food source wherever humans co-existed (Wing 1993:247). At the Mill Reef site, Agouti remains increased over time, implying that the animals may have been domesticated as a food resource (Stokes 1991:45). The discovery of an Agouti within a human burial at the Sugar Factory Pier site on St. Kitts further indicates the significance of this animal to prehistoric people (Wing 1993:247). Their scarcity in midden contexts may also imply that the Agouti was buried elsewhere as part of the prehistoric Caribbean mortuary custom (Wing 1993:247).

Other wild and domestic terrestrial animals introduced to Antigua during the initial European contact period include wild deer (*Odocoileus virginianus*), the mongoose (*Herpestes auropunctatus*), the Black rat or Old World rat (*Rattus rattus*) and domesticates such as pig (*Sus scrofa*), cattle (*Bos taurus*), sheep (*Ovis aries*), horse (*Equus caballus*), goat (*Capra hircus*) and chicken (*Gallus gallus*) (Harris 1965:61, 65-67; Steadman et al. 1984*a*:4450). Wild deer was brought during the seventeenth century to provide game for European residents of Antigua (Harris 1965:61). The mongoose was introduced in the nineteenth century to eradicate the introduced Old World rat population that was destroying sugar plantations. Mongoose are still abundant today on Antigua (Harris 1965:62).

Birds. Across the Antilles, most birds represented at archaeological sites are moderately large and can be identified as nesting or ground dwelling species occupying terrestrial and coastal or inshore-estuarine habitats (Wing 1989:140). At various sites on Antigua, nesting or ground dwelling birds were possibly consumed or used for other purposes by prehistoric inhabitants (Table 2). Such possible species include Audobon's Shearwater (*Puffinus lherminieri*), Manx Shearwater (*Puffinus puffinus*), Red-billed Tropic-bird (*Phaethon aethereus*), White-tailed Tropic-bird (*Phaethon lepturus)*, Pelican (*Pelcanus* sp.), Booby (*Sula* sp.), Magnificent Frigatebird (*Fregata magnificens)*, Green Heron (*Ardeola striata*), Egret (*Egretta* sp.), Yellow-crowned Night-heron (*Nyctanassa violacea*), Great Blue Heron (*Ardea herodias*), Black-crowned Night-Heron (*Nycticorax* cf. *nycticorax*), Greater Flamingo (*Phoenicopterus ruber*), White-cheeked Pintail (*Anas bahamensis*), Broad-Winged Hawk (*Buteo platypterus*), Osprey (*Pandion haliaetus*), Purple gallinule (*Poryphyrula martinica*), American Oystercatcher (*Haematopus palliatus*), Pectoral Sandpiper (*Calidris melanotos*), Laughing gull (*Larus atricilla*), Red Necked Pigeon (*Columba squamosa*), Zenaida Dove (*Zenaidura* sp.), Common Ground-dove (*Columba passerina*), Ruddy Quail-dove (*Geotrygon mystacea*), Puerto Rican Parrot (*Amazona vittata*), Burrowing Owl (*Athene cunicularia*), Antillean Nighthawk (*Chordelies gundlachii*), Scaly-breasted Thrasher (*Margarops fuscatus*), and Passerines (Passeriformes sp.) (Pregill et al. 1994:47-48; Steadman et al. 1984a; Wing et al. 1968;

Wing and Reitz 1982:16-20). It must be noted that as native land mammals underwent extinction and extirpation the same fate befell native avifauna of Antigua (Table 2). All of the above avifauna has been found at the Burma Quarry site, the Indian Creek site, and the Mill Reef site (Pregill et al. 1994; Steadman et al. 1984*a*; Wing 1999; Wing et al. 1968).

Reptiles. On Antigua eight species of terrestrial reptiles have been identified at the following archaeological sites: Burma Quarry, Muddy Bay, Indian Creek, and Mill Reef (Cruz and LaRose 1995; Pregill et al. 1994; Steadman et al. 1984*a*; Wing 1999; Wing et al. 1968). These species include the Wood Slave (*Thecadactylus rapicuada*), Antigua Large Anole (*Anolis bimaculatus*), Antigua Small Anole (*Anolis* cf. *A. wattsi*), Iguana (*Iguana iguana* or *Iguana delicatissima*), Curly-tailed Lizard (*Leiocephalus cuneus*), Antigua Ameiva (*Ameiva griswoldi*), Antigua Blind Snake (*Typhlops monastus*), Boa Constrictor (*Boa constrictor*), and Lesser Antillean Ground Snake (*Alsophis* cf. *A. antillensis*), (Pregill et al. 1994; Steadman et al 1984*a*, Wing et al. 1968; Wing and Reitz 1982:19). Most of these reptiles have been drastically reduced to the point of extinction by the impact of the mongoose and overhunting by humans (Harris 1965:64). Of all the terrestrial reptiles from Antigua, the iguana was consumed by prehistoric Antiguans and heavy predation further reduced their numbers during historic times (Harris 1965:64; Wing 1989:140). Of interest is the fact that the *Boa constrictor* was introduced to Antigua from South America (Steadman et al. 1984a:4450) and its remains have been found at the Indian Creek site (Rouse and Allaire 1978; Steadman et al. 1984*a*:4449).

Amphibians. Two species of amphibians have been identified on Antigua, these are the Whistling Frog (*Eleutherodactylus johnstonei*) and the Crapaud or Mountain

Chicken (*Leptodactylus fallax*) (Harris 1965:62; Pregill et al. 1994:47). The Mountain Chicken was considered highly delectable by French and English settlers, and became extinct during the post-contact era on Antigua (Harris 1965:62).

Crustaceans. Four genera of land crabs are represented at archaeological sites on Antigua. These species are represented by the Land Hermit Crab (*Coenobita clypeatus*), the Great Land Crab (*Cardisoma guanhami*), Black Land Crab (*Gecarcinus lateralis*), and the Black/Blue Mountain Crab (*Gecarcinus ruricola*) (Voss 1988; Wing 1997). Some of these land crabs occupy inshore and mangrove areas; *Coenobita clypeatus* is known to wander 15 km inland because it can maintain a water balance within the shell of the West Indian Topshell, *Cittarium pica* (Wing 1997:5). Numbers for the Land Hermit Crab (*Coenobita clypeatus*) can be high within midden contexts and reliance upon them is suspect, because their presence within these contexts may result from their scavenging activities (Wing 1997:5). Archaeological evidence across the Caribbean also indicates that reliance upon Gecarcinid crabs (*Cardisoma guanhami*, *Gecarcinus lateralis*, and *Gecarcinus ruricola*) as a food source was common (Wing 1989).

Aquatic Zone Fauna

Mammals. The distribution of marine mammals is known from historic accounts indicating their possible presence at Amerindian sites (Lovén 1935:424-425; Rouse 1948: 524; Sauer 1966:58). The discovery of manatee (*Trichechus manatus*) remains at the Mill Reef site on Antigua corroborates this argument (Wing et al. 1968). Other possible marine mammal species include Dolphin (Delphinidae sp.), Whale/Porpoise (*Cetacea* sp.), and the Monk Seal (*Monachus tropicalis*) (Stokes 1991:52; Steadman et al. 1984*a*:4450; Wing and Reitz 1982:16).

Bony and Cartilaginous Fish. A variety of fish from Antigua's aquatic resource zones could have been present in the prehistoric Antiguan diet. Within the Inshore, Estuarine and Tidal Flats habitat lie Bonefish (Albulidae sp.) Sea Catfish (Ariidae sp.), Jackfish (Carangidae sp.), Snook (Centropomidae sp.), Tarpoon (Elopidae sp.), Sheepshead or Porgies (Sparidae sp.), and Drum (Sciaenidae sp.) (Murphy 1996:109; Stokes 1991:49-50; Wing, 1989:143; Wing and Reitz 1982:16-20). The Coral Reef and Rocky Banks habitat is home to the largest variety of fish (Wing 1989:143). These consist of the Squirrelfish (Holocentridae sp.), Grunt (Haemulidae sp.), Angelfish (Pomacanthidae sp.), Hogfish (Labridae sp.), Parrotfish (Scaridae sp.), Barracuda (*Sphyraena* sp.), Surgeonfish (Acanthuridae sp.), Triggerfish (Balistidae sp.), and Porcupinefish (Diodontidae sp.). Within the dead coral and rock ledges of the rocky banks lie the Grouper (Serranidae sp.), and Snapper (Lutjanidae sp.). Of further importance is that Snapper (Lutjanidae sp.) can also be present within the inshore and estuarine habitat. Furthermore, various sharks (Squaliformes) and rays (Rajiformes) are associated with these habitats; possible species include the Nurse Shark (*Ginglymostoma cirratum*), and the Requiem Shark (Carcharhinidae sp.) (Wing 1999:Table 2; Wing et al. 1968:131; Wing and Reitz 1982:9-11). The Offshore Pelagic habitat is represented by a small number of fish. These include Mackerel and Tuna (Scombridae sp.), Flying Fish (Exoceotidae sp.), and occasionally Barracuda (*Sphyraena* sp.) (Murphy 1996:112; Wing 1999:58).

Molluscs. On Antigua, the most common molluscs at archaeological sites are from the Inshore Estuarine and Tidal Flats habitat (Murphy 1996: 109; Rote 1991:13). Three classes of molluscs that are common at archaeological sites on Antigua are from this habitat. These include Gastropoda, Bivalvia, and Polyplacophora. Gastropoda is represented by Limpet (Acmaeidae sp. and Fissurellidae sp.), Periwinkle (Littorinidae sp.), Murex (Muricidae sp.), Olive Shell (Olividae sp.), Nerite (Phasianellidae sp.), Conch (Strombidae sp.), Star Shell (Turbinidae sp.), and Top Shell (Trochidae sp.). Bivalvia species consist of Ark Shells (Arcidae sp.), Slipper Shell (Calyptraeidae sp.), Jewel Box Shell (Chamidae sp.), Bean Clams (Donacidae sp.), Purse Shell (Isognomonidae sp.), Lucine Shell (Lucinidae sp.), Mussel (Mytilidae sp.), Oyster (Ostreidae sp.), and Pearl Oyster (Pteriidae sp.). Finally, Polyplacophara species include the Chiton (Chitonidae sp.) (Rote 1991:31-37). Numerous other species can be included within the above classes, but for the scope of the research area, the most common species identified at archaeological sites within the Inshore, Estuarine and Tidal Flats habitat were selected.

Marine Reptiles. Throughout the history of the Caribbean marine reptiles, specifically sea turtles, were highly sought for their meat, eggs, oil from eggs, and carapace (Harris 1965:64). Consequently heavy predation, especially during modern times, has reduced the large abundance of sea turtles from the past (Harris 1965: 65; Stokes 1991:51). Three common species on Antigua include Loggerhead (*Caretta caretta*), Green Sea Turtle (*Chelonia myadas*), and Hawksbill Turtle (*Eretmochelys imbricata*) (Harris 1965:64; Pregill et al. 1994:47; Wing 1999:58).

Marine Crustaceans. On Antigua, crabs that occupy aquatic habitats include the Spider Crab (Majidae sp.) and the Cancroid Crab (Portunidae sp. and Xanthidae sp.) (Cruz and LaRose 1995; Healy et al. 1999; Murphy 1996; Voss 1980). Although the above list may appear small, this does not rule out the possibility that numerous other species of marine crustaceans were procured by prehistoric Antiguans.

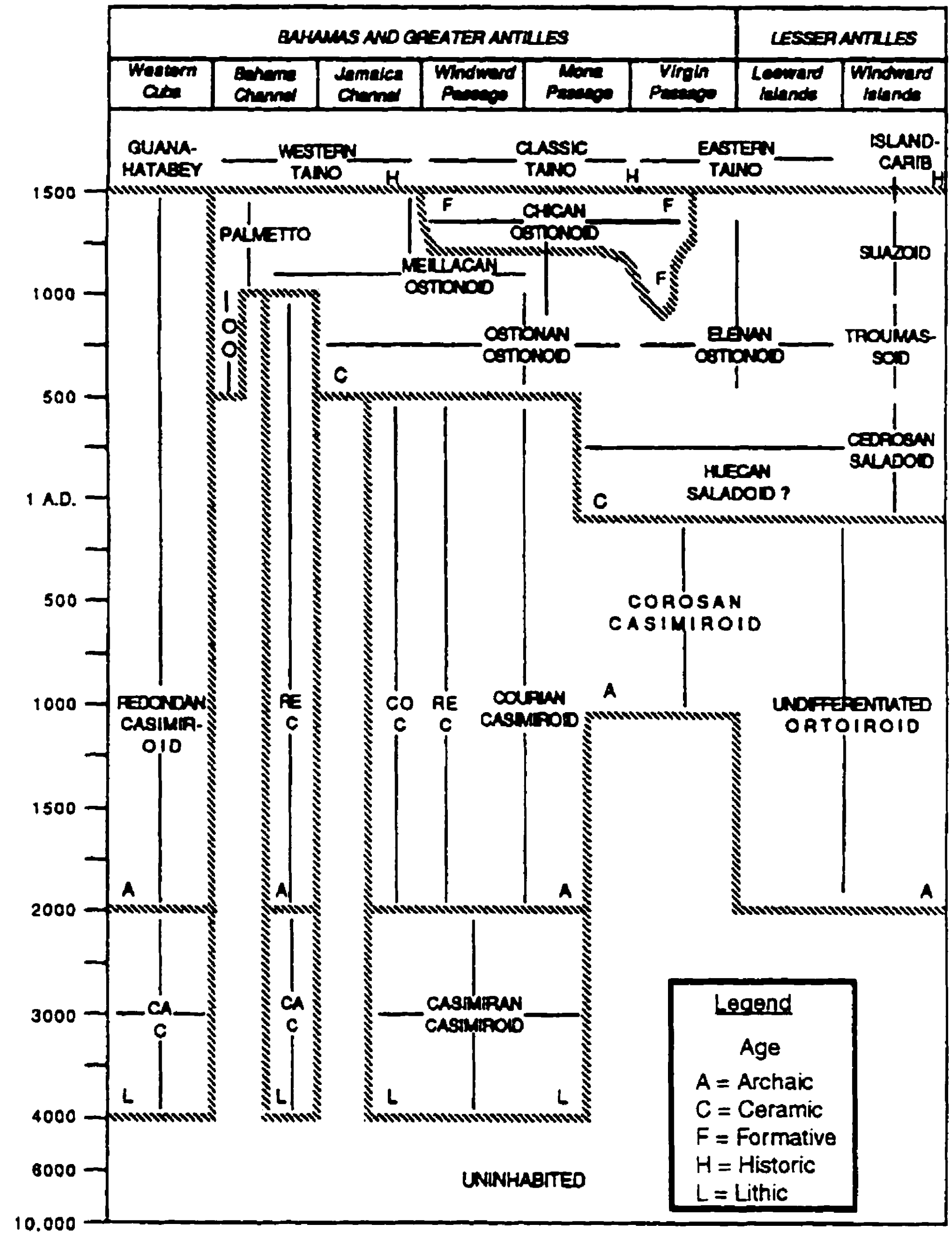
CHAPTER III

PREHISTORY OF THE WEST INDIES: CERAMIC AGE AND CERAMIC CHRONOLOGY OF ANTIGUA AND SITE HISTORY: MUDDY BAY (PH-14) AND ROYALL'S (JO-11)

Ceramic Age

On the basis of past and ongoing research, the prehistory of the West Indies can be divided into five general periods of occupation: Lithic (ca. 4000-2000 B.C.), Archaic (2000-500 B.C.), Ceramic (ca. 500 B.C.- 1500 A.D.), Formative (800 -1500 A.D.) and Historic (ca. 1492- 1600) (Petersen 1997: 119; Rouse 1992: 32-33; Figure 11). Each of these periods represents at least four separate migrations and corresponds to different technological complexes (Keegan 1994:262; Rouse 1992:33). Research on defining accurate chronologies is ongoing, and is in need of further refinement. By the time this research is completed, it is possible that more chronological taxonomies will emerge. For the purposes of this research project, I describe the Caribbean Ceramic Age on Antigua and in the Lesser Antilles.

It is generally accepted that origins of the Caribbean Ceramic Age in the Lesser Antilles are from the Orinoco River Basin in the Northeast Coast of South America and the Guianas, occurring around the fourth and fifth century B.C (see Allaire 1997; Haviser 1997:59; see Rouse 1992; Stokes 1998:57). The cultural group associated with this migration is named Saladoid, after the Saladero site located on the Orinoco River, Venezuela (Rouse 1992; Stokes 1998:57). Other archaeologists have further divided the Ceramic Age into the Early Ceramic Age or Saladoid Period: the early period ca. 500 – 0



Legend
Age
A = Archaic
C = Ceramic
F = Formative
H = Historic
L = Lithic

Figure 11. Chronology of the Series and Subseries of Cultures in the West Indies (Rouse 1992:Figure 8).

B.C. and the late period ca. 0 - 600 A.D, and the Late Ceramic Age: Terminal Saladoid: ca. 600 A.D. – 900 A.D. and post-Saladoid Period ca. 900-1400 A.D. (Haviser 1997:60; see Keegan 1994; Petersen 1997:119; see Rouse 1992; Stokes 1998:63-65). The term

Saladoid derives from terminology developed by Rouse (1952, 1989, 1992) and Vescelius (1980) in which cultural periods are named after type-sites "...divided into 'series' designated by the suffix –oid, and 'subseries', designated by with –an" (Rouse 1992:33; Stokes 1998:50). The Saladoid cultural group is characterized by a sedentary horticulturalist lifestyle; the development of elaborate pottery vessels with white-on-red painting (WOR); zone-incised-crosshatching (ZIC); polychrome painting in red, white and black and d-shaped handle; inverted bell-shape vessels; and artifacts representing a symbolic belief system (zemi -three point stones and incense burners) (Nicholson 1992:5-6; Petersen 1997:120; Rouse 1992:71-137; Stokes 1998:61).

There are three other contending views regarding the migration of the Saladoid cultural group based on three distinctive ceramic styles (Haviser 1997:59; Stokes 1998:57). Some Caribbeanists argue that several sites have ZIC ceramics and not WOR pottery, implying a pre-Saladoid or a parallel Saladoid migration of different peoples from north central Venezuela (Chanlatte Baik and Narganes Storde 1984, 1989; Haviser 1997:59; Stokes 1998:59). This cultural group is identified as Huecoid or Huecan Saladoid after the La Hueca/Sorce site, Vieques, Puerto Rico or Guapoid after the Rio Guapo site, Venezuela (Haviser 1997:59; Stokes 1998:59). The second suggestion is that an older horticultural cultural group from the Guianas practicing non-painting styles on pottery, particularly zone punctation, migrated earlier than the Saladoid groups. Haviser has named this group as the Early Ceramic and defines it as a hybridization of Archaic and Ceramic developmental stages (Haviser 1991:655; Haviser 1997:59). Finally, the third view is that the ZIC and WOR styles represent a 'duality' or plurality within the Saladoid culture group (Haviser 1997:59-60; Rouse 1992:89). These differences could possibly be family lineages or subgroups. Following this line of reasoning, the Huecan-Saladoid group is associated with ZIC ware and the Cedrosan-Saladoid is represented by WOR ware (Haviser 1997:59-60; Rouse 1992:77-90; Stokes 1998:57).

The early period of the Early Ceramic Age is denoted by a direct dispersal from Venezuela and Trinidad into the Leeward Islands, the U.S. Virgin Islands, and Eastern Puerto Rico. As expansion continued west, it was halted by the presence of Archaic foragers in the Greater Antilles. Probable causes could have been direct conflict or competition for terrestrial resources. These Archaic foragers were not present during the Spanish conquest of the Caribbean (Keegan and Diamond 1987:70; Keegan 1994:271; Rouse 1992; Stokes 1998:57). During this phase, settlement of the islands appears to be in the north half for most of the islands with coastal settlements and an increased number of inland sites, except for Puerto Rico, and Trinidad and Tobago. The late period of the Early Ceramic Age is characterized by one major site on each island throughout the Caribbean. and approximately 80% of these are located on the southern coastal regions of the islands (Haviser 1997:67).

The majority of Early Ceramic Age or Saladoid sites had small villages with large pole and thatch houses holding 60 individuals (Curet 1992; Haviser 1997:66; Stokes 1998:60). These houses were arranged around a central plaza that at some sites served as a cemetery. Ancestor worship was believed to have been represented by this spatial arrangement (Curet 1992; Keegan et al 1998:227; see Siegel 1992). Saladoid people were organized socially into ‘complex tribes’, lacking a centralized authority (Allaire 1997:23; Siegel 1989; Stokes 1998:60). Archaeological evidence also suggests that Saladoid occupants may have transplanted a mainland subsistence economy and settlement preference reminiscent to one practiced in South America (Petersen 1997:123-127). As indicated earlier, this settlement and subsistence economy entailed the occupation of river valleys for the cultivation of root crops and subsistence upon terrestrial species such as land crabs (Haviser 1997:66; Ortiz Aguilú et al. 1991). According to Keegan (1995:409), such an adaptation made good economic sense for these migrants.

The Late Ceramic Age or post-Saladoid period marked the continued expansion into the Greater Antilles (Cuba, Jamaica, Puerto Rico, and Hispaniola), the Bahamas and the Lesser Antilles. Most sites were assumed to have been in the fertile interior valleys of the larger islands where horticulture was heavily practiced, as it was during the Early Ceramic Age. During this period, the number and size of sites in the Caribbean increased, especially in the Leeward Islands, resulting in a human population expansion (Petersen 1997:124). For example, on Nevis 17 of 19 Ceramic Age sites have been dated to the post-Saladoid era (Stokes 1998:63; Versteeg et al. 1993:146-147; Wilson 1989:436).

Along with the increase in sites, a regional division in pottery styles emerged, which in turn was probably initiated by local cultural development across the islands (Stokes 1998:63). For most of the islands in the Lesser Antilles, pottery vessel form became less detailed and ZIC design disappeared, whereas WOR painted styles remained but only in rectilinear designs (Stokes 1998:63). Some archaeologists argue that the variety in pottery assemblages in the post-Saladoid period resulted from the break down of the Saladoid social system. This occurrence established local trajectories of new cultural groups (Hoogland 1996:220; Stokes 1998:63). These new cultural groups were created as a result of "shifting alliances and changing interaction spheres" (Stokes 1998:

64), which eventually led to the formation of complex tribes and/or simple chiefdoms (Hoogland 1996:220; Keegan et al. 1998:229; Stokes 1998:64).

Ceramic Chronology of Antigua

On Antigua, four complexes spanning from the first millennium A.D. until the late fourteenth century represent the Ceramic Age (Table 3). The complexes on Antigua are named after type-sites and chronological designations have been assigned through radiocarbon dating and the sequencing of ceramics (Murphy 1996:34).

The Indian Creek ceramic sequence is the first distinct phase within the Saladoid period on Antigua dating from 71 A.D. to 600 A.D. The Indian Creek site is located relatively inland adjacent to a dried up streambed, approximately 800 m from a rocky cove (Rouse and Morse 1999:7; Figure 12). The settlement arrangement of the Indian Creek site constitutes a circle of middens surrounding houses that face a small plaza located in the centre (Rouse and Morse 1999:50). This arrangement is similar to other Saladoid (early and late period respectively) sites across the Caribbean such as Maisabel, Puerto Rico and Golden Rock, St. Eustatius (Siegel 1992; Versteeg and Schinkel 1992). The Indian Creek site complex is characterized by pottery with ZIC and WOR decoration, D-shaped strap handles, bell-shaped bowls, black and orange painted wares, and tabular lugs with incised lines and zoomorphic and anthropomorphic heads (Rouse and Morse 1999:19-29; Rouse 1976:35; Figure 12). Indian Creek ceramics are consistent with the Saladoid tradition in the Lesser Antilles but appear later on Antigua than at other sites in the Northern Leeward Islands such as Trants, Montserrat and Fountain Cavern,

Table 3. Ceramic Age Chronology of Antigua[a].

Culture and Type Site	Associated Dates	Radiometric Dates cal
Post-Saladoid		
Phase 4: Freeman's Bay	c. 1200 AD-1500 AD	I-7839 AD 1109
Phase 3: Mamora Bay	c. 900 AD-1200 AD	I-7845 AD 999
Terminal Saladoid		
Phase 2: Mill Reef	c. 600 AD-900 AD	O-2258 AD 623
Saladoid		
Phase 1: Indian Creek	c. 71 AD-600 AD	I-7980 AD 71

(a) From Murphy 1999: Table 1.

Anguilla (Murphy 1999:29; Petersen and Watters 1991). It also contains other ceramic complexes such as Mill Reef and Mamora Bay that were found at different units at the site (Rouse and Morse 1999:19-43). Other artifacts include effigy vessels, clay griddles, shell artifacts (celts, pendants, beads, inlays, spoons, and three-pointers) and ground stone and chip-stone artifacts (Nicholson 1992:6; Rouse and Morse 1999:29-31). The subsistence strategy practiced included the procurement of terrestrial, inshore-estuarine and coral reef species along with the cultivation of root crops as evidenced by Cassava griddles (Jones 1985; Petersen 1997:126).

The Mill Reef phase follows, and it is recognized as terminal Saladoid dating to 600 A.D. until 900 A.D. and through its divergence in ceramic style from the earlier Saladoid period (Murphy 1996:36-37; Nicholson 1992:7). The Mill Reef site is located 100 m inland from Great Deep Bay on top of the crest of a ridge (Murphy 1999:200; Wing et al. 1968:124) making it a coastal settlement. Overall, Mill Reef ceramics

Figure 12. Aerial Photograph of the Indian Creek Site, Looking South (Rouse and Morse 1999:Figure 4).

deteriorate in quality; WOR decoration changes from curvilinear designs to straight and diagonal striping; ZIC decoration disappears and Cassava griddles are built with legs. Vessel walls are thicker with roughened and scratched surfaces (Rouse 1976:36). The subsistence strategy practiced at Mill Reef involved mainly the procurement of coral reef and inshore-estuarine species with the inclusion of terrestrial mammals, birds and reptiles (Murphy 1999:209-211; Wing et al. 1968).

The Mamora Bay Complex appears around 900 A.D. and continues until 1200 A.D. during the post-Saladoid sequence. The type site is located at the foot of a high hill on a small peninsula on the southeast coast of Antigua relatively close to shore just east of the Indian Creek (Rouse 1976:37; Wing et al. 1968:126). The site is denoted by two long middens paralleling one another on each side of the peninsula with a smaller one at the end of it (Wing et al. 1968:126). Between the middens lies a flat 'courtlike' surface believed by the late Fred Olsen to be a ball court, because of the arrangement of low middens, although it could be a plaza as well (Wing et al. 1968:126). This area contained a number of pottery, stone, and shell remains. Mamora Bay ceramics are characterized by a number of traits. First, some vessels lack white paint on them and have the occasional rectilinear designs (Rouse 1976:36). In addition, the use of red painting is present, but only for the limited purpose of covering certain surfaces on vessels. Broad-line, curvilinear incisions, thickened and folded wedge-shaped rims and scratched surfaces are present. The use of handles is absent and lugs are rarely visible on vessels (Murphy 1996:38, 1999:30-31; Nicholson 1992:7; Rouse 1976:36). Particular ceramic designs of this complex are similar to other series in the Windward Islands such as the Troumassoid series found on St. Lucia (Nicholson 1992:7). The Mamora Bay complex is now called the Mamoran-Troumassoid complex (Hofman 1993:152-153; Nicholson 1992:7). Information regarding subsistence strategies is not available but they can be assumed to be similar to Mill Reef considering the site's coastal location.

The Freeman's Bay complex is characterized as the final stage of the Antiguan ceramic chronology (Murphy 1996:38). This complex dates from 1200 A.D. to 1500 A.D., but only based on a small sample (464 ceramic sherds) and limited survey and excavations (Murphy 1996:38,1999:31; Nicholson 1992:8; Rouse 1976:39). It is also considered to overlap in time and in ceramic type with the previous Mamora Bay complex (Davis 1988a:58; Murphy 1996:40;1999:32; Nicholson 1992:5-7; Rouse 1976:37). The Freeman's Bay site is located west of Indian Creek on a sandy beach at the mouth of English Harbour (Rouse 1976:37). This ceramic sequence is defined by pottery that has deeper, narrower, and irregular shaped incised lines. Red slip on vessels is thinner and appears on both sides, and white painting is absent. Vessel forms are jars with pronounced necks and shoulders, and Cassava griddles with legs are not present in this complex (Murphy 1996:39; Rouse 1976:37). The Freeman's Bay complex can also be associated with ceramic developments in the Bahamas and southern Windward Islands, again dismissing the idea that its development was a local occurrence (Rouse 1992:129).

Site Setting and Research History

Muddy Bay (PH-14)

Archaeological investigations at Nonsuch Bay by the Museum of Antigua began with the development of luxury villas in this region within the last decade (Murphy

1996:18). Although most of the research has been conducted as salvage archaeology, current investigations are research-oriented and scholarly in nature (Cruz 2000; Murphy 1996; Stokes 1991). The earliest research here took place during the summers of 1986 and 1987, led by Dr. David Davis, then of Tulane University.

From his research, two radiocarbon dates (± 640 A.D. and ± 930 A.D.) were provided from the nearby PH-11 site, but his overall results from the Nonsuch Bay archaeological investigations have not been published yet (Murphy 1996:18; Stokes 1991:98-99). Continued research on several sites (PH-11, PH-14, and PH-18) in January 1987, by Dr. Aad Versteeg from the University of Leiden, produced a report for the Museum of Antigua containing information concerning the archaeological significance of the Nonsuch Bay area (Murphy 1996:18; Versteeg 1987). In 1988, Bruce Nodine a Ph.d. candidate from the University of Pennsylvania, excavated the Cloverleaf (PH-12) site dating to ± 383 B.C., suggesting that it is one of the earliest Ceramic Age sites on Antigua (Nicholson 1992). In the same year, Anne Stokes of the University of Florida conducted a site survey of the area. Stokes (1991) mapped all Preceramic and Ceramic Age sites, and did some excavation to determine the settlement and subsistence strategies for the prehistoric inhabitants of this bay. In 1991 and 1992, research was renewed by Desmond Nicholson of the Museum of Antigua and Barbuda and Arthur Reg. Murphy, a M.A. candidate from Trent University, Canada (Murphy 1996:20; Wilson 1993:151). The focus of research centred upon the investigation of settlement patterns through ceramic analysis and examination of the potential for more archaeological research in this region (Murphy 1996:20). Preliminary excavations established that preservation of artifactual material, especially faunal material, was excellent and the ceramics suggested a Terminal

Saladoid to post-Saladoid period of occupation, a poorly understood time period (Murphy 1996:20; Stokes 1991:99). Further excavations of the Nonsuch Bay area were conducted in 1992, 1994, and 1996, and concentrated upon the Muddy Bay (PH-14) site under Murphy's (1996) direction. Other research and graduate studies have emerged from Murphy's archaeological research as well (Cruz and LaRose 1995; Healy and Murphy 1995; Murphy 1999).

The Muddy Bay (PH-14) site is located on the eastern coast of Antigua within the sheltered area known as Nonsuch Bay (Figure 13). It is one of many archaeological sites dating to the Preceramic and Ceramic Ages within this bay system (Davis 1982; Murphy 1996:18; Nicholson 1992; Stokes 1991:98). The site lies within the Northeastern Limestone district, which receives less than 1016 mm of rain per annum (Harris 1965:9-11; Murphy 1996:14). Within two kilometres lies Ayres Creek, the only visible fresh water source near the bay (Murphy 1996:14; Figure 13).

The area of the site is approximately 166 m east/west by 118 m north/south, and starts at the waterfront of the bay (Murphy 1996:14; Figure 14). The site is located at the southwestern end of the villa development area, which is divided into a series of building lots (Murphy 1996:17; Figure 14). The area of the site is delineated by a surface scatter of pottery sherds, lithic material, and shell remains (Murphy 1996:14). The site is surrounded by mangrove and shallow estuarine systems, and is enclosed by a barrier reef and, further out by a small island, Green Island (Murphy 1996:14). The large barrier reef provides sheltered access from the aquatic resources of the deeper pelagic waters of the Atlantic (Murphy 1996:14).

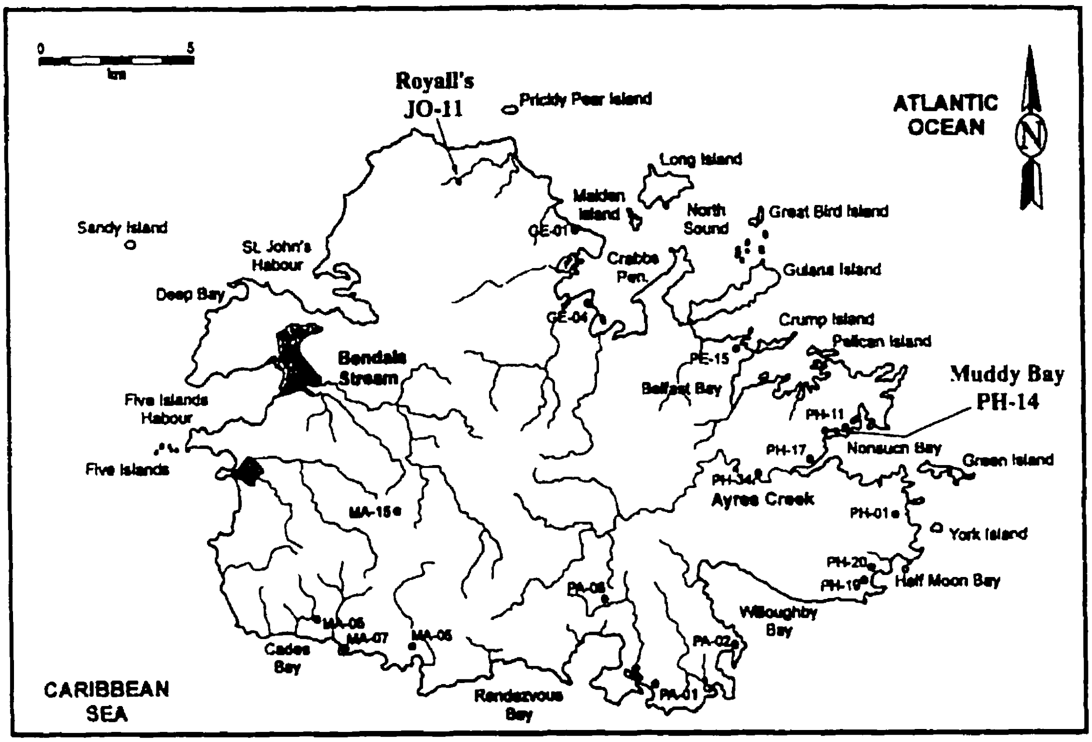


Figure 13. Site Location Maps of the Muddy Bay (PH-14) and Royall's (JO-11) Sites, Antigua.

The vegetation surrounding the site is classified as "...xerophytic evergreen bushland, typical of the limestone region on offshore islands of Antigua" (Murphy 1996:16). Forest cover consists of a low open canopy with dense undergrowth of thorny scrubs (Murphy 1996:16). According to Murphy (1996:14-16), the topsoil of PH-14 is fertile with good drainage which would have been ideal for the production of manioc, a staple in the Island-Arawak diet (Lovén 1935; Rouse 1992:12; Stokes 1991:55-56). In 1994, a botanical survey was conducted by Murphy and Kevel Lindsay, a government forestry officer. It was determined that the current botanical environment within the vicinity of the site is native to Antigua (Murphy 1996:16; Table 4). Given the history of agricultural practices in this vicinity during the Historic Age, subsurface disturbances

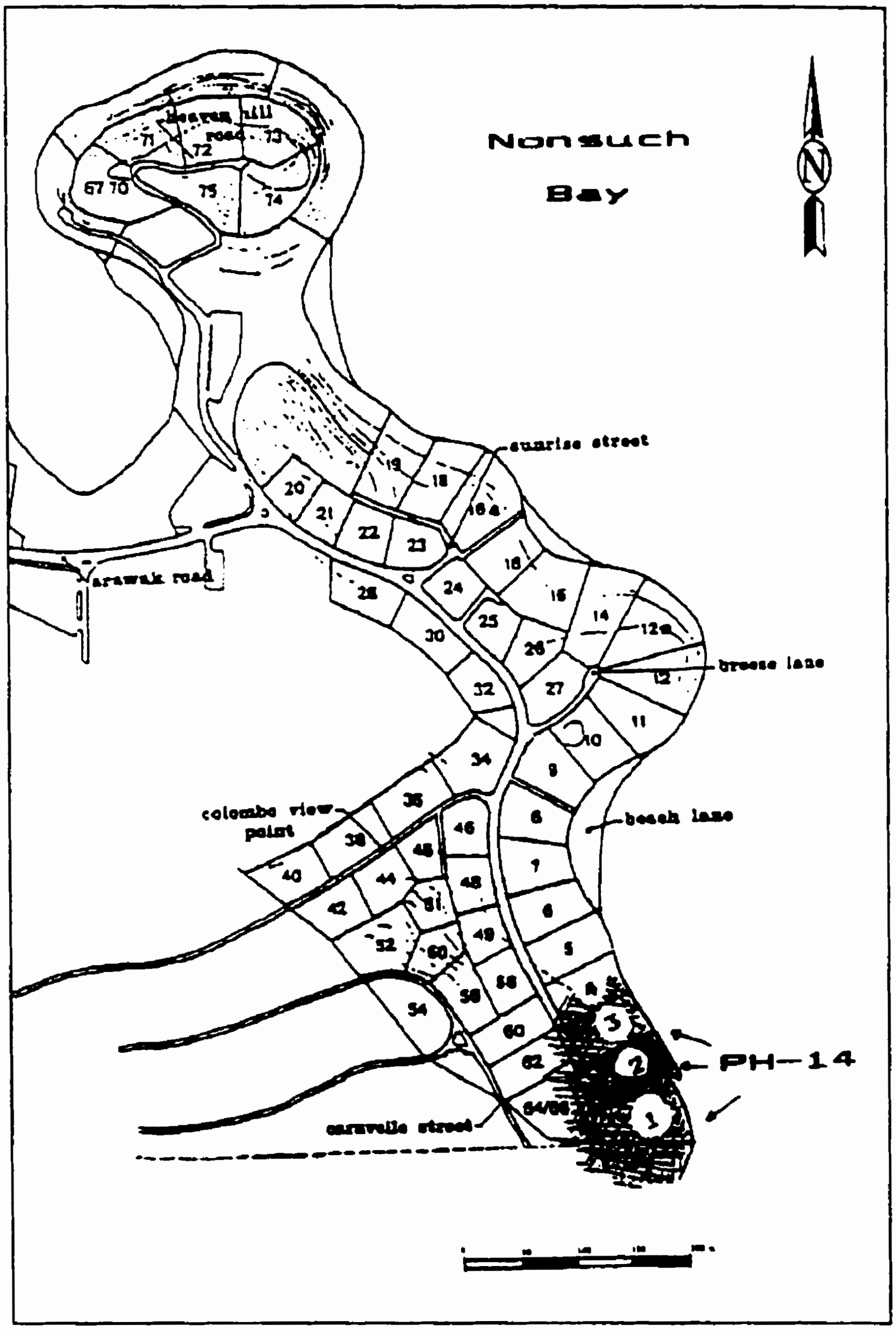


Figure 14. Location of Muddy Bay (PH-14) within Land Development Site (Murphy 1996:Figure 5).

Table 4. Present Vegetation of the Muddy Bay (PH-14) Site, Antigua[a].

Taxon	Common Name	N=Native/A=Alien
Trees and Shrubs		
Acacia tortuosa	Acacia/Cassie	A
Avicennia germinans	Black Mangrove	N
Bursera simaruba	Turpentine	N
Capparis flexuosa	Black Willow	N
Canella winterana	Cinnamon	N
Colubrina arborescens	Mabi	N
Hippomane mancinella	Manchineel	N
Laguncularia racemosa	White mangrove	N
Leucaena leucocephala	Wild Tamarind	A
Pisonia fragrans	Black Loblolly	N
Pisonia subcordata	Loblolly	N
Pithecellobium unguis-cati	Bread and Cheese	N
Rhizophora mangle	Red Mangrove	N
Under Shrubs		
Croton balsamifer	Balsam	N
Lantana camera	Sage	N
Lantana involucrata	Sweet Sage	N
Melochia tormentosa	Broom	N
Solanum racemosum	Cankerberry	N
Succulents		
Agave karatto	Dagger	N
Cephalocereus royeni	Dildo	N

(a) From Murphy 1996: Table1.

may have occurred at Muddy Bay (Harris 1965: Figure 8). Such agriculture practices included the harvesting of sugarcane and, more recently, cotton (Murphy 1996:16). The continued use of these fields for agricultural/horticultural purposes could possibly explain the fertility of the topsoil of PH-14.

Between 1992 and 1997, the Muddy Bay (PH-14) site underwent considerable investigation. Research was conducted primarily by Murphy, under the guidance of Desmond Nicholson from the Antigua Archaeological and Historical Society Museum of

Antigua and, Paul Healy of Trent University. The investigations conducted by Murphy included salvage archaeology and an archaeological field school, eventually leading to the completion of his Master's thesis on the settlement of the Muddy Bay (PH-14) site (Murphy 1996).

In total, nine excavation units have been dug, ranging in size from 1 m^2 to 1 m by 2 m. Most of these units are from a deep shell midden that is located in lots 1, 2, and 3 near the waterfront of the development (Figure 15). Further survey indicated that the midden extended northwards towards an access road. The size of the midden is roughly 19, 588 m^2 with varying depths (Murphy 1996:24). It must be noted that extensive land clearing by the owners had occurred prior to excavation in each of the housing lots examined (Murphy 1996:22-23) and the recent surface disturbance may have had an affect upon the density and distribution of the archaeological material. This is in addition to the subsurface disturbance from possible earlier agricultural activities.

Throughout the excavation history of Muddy Bay, research objectives have varied from unit to unit. In 1991 and 1992, two test pits measuring 1 m^2 were placed within the shell midden in lot 2 to establish the presence of an archaeological site (Murphy 1996:20; Figure 15). With the establishment of Muddy Bay as a Terminal Saladoid to Post-Saladoid occupation, continued investigations were in order. In 1994, two additional excavation units were placed in lots 1 and 2. A 2 m^2 unit (Excavation 1) was placed in lot 1, approximately 15 m from the sea (Figure 15), and a 1 m by 1 m unit (Excavation 2) was excavated in lot 2 in a more elevated area. Four samples of charcoal material were submitted for radiocarbon dating from excavations 1 and 2. In Excavation 1, Beta-74426

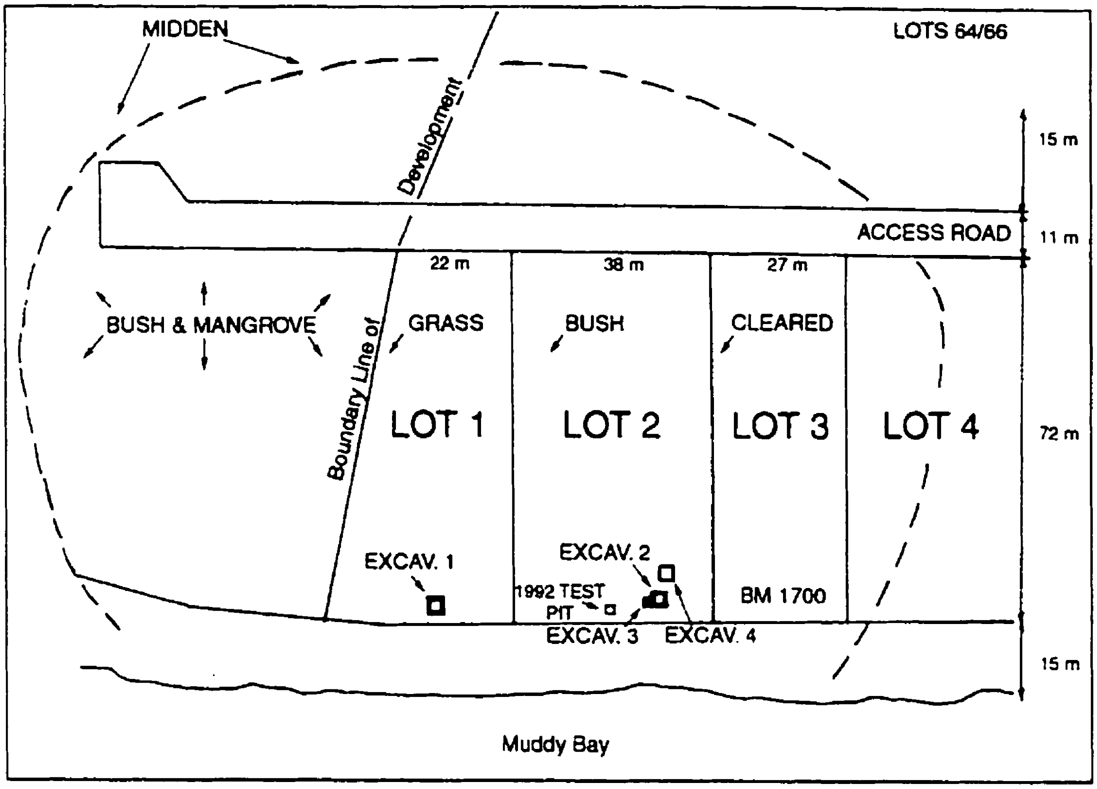


Figure 15. Location of the Muddy Bay (PH-14) Site within Residential Lots (Murphy 1996:Figure 7).

was taken from level 4, 28 cm below the surface and provided a date of 1230 ± 60 A.D. Beta-74427 was taken from level 7, 49 cm below the surface with an associate burial, and produced a date of 1220 ± 70 A.D. For Excavation 2, Beta-74428, was from level 2, 28 cm below surface level, yielding a date of 1020 ± 60 A.D., and Beta –74429 was taken from level 3, 42 cm below surface level, producing a date of 1240 ± 60 A.D. (Murphy 1996:31-32). Based on the uncorrected dates, the Muddy Bay site was occupied between 960 A.D. and 1300 A.D. Three of the dates fall within a thirty year span, and the fourth sample is 200 year older than the rest (Table 5). Using calibrated dates all samples overlap between 1220 and 1240 A.D. (Murphy 1996:32). On a cautionary note, it should

Table 5. Uncorrected Radiocarbon Dates from Muddy Bay Site (PH-14)[a].

Sample No.	**Context**	**C-14 Age**	**Calibrated Date (2 Sigma)**	**Date BC/AD**
Beta 74426	Excavation 1, Level 4	720 ± 60 BP	cal AD 1220 to 1400	AD 1230 ± 60
Beta 74427	Excavation 1, Level 7	730 ± 70 BP	cal AD 1190 to 1400	AD 1220 ± 70
Beta 74428	Excavation 2, Level 2	930 ± 60 BP	cal AD 1000-1240	AD 1020 ± 60
Beta 74429	Excavation 2, Level 3	710 ± 60 BP	cal AD 1230 to 1400	AD 1240 ± 60

(a) From Murphy 1996:Tables 2 and 3.

be noted that since shell middens do not conform to the standard principles of stratigraphy they can be classified as secondary contexts due to taphonomic, post-depositional, and depositional factors (Claassen 1998:86: Murphy 1996:32; Stein 1992:71-94). Other forms of evidence should be used in conjunction to establish dates when such processes occur. As Murphy states artifacts or radiocarbon dates should not be interpreted individually, "...artifacts must be considered collectively, within the overall site context" (Murphy 1996:32). All of these factors were taken into consideration to determine the age of the Muddy Bay site.

According to Murphy (1996:25), the placement of Excavation 1 was "selected in anticipation of uncovering evidence diagnostic of specific near shore activity." Excavation 2 was placed adjacent to the 1992 test pits in anticipation of uncovering well preserved faunal and macrobotanical remains that had been encountered in the 1992 test units (Murphy 1996:25). Both 1994 units were excavated by trowel and brush at arbitrary

In 1995, Murphy continued investigations at the Muddy Bay Site as an archaeological field school coordinated by Trent University. An additional 5 units were excavated and continued from the 1994 field season. Unit size differed, as did the research objectives. Excavations 3 (50 cm^2) and 4 (1 m^2) were placed in lot 2, and all recovered material was to be processed and analyzed. Excavation 3 was an extension of Excavation 2 from the 1994 field season. Excavations 5 and 6 of 1995 were both 1 m by 2 m, and placed in lot 3 (Arthur R. Murphy, personal communication, 1998). All remains within Excavations 5 and 6 were collected except for faunal material. Excavation 7 (1 m by 2 m unit) was placed on an incline in lot 3, which was in line with benchmark 1700 (Figure 15). Ceramic, lithic and modified shell remains were recovered from Excavation 7, but other faunal material was not collected. A final unit (Excavation 8) was partially excavated in 1995 but, due to time constraints, artifacts were not collected. All units were excavated by trowel and brush, at 10 cm arbitrary levels and dry screened through 2 mm mesh (Arthur R. Murphy, personal communication, 1998).

For the research purposes of this thesis, I analyzed only the faunal remains from Excavation 4 using vertebrate and invertebrate comparative collections from Trent University and the Vertebrate-Paleontological collection at the Royal Ontario Museum. In total, 10 levels were designated for Excavation Unit 4 (Figure 16). The excavation yielded fauna from terrestrial, inshore, estuarine, tidal flats, coral reef and rocky banks habitats. In addition, all of the mollusc remains were identified and enumerated in the field by Murphy.

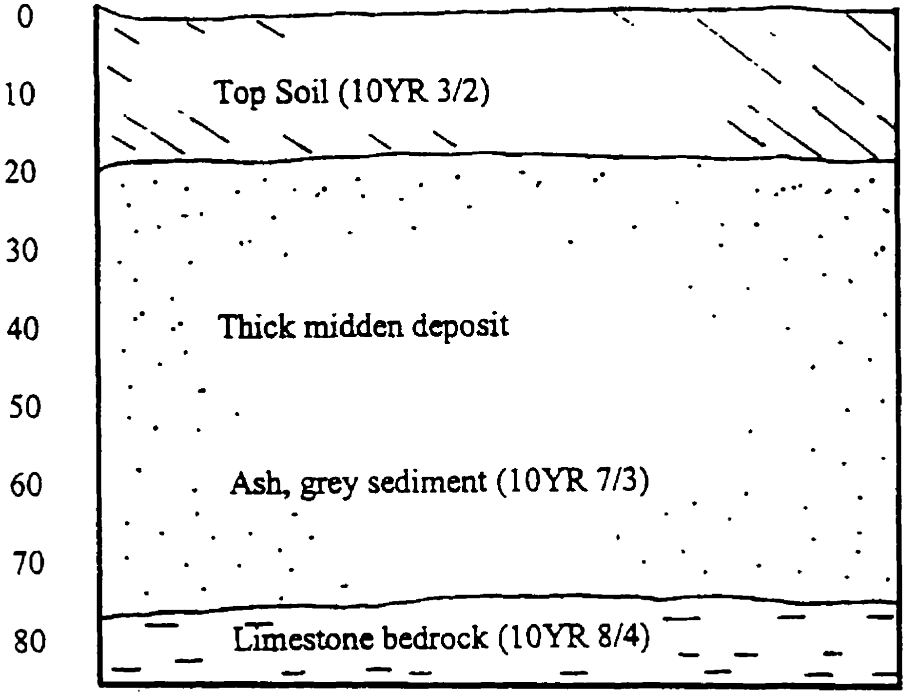


Figure 16. Profile Map of Excavation Unit 4, Muddy Bay (PH-14): 1 m^2 (Murphy 1999:Figure 54).

Royall's (JO-11)

In February 1998, the Museum of Antigua was presented with an assortment of Amerindian artifacts from an unknown site in Northern Antigua. Further research by an amateur archaeologist, John Fuller, indicated that the artifacts were from an inland site that was exposed by land clearing for residential development (Healy et al. 1999:1, 2000). Subsequent excavation and subsurface testing were directed by Murphy in July and August of 1998.

The Royall's site is located 1 km inland just east of Cedar Grove village, St. John's Parish, on the northern part of the island near Mt. Joshua (Figures 13 and 17). Transect surveys have determined that the site is approximately 700 m east/west by 600

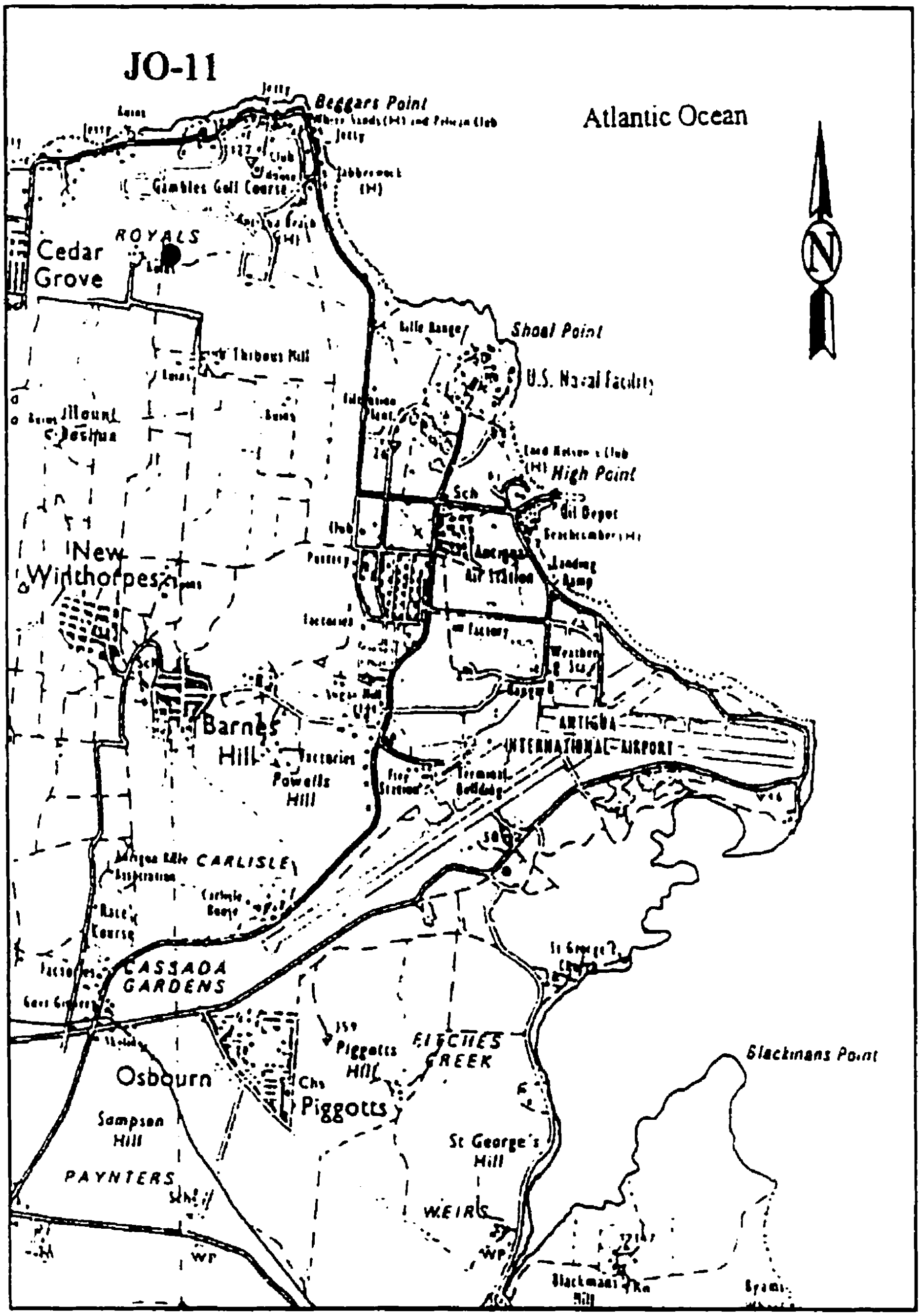


Figure 17. The Royall's (JO-11) Site within the Vicinity of Cedar Grove Village.

m north/south, with an area of 42 ha, and possibly extends further into areas of uncleared brush (Healy et al. 1999:3). This makes Royall's one of the largest Pre-Columbian sites identified on Antigua in comparison to the better known site, Indian Creek, which is 4.7 ha in area (Healy et al. 1999:3; Rouse 1974:167,169; Rouse and Morse 1999).

The current vegetation surrounding the site today is probably reminiscent of vegetation present during Royall's prehistoric occupation. A good number of the plant species are alien to Antigua and, the vegetation is "...largely composed of an impenetrable mass of thorny acacias, interspersed with wild tamarind, logwood, and the occasional tamarind" (Healy et al. 1999:2; Table 6). The presence of alien flora may have resulted from initial colonizers of the island bringing vegetation from their 'homeland' to be planted, and the current foreign flora assemblage may represent this process. On the other hand, sampling selection and recovery techniques might have influenced the creation of this assemblage as well.

Soil samples were taken from Excavation Units 1 and 2. The pH of the soil from these units ranges from 8.18 to 8.78 (Healy et al. 1999:2). Such alkaline soil conditions allow for excellent preservation of faunal remains (Healy et al. 1999:2). However, a good number of the faunal remains were encrusted with a calcium carbonate soil concretion that was difficult to remove, making identifications difficult. Further investigation of the soil horizons indicated that the soil is intermixed with layers of dark humus. The deposition of cultural remains is at an average depth of 90 cm (Healy et al. 1999:2). Underneath this matrix lies a compact grayish-brown band of sterile soil approximately 15 cm thick, or less, overlying the limestone bedrock stratum known as the Antigua Formation or the Limestone District (Harris 1965; Healy et al. 1999:2).

Table 6. Vegetation at Royall's (JO-11), Antigua[a].

Taxon	Common Name	N=Native/A=Alien
Trees and Shrubs		
Acacia tortuosa	Acacia/Cassie	A
Haematoxylon campechianum	Logwood	N
Leucaena leucocephala	Wild Tamarind	A
Tamarindus indica	Tamarind	A
Tabebuia pallida	White Cedar	N
Azadirachta indica	Neem	A
Under Shrubs		
Croton balsamifer	Balsam	N
Lantana camera	Sage	N
Melochia tormentosa	Broom	N
Succulents		
Cephalocereus royeni	Dildo Cactus	N

(a) From Murphy 1999: Table 11.

Most of the Royall's site was exposed during land clearing by a backhoe. Ironically, this facilitated a modern archaeological surface survey. Three transect lines were placed across the site (Figure 18) and surface collections at 20 m intervals were positioned along them. Shovel and trowel test pits were also incorporated at these specific collection points, dug to depths of 30-50 cm (Healy et al. 1999:3). In light of the historic agricultural practices of growing sugarcane and cotton, subsurface disturbance was evident but not uniform across the Royall's site. Within the first 10 cm in depth, ceramic remains were highly fragmented (Healy et al. 1999:2). However, some locations below the plow zone produced remains that were not badly fragmented and even an entire ceramic vessel was recovered (Healy et al. 1999:2).

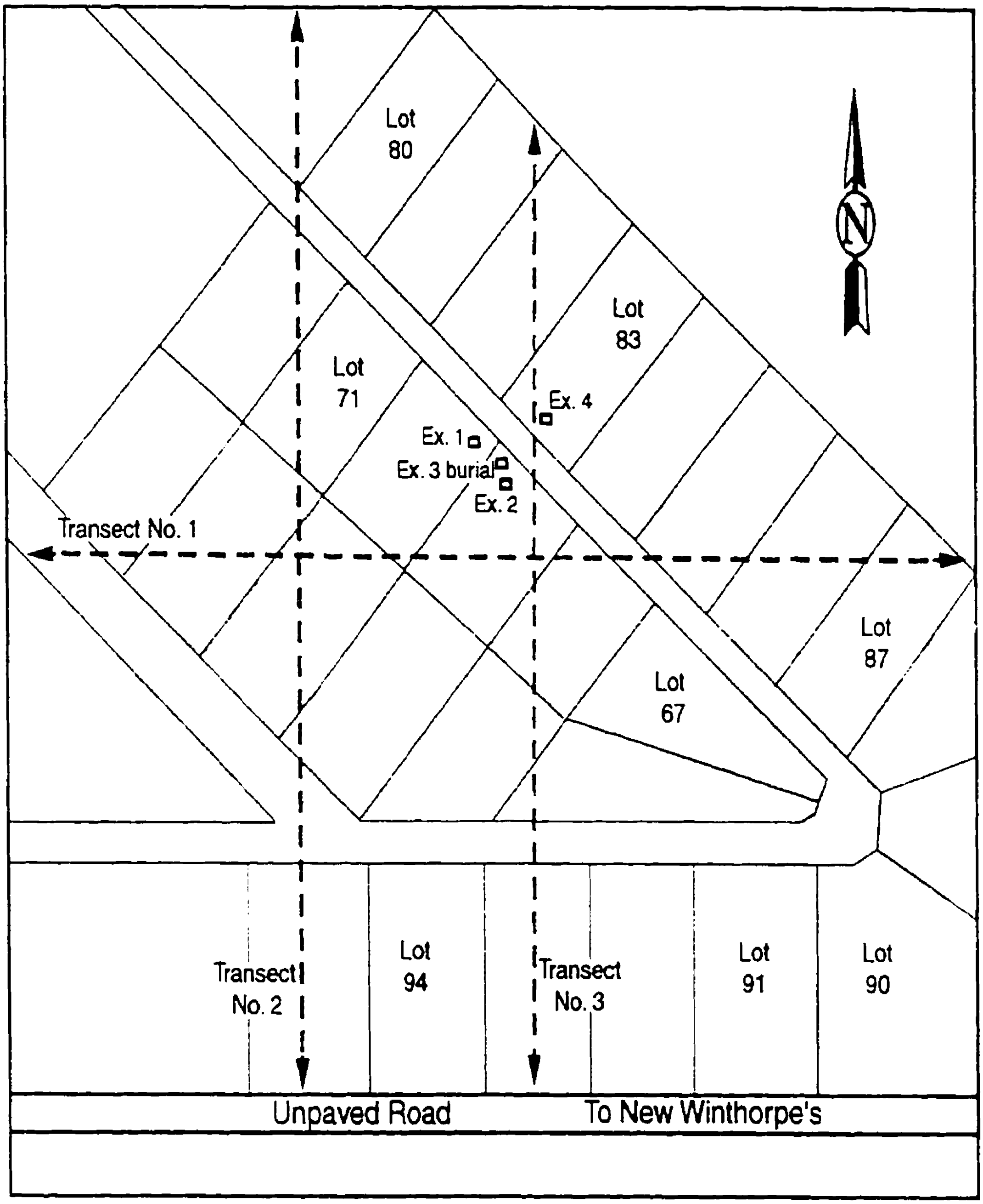


Figure 18. Area Map of Royall's (JO-11) Site with Transect Surveys (Excavations Units Plotted, Murphy 1999:Figure 31).

A burial exposed during the land clearing prompted more formal excavation units (Healy et al. 1999:3). A total of four units were excavated at 10-cm arbitrary levels in lots 71 and 83 (Figure 19). Excavated remains were dry screened through a 2 mm mesh as at Muddy Bay screen and some soil samples were taken for flotation. The excavations were complete recovery units, and all faunal, lithic, ceramics, and botanical (charcoal) remains were collected (Healy et al. 1999:3). Identification and enumeration of shellfish species were completed in the field. Of interest, excavation profiles from the units denoted an absence of shellfish lenses, which are typical of post-Saladoid sites on Antigua (Healy et al. 1999:3). Perhaps the Royall's site conforms to the Crab-shell dichotomy advocated by several archaeologists across the Caribbean (Petersen 1997; Wing 1989). Such issues will be discussed later within the thesis. Excavation Unit 2 focussed upon the recovery of the disturbed burial (Healy et al. 1999:3).

As with the Muddy Bay site, faunal remains from Unit 4 at Royall's were analyzed by the author again using the vertebrate and invertebrate comparative collections from Trent University and the Vertebrate-Paleontological Laboratory of the Royal Ontario Museum. Eight levels were designated to Excavation Unit 4 (Figure 19). However, artifactual remains from a depth of 0-30 cm were ignored due to the significant disturbance by land clearing and cultivation activities such as sugar plantation and cotton farming (Murphy, personal communication, 1999). The zooarchaeological assemblage at Royall's has an assortment of marine and terrestrial fauna from various habitats characteristic of the island environment of Antigua including Terrestrial, Inshore Estuarine and Tidal Flats, and Coral Reefs and Rocky Banks zones.

Two samples of charcoal were taken from Unit 4 for radiometric dating (Table 7).

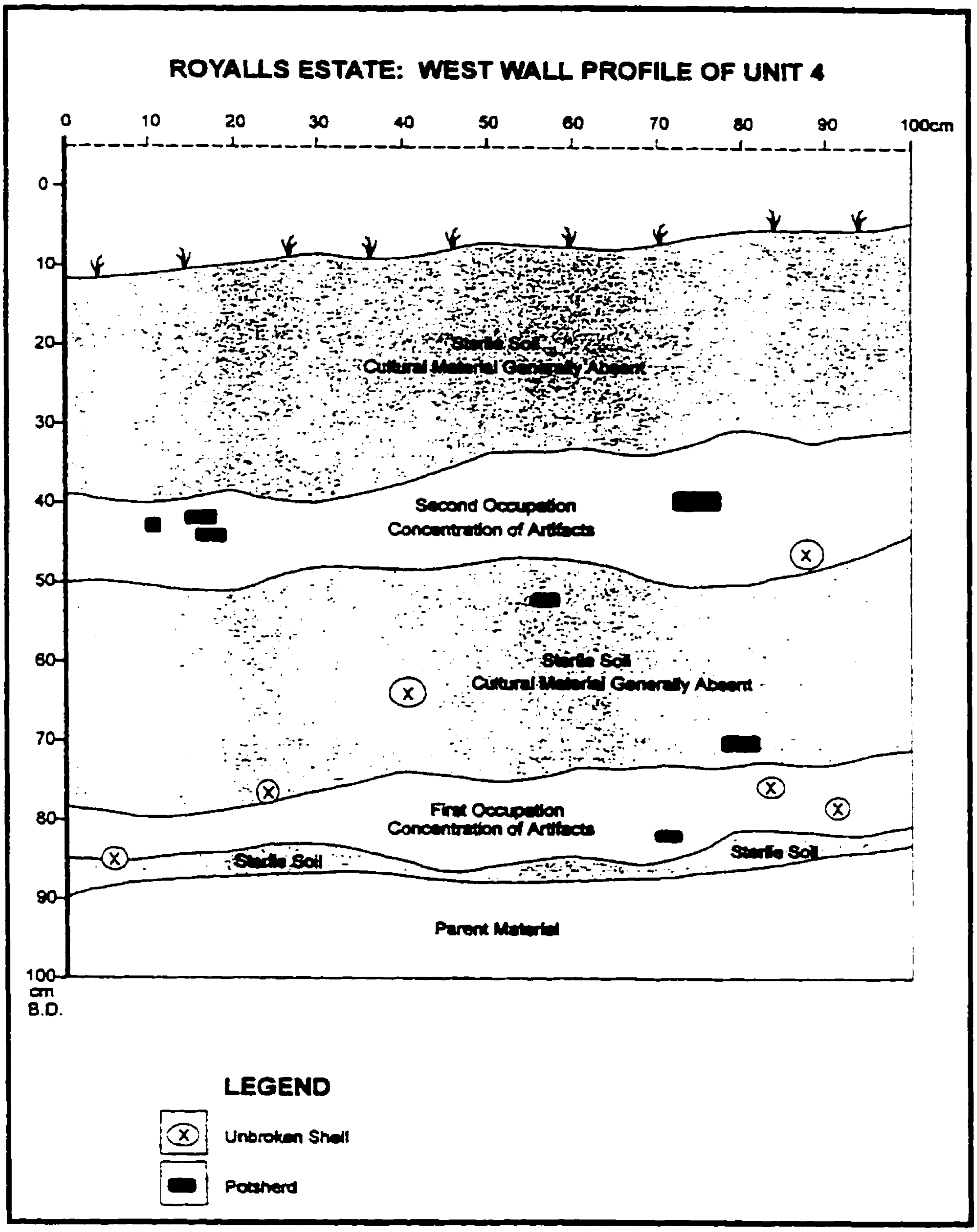


Figure 19. Profile of excavation Unit 4, Royall's (JO-11) West Wall (Murphy 1999:Figure33).

Table 7. Radiocarbon Dates from the Royall's Site (JO-11)[a].

Sample No.	**Excavation**	**C-14 Age**	**Calibrated Date (2 sigma)**	**Intercept Age**
Beta[b]-124126	Unit 4, Level 8	1600±50 BP	cal AD 380 to 590	cal AD 440
Beta-124127	Unit 4 Level 8	1610±80 BP	cal AD 250 to 630	cal AD 435

(a) From Healy et al. 1999: Table 4.

(b) Both samples were given an acid/alkali/acid pretreatment. Samples were analyzed by Beta Analytic Inc., by standard radiometric analysis with extended counting time.

The first sample, Beta-124126, is from level 8, 70-80 cm below surface level and produced a calibrated date of A.D. 380-590. The second sample, Beta-124127, is from level 9, 80-90 cm below surface level and yielded a calibrated date of A.D. 250-630. Both dates overlap and are consistent with their stratigraphic contexts (Healy et al. 1999).

Summary

The sites under examination represent two different settlement strategies practiced during the Ceramic Age on Antigua. Muddy Bay is a coastal settlement from the post-Saladoid period, while Royall's is an inland settlement from the Saladoid period. By comparing the zooarchaeological data from an inland and coastal settlement, contrasting subsistence economies may be presented for the Ceramic Age on Antigua.

CHAPTER IV

HISTORY OF CARIBBEAN ZOOARCHAEOLOGY

Introduction

This history of zooarchaeological research in the West Indies follows Rouse's (in press) classification of the research periods within Caribbean archaeology, along with contributions by other archaeologists (Brewer 1992; DeFrance 1988; Keegan 1989:119-128; Petersen 1997:118-130; Siegel 1991:79-91; Reitz and Wing 1999:12-30). Discussion will focus on the forms of zooarchaeological studies employed in archaeological research within the Caribbean and how this research pertains to the zooarchaeological investigations conducted on Antigua. These include subsistence studies, biogeography, subsistence technology, and social complexity. This chapter concludes with a discussion of possible future directions in zooarchaeological research in the Caribbean.

To understand Caribbean zooarchaeological research more extensively, I will discuss its position within the history of Caribbean archaeology. Pinsky (1989) and Wylie (1989) contend that a form of inquiry is constituted by its political, social, and ideological contexts, which in turn determine the theories researchers receive and practice. When discussing the position of zooarchaeology within archaeology such issues should be considered. Ultimately, Caribbean zooarchaeologists will be working with different theoretical paradigms that are shaped by these very factors (Brewer 1992:195).

Rouse's *History of Archaeology in the Caribbean Area* (in press), presents a scheme that illustrates the influences affecting zooarchaeology in the Caribbean. According to Rouse, the history of Caribbean archaeological research can be divided into four periods of research: Artifactual, Chronological, Cultural-Historical, and Sociocultural. Each period constitutes a definitive form of research composed of the work of many anthropologists, ethnographers, archaeologists (avocational and professional), conservators, and historians. Rouse (in press:3) claims that these periods are a series of transitions which can be understood as shifts in the interpretations of archaeological data. The shift in interpretations arose as archaeological techniques improved, and increasingly complex questions could be asked of the existing and growing archaeological record.

Although Rouse's classification of archaeological research is insightful, it is not definitive. Many of his earlier phases of research are practiced today and are present within many theoretical paradigms in archaeology. It must also be noted that this history of Caribbean zooarchaeology concentrates extensively on the Ceramic Age, and very few sites of the Preceramic Age are discussed (Davis 1988b:177). Rouse claims that the emphasis on zooarchaeological research of the Ceramic Age is the result of the focus upon the Crab-Shell Dichotomy debate. Furthermore, the use of ceramics to identify the migration and diffusion of indigenous peoples from South America and the cultural change that ceramic styles may exhibited, interested many Caribbeanists and increased the intensity of research during this period (Stokes 1991:88).

Artifactual Research (1700-1900)

According to Rouse (in press: 4), archaeological research began in the Caribbean as early as the 18th century. Some examples include the detailed analysis of four zemi (representation of deities made from remains of ancestors or natural objects) from the Dominican Republic by Father Juan de Talamanco Taíno (Osgood 1946:21), and the study of a Taíno dujo (ceremonial stool) from Cuba in 1775 by Pedro del Padro (Ortiz 1935:71-72). Further interest and research continued in the 19th century, with the establishment of archaeological exhibits and museums in Cuba and Guyana. In Cuba, Miguel Rodriguez Ferrer's archaeological research in the late 19th century culminated in the publication of *Naturaleza y Civilizacion de la Gradiosa Isala de Cuba* (Alegría 1997:17). Zooarchaeological research in the Caribbean had not yet begun and during the same period in Europe, archaeologists were conducting zooarchaeological research on shell middens and pollen analysis in Switzerland (Crabtree 1990:157; Reitz and Wing 1999:17; Trigger 1989:80-86). The only information regarding subsistence strategies and description of the fauna and flora of the Caribbean appeared in ethnohistorical documents and their translated versions (Cunningham 1997; see Las Casas 1951, see Lovén 1935; see Oviedo y Valdes 1959; Rouse 1948), and through the research of various zoologists and naturalists. Even further, most of these accounts were from the larger islands of initial contact (Hispaniola and Puerto Rico), which in certain cases had poor reports or inaccurate descriptions of the various indigenous subsistence economies (Petersen 1997:127).

During the Artifactual Research stage (1700-1900), archaeologists were concerned with the identification and description of material culture. The interest gradually shifted from examining the function and description of individual artifacts, to the interpretation of archaeological assemblages (Rouse, in press:8). Although zooarchaeology was not explicitly practiced at the beginning of the twentieth century, the floral and faunal remains were identified. "With the shift of interest from individual artifacts to assemblages came a realization that the latter contain not only artifacts but also human skeletal material, food remains, charcoal, and other traces of human activity" (Rouse, in press:8). Caribbean archaeologists began to recognize the validity of studying faunal remains. It was also during this period that Caribbean archaeologists concerned themselves with the collection of artifacts. These individuals were principally avocational archaeologists interested solely in maintaining their private collections. They usually refused to catalog and record all their finds, making it difficult for professional archaeologists to use their artifacts for research (Rouse in press:8). Furthermore, there was even less attention paid to the curation of zooarchaeological data, which was considered less appealing than the study of zemis, dujos, ceramics, stone and shell tools.

During this stage zooarchaeological research in the Caribbean was conducted by those primarily interested in zoology and paleontology (Brewer 1992:196; Reitz and Wing 1999:15-16; Rouse in press; Siegel 1991). According to Rouse, most anthropology departments during the "early years" were associated with museums of natural history (Siegel 1996:671). The emphasis on listing faunal remains in a systematic manner (zoological nomenclature) emphasized this perspective (Brewer 1992, Crabtree 1990; Reitz and Wing 1999:16). However, Brewer (1992:196) would argue that faunal analysis was important for archaeological research, because "...the recognition of associations between human remains, cultural materials, and the bones of extinct animals was the major contribution faunal analysis provided nineteenth century archaeology and is in large part responsible for establishing the antiquity of humans."

An example of such research during this period was the discovery of the extinct rodent *Amblyrhiza inundata* in cave deposits on Anguilla (Watters 1989). The retrieval of cave earth from the Caribbean for its use as a fertilizing agent was common during the nineteenth century in North America (Watters 1989). During one expedition to Anguilla, the remains of the extinct rodent were found in a matrix of cave earth, limestone fragments, and breccia, and more material was recovered from the same cave at a later date (Cope 1883). On both occasions, the precise provenience of these remains was never recorded (Watters 1989:160). An artifact of human manufacture, a shell celt, was discovered and shipped to North America. Unfortunately, it was unclear whether it was associated with the extinct remains or not. First interpretations were that the shell celt was associated with the extinct rodent (Cope 1869, 1883). Nevertheless, no concrete evidence for a linked contextual relationship between the animal remains and the celt was confirmed. Though the contextual relationship was problematic, individuals at the time did realize that artifacts (products of human behaviour) could be associated and identified with zooarchaeological data and that such a connection and contexts could prove valuable in reconstructions.

Chronological Research (1900-1960)

Aside from using faunal remains as evidence for subsistence studies, researchers have applied this form of data to define prehistoric cultures in the Caribbean. The first archaeologist to do so was Froelich Rainey. As discussed in Chapter I Rainey (1940) devised a chronological scheme based on the development of a ceramic style coinciding with changes in the concentrations of crab and shell remains in Caribbean archaeological deposits. Of course, this nominal classification was employed during a period in archaeology before absolute radiometric dating was available. However, as a relative dating method and classificatory scheme, Rainey's Crab-Shell culture dichotomy was well ahead of most contemporaries in Caribbean archaeology and his basic scheme is still accepted by some archaeologists today (Petersen 1997:123; Wing 1989).

Later archaeological research dispelled the notion that the Crab-Shell culture dichotomy represented either a culture shift, or different waves of migration of cultural groups. Rouse (1952) argued that the sole use of zooarchaeological remains was not suitable for chronological research because the presence of these remains depended on their availability at sites. If none were present at a site how could they be classified? Moreover, two different cultures at different times may have similar subsistence patterns. Instead, Rouse (1986, 1992, in press:20-21) urged the use of type-sites to trace Caribbean ancestry, supplemented by other lines of evidence such as the origin of indigenous Caribbean languages and human remains. The variability between the shifts in diet from island to island was another critical factor that should have been considered at the time (Goodwin 1980:45).

Subsequently, Rouse (1986, 1992, in press) and many other Caribbeanists' research have filled in the chronological gaps by using stylistic changes in the ceramics to define these sequences (Goodwin 1980; Keegan 1992:225; see Rouse 1992). As indicated earlier, the period known as the Crab culture has been identified as the Saladoid series, and the shell period is defined as the Terminal Saladoid and post-Saladoid series (Haviser 1997; Rouse 1992). Each of these series will differ somewhat from island to island, but the basic taxonomic classification and sequence is accepted by most archaeologists. Rainey's neo-evolutionary approach established the first use of zooarchaeological remains to illustrate a gradual transition in diet and the classification of cultures (Goodwin 1980; Jones 1985). However, it must be noted that Rainey (1940:14) excluded other forms of fauna in his classification. In my opinion, the inclusion of this other faunal material could have had an interesting effect upon his classificatory scheme, even drastically altering it.

Cultural Historical Research (1950-1960)

During the post war Cultural Historical Research stage, 1950-1960, zooarchaeological research in the Caribbean was minimal at best (Wing 1990:87). Some may argue that the Cultural Historical Research stage occurred earlier and was superseded by neo-evolutionary and functionalist schools of archaeological thought (Goodwin 1980; Trigger 1989), but Rouse (in press) feels that this was not the case in the Caribbean. At the Hacienda Grande site, for example, Nicholson and Alegría collected representative samples of the ecofacts (faunal remains only, paleobotanical studies had not yet been conducted) for potential forthcoming research, "for the benefit of future students of technology and the diet" (Rouse and Alegría 1990:31). Selected samples were not initially analyzed, but the recognition of their importance for future research was apparent. Caribbeanists had come to realize the potential usefulness of understanding past lifeways by conducting faunal analysis. In North America, archaeologists were interested in the role plants and animals had in cultural adaptations (Reitz and Wing 1999:19-20; Steward 1955; Taylor 1948). However, emphasis on this period in the Antilles remained on the construction of regional chronological systems (Davis 1988b:177; Rouse 1992:31; Siegel 1991: 79, 1996:671-672), instead of critical zooarchaeological analysis.

Sociocultural Research (1960-present)

Concentrated efforts in Caribbean zooarchaeology did not begin until the 1960s (Siegel 1991: 79, 1996; Wing 1962; Wing et al. 1968). With the advent of processualism and the de-emphasis of cultural-historical and functionalist approaches, archaeologists became more interested in the interaction of human populations with their environment (Brewer 1992; Siegel 1991: 79; Trigger 1989). Rouse (in press:26) claims that this form of research emerged as a result of the shift in attention from the individuals who produced the local artifacts to the societies which used them. Even though these types of original studies had been conducted discursively during the earlier Artifactual and Cultural-Historical Research stages, the depth of past analysis had been superficial and concentrated on zoological and paleontological studies (Brewer 1992:196; Reitz and Wing 1999:15-16).

With improved recovery techniques and new methods of analysis, zooarchaeology became more specialized and emerged as an important new branch of archaeological research (see Wing 1962; Rouse in press:29). At this time, research on the classification and identification of faunal remains was still prevalent, but the archaeological significance of fauna was being transformed by new interpretations. By identifying various species of fauna, zooarchaeologists could now distinguish between the different environments exploited by indigenous peoples and the methods used to obtain these resources (Wing et al. 1968).

In the 1960s, Caribbean zooarchaeological studies were initiated by the Museum of Natural History at the University of Florida under the auspices of Dr. Elizabeth S. Wing. Interestingly, this research was associated with a natural history museum, as during the earlier Artifactual Research stage, and focussed on subsistence adaptations during the Early Ceramic Age (Rouse, in press; Wing et al. 1968). Working on the Crab-Shell dichotomy debate, emphasis was placed on determining whether subsistence adaptations shifted from the exploitation of terrestrial resources to marine resources (Rouse, in press:29-32; Keegan 1989:119-128; Petersen 1997:118-130). Zooarchaeological studies coincided with research questions about population movements and settlement patterns. This form of investigation was appropriate at the time, as most North American archaeologists were interested in subsistence-settlement archaeology, introduced in the 1950s, which became a major theoretical approach in the 1960s (Siegel 1991: 79; Trigger 1989; Willey and Sabloff 1993).

Wing (1989; 1990; 1994; Wing et al. 1968) was responsible for advocating rigorous recovery methods by introducing the use of smaller screen mesh sizes (1-2 mm) on archaeological excavations. Most archaeologists at the time used 6 to 12 mm mesh screen allowing the remains of smaller fauna to slip through, creating a bias in the representativeness of a species from a sample (Wing 1990). The recovery of smaller fauna contributed to a more complete understanding of the ecological zones exploited by prehistoric indigenous people. In addition, differentiating between the size of species could provide information about overexploitation. If heavy exploitation or predation occurs over a prolonged time, a species will respond by producing more offspring. If a large number of juvenile skeletal remains are recovered from a deposit, archaeologists would be in a better position to speculate about the overexploitation of a species (Wing and Wing, in press:6-9).

In the 1970's, laboratories or research centres designated specifically for zooarchaeological and paleobotanical research emerged. For example, the Museo Del Hombre Dominicano (Dominican Republic) constructed laboratories specifically for the study of faunal and floral remains. Research interests dealt with paleoecological changes associated with human behavior such as the overexploitation of animals like the ground sloth (Veloz Maggiolo and Ortega 1976; Alegría 1997:18). Other archaeologists working in the circum-Caribbean region examined the implementation of agriculture in prehistoric subsistence economies in addition to the subsistence activities of hunting and fishing (Roosevelt 1980; Rouse, in press:30-31). Eventually, most archaeologists realized the importance of zooarchaeological studies, especially in conjunction with archaeobotanical and human bone isotopic analyses. The combination of these methods has the potential to contribute substantially to the comprehension of past indigenous lifeways in the Greater and Lesser Antilles (DeFrance et al. 1996; Keegan 1989; Keegan and DeNiro 1988; Petersen 1997; Stokes 1994, 1998; Stokes and Keegan 1994).

Forms of Zooarchaeological Research in the Caribbean

Numerous forms of zooarchaeological research have been conducted in the Caribbean that have shed light upon past human behavior. For the most part, these studies determined prehistoric subsistence patterns. However, with refined sampling and recovery methods and the incorporation of many disciplines outside of archaeology, Caribbeanists have recently begun to answer more than the traditional subsistence research questions. It must be kept in mind that most of these new approaches have resulted from one another, because these forms of research tend to overlap. It must also be taken into consideration that a comprehensive history of zooarchaeological research in the Caribbean is difficult to achieve, because of the existence of obscure or unpublished field reports or laboratory studies conducted by various Caribbeanists. Material used for this study was derived from papers presented at conferences, refereed articles and texts. As a result, the following will be a general synopsis of the zooarchaeological research conducted in the Caribbean, with a special emphasis on the research results derived from Antigua.

Subsistence Models: Lithic, Archaic, Ceramic, and Historic Ages

Throughout the history of Caribbean archaeology, various chronologies have been proposed. Archaeologists have equated these chronological periods to the subsistence strategies of the indigenous people of the Caribbean in addition to various assemblages of lithic and ceramic artifacts (Carbone 1980; Cruxent and Rouse 1969; DeFrance 1988; Goodwin 1980; Jones 1985; Keegan 1989, 1994; Kozlowski 1980; Lundberg 1989; Rainey 1940; Veloz Maggiolo and Vega 1982; Watters and Rouse 1989, 1992; Wing 1989).

Evidence for subsistence strategies during the Lithic and Archaic Ages in the Caribbean is limited. Petersen (1997:121) argues that most of Preceramic period research has centred on the development of shell and lithic technologies. Although zooarchaeological evidence does indicate that Preceramic people adapted to the use of land and marine animals, very little Caribbean archaeological research has focused upon Preceramic period subsistence. Instead, emphasis has been placed on the subsistence models for the Ceramic Age (Davis 1988b:177; Rouse in press). As indicated previously, archaeologists were concerned with the Crab-Shell dichotomy, and with the large number of sites to study in this period, researchers have concentrated on defining Ceramic Age subsistence economies. Importantly, Wing (1999:51) indicates that more intensive zooarchaeological studies of Ceramic Age sites have been conducted on Antigua than many other Lesser Antillean islands. The lack of Lithic and Archaic Age sites could be a result of poor sampling methods and/or the rise of sea levels, submerging the earliest sites underwater. The need for more research about these ages is evident.

Lithic Age

The Lithic Age (4000-2000 B.C.) is denoted by the presence of a stone flaking industry, a foraging strategy (roots and berries), and the exploitation of both marine (fish, shellfish, and sea mammals) and terrestrial (small mammals, reptiles, and nesting birds) species (Keegan 1994:264; Kozlowski 1974, 1980; Petersen 1997; Veloz Maggiolo and Vega 1982). This period is represented by a small number of archaeological sites in the Greater Antilles, specifically in Cuba and Hispaniola; none have been found in the Lesser Antilles (Cruxent and Rouse 1969; Dacal Moure and De La Calle 1996; Keegan 1994; Kozlowski 1980; Rouse 1992). On the basis of archaeological research, the location of Lithic Age sites includes rockshelters, river basins, open air areas, and coastal settlements (see Kozlowski 1980; Keegan 1994: 264; Rouse 1992:49-62; Veloz Maggiolo and Vega 1982). Very little information regarding the sociocultural arrangement and make-up of settlements and dwellings has been completed for this period.

Lithic Age stone tool technology can be equated with similar percussion techniques used to create tools to hunt now extinct megafauna from the American mainland (Keegan 1994:264). The discovery of such large game in the Caribbean has yet to be made and the actual similarity between the morphologies of the tool forms from North, Middle, and South America to those in the Greater Antilles is dubious. In addition, the dates for this period in the Caribbean fall well after comparable assemblages from mainland areas. The remains of whales have been recovered, but we do not know whether these mammals were actually hunted by humans and it is possible that beached whales could have been used opportunistically at this early time (Petersen 1997:121; see Veloz

Maggiolo and Ortega 1976). Nevertheless, if such large sea mammals are interpreted as megafauna, the inhabitants of these sites could be described as Lithic Age settlers. Lithic Age sites are further defined by the lack of ground stone and shell tools prevalent during the succeeding Archaic Age (see below), and a lesser emphasis on gathering plant goods for consumption (Keegan 1994:264; Petersen 1997:121).

Archaic Age

The Archaic Age (2000-500 B.C.) is defined by a flaked and ground stone tool technology, worked shell artifacts, evidence of plant husbandry and a terrestrial and marine subsistence economy, with a marked emphasis on shellfish-gathering (Armstrong 1980; Crock et al. 1994; see Davis 1982, 1988b, 2000; Lundberg 1989; Keegan 1994:265-270; Newsom 1993; Rouse 1992:62-69). Petersen (1997:121) contends that most Archaic sites on the larger islands are characterized by a mixed economy of marine and terrestrial resources, while in the Lesser Antilles and on smaller islands the sole emphasis seems to have been on shellfish. For example, the zooarchaeological assemblage from the Jolly Beach site on Antigua contained a small number of vertebrate species and no land crabs, suggesting an intense exploitation of shellfish throughout the occupation (Davis 1982:114, 2000:83-91). However, Petersen (1997: 121) argues that "...these findings may reflect the presence of temporary marine-oriented sites or a preservation bias against other fauna." Stokes (1991:74) even suggests that Preceramic sites could have been occupied seasonally, "one group may have moved to the low elevation sites in the off-hurricane season and then moved to sites of higher elevation which were protected from the trade winds and hurricanes from July to November, the hurricane season."

On the other hand, inland Archaic sites on Hispaniola and Cuba do not exhibit coastal resource exploitation, but there are remains of rich inland resources (freshwater fish, reptiles, and rodents) indicating a shift during the Archaic Age (Watters and Rouse 1989:136). In essence, the location of Archaic Age sites seems to reflect the exploitation of available resources - reflecting the environmental diversity of such sites. Additionally, the recovery methods and sampling strategies used might bias the samples. The long time use of 1/4 in. or 6 mm mesh as opposed to 1/16 in. or 2 mm mesh for screening, and the almost exclusive excavation of shell middens, precludes the analysis of assemblages from activity areas, such as cooking hearths or dwellings. Usage of certain species absent in Archaic Age middens may indicate preferential selection of animals for ceremonial use, food, hunting, or pets (Figueredo 1978; Lovén 1935:433-434).

The presence of ground stone tools at Archaic Age sites also suggests the processing of plants. Current studies suggests that Archaic people did not practice agriculture by definition, but they may have practiced plant husbandry or aboriculture, and introduced new plant species from Central and South America (see Newsom 1993; Petersen 1997:123). Identified remains of Preceramic period plants include the fruits of several palms, Wild Fig, Wild Avocado, Yellow Sapote, medicinal plants, and many more (DeFrance et al. 1996:295; see Newsom 1993; Petersen 1997:122; Rouse and Alegría 1990:22). None of these plants have yet been classified as true domesticates, which suggests farming was not practiced during this early period (Petersen 1997:123). However, sedentary practices may have began to emerge during this period, because of the investment in time and artifacts required for ground stone tool technology and aboriculture. Agriculture and reliance on domesticated crops was well advanced by this time (2000 – 500 B.C.) on mainland sites in Mesoamerica and South America.

Ceramic Age

Using Rainey's (1940) pan-Caribbean model of cultural and subsistence change based on the Crab-Shell dichotomy, many archaeologists have constructed alternate or expanded explanations for the general transition from terrestrial to marine resources (Carbone 1980; DeFrance 1988, 1989; Goodwin 1980; Jones 1980, 1985; Keegan 1985, 1989; Levin 1983; Petersen 1997; Watters and Rouse 1989; Wing 1989, 1999). Though some archaeologists have supported Rainey's Crab-Shell dichotomy (Petersen 1997:123), most archaeological and zooarchaeological research indicates that a chain of unbroken cultural development occurred between Rainey's 'Crab' and 'Shell' cultures (Keegan 1989:119; Petersen 1997: 123, see Rouse 1992). I will discuss alternative explanations for shifts in diet throughout the Ceramic Age as presented by other archaeological studies in the Caribbean. These include climate change, population pressure, optimal foraging, and cultural change.

In Antigua, the first published zooarchaeological study for the Ceramic Age was conducted by Elizabeth Wing, Charles Hoffman and Clayton Ray (1968) from the Mill Reef site (500 to 900 A.D.). The focus of their research was to determine the subsistence strategies for this Terminal Saladoid settlement. The authors concluded that reliance upon marine fauna based on MNI counts (63% to 77%) far exceeded that of terrestrial animals.

The authors also indicated that the occupants caught fish far more with the use of traps because of the large number of reef fish present within the assemblage (Wing et al.1968:133-134). The main emphasis of their study was placed on the identification of fauna with little emphasis placed on explaining shifts in diet that occurred as a result of the Crab-Shell dichotomy.

Carbone (1980) postulated that the shift in subsistence strategies was caused by climatic factors. According to Carbone (1980:100-103), an abrupt change in the climate had devastating effects upon the terrestrial crab populations. These climatic changes entailed intervals of extreme aridity. Dry weather would have decreased the humidity, which would have increased the crab mortality rate (Carbone 1980:103). Consequently, a shift in the procurement of other species by humans was inevitable; this climate shift forced people to subsist more upon other resources such as shellfish.

Although this scenario is plausible as a local occurrence or phenomenon, broader archaeological and paleoenvironmental evidence does not suggest that this was a pan-Caribbean phenomenon. The archaeological evidence indicates that the transition from land crab to shell exploitation seems to have occurred at different times and in different areas in the Caribbean (Davis 1988b:182; DeFrance 1988:16, 1989:62; Jones 1985:523; Goodwin 1980). On Antigua, Davis' (1988b) archaeological research at Nonsuch Bay (1000-1300 A.D.) illustrated that a land crab-shell shift was a local phenomenon rather than an island wide occurrence. Jones (1985:523) and DeFrance (1989:16) argue that large-scale information on the climatic history during this period is insufficient, because Carbone's field observations were only applied to the islands of Puerto Rico and Hispaniola. Furthermore, the rise in sea levels and tectonic shifts do not correlate with the increased aridity and decreased humidity (DeFrance 1988:16). The fact that the transition occurred at different times across the Caribbean further substantiates that a change in climate could not have been the cause for this shift. Keegan (1989:119) argues that "if a region-wide change in climate was the primary stimulus, then the shift should occur simultaneously on every island," but archaeological and paleoenvironmental evidence reveals that this was never the case. A more productive research question would be to ask "why did the shift occur at different times and areas across the Caribbean" (DeFrance 1988; Petersen 1997; Rouse 1986)?

Other ecological or environmental models have been offered as explanations for the crab-shell shift. Goodwin (1979, 1980:47, 1987) has argued that population pressure induced the intensification of different subsistence economies, giving rise to a shift in the exploitation of different resources. Population growth was responsible for the shift in diet, as one environmental niche was overexploited a new resource had to be added. Using archaeological evidence from St. Kitts, Goodwin (1979, 1980) argued that the occupants of early inland sites subsisted heavily upon terrestrial species such as land crabs. Over time, the indigenous population grew, and settlements started to appear on the coast. The migration was triggered by the depletion of the terrestrial species. To compensate for this trend, the migrants exploited more coastal resources (see Goodwin 1980). In addition, zooarchaeological evidence from the Cayon site and the Sugar Factory Pier site analyzed by Wing and Scudder (1980), illustrated that a decline in terrestrial crab remains was indicative of this induced shift in resource exploitation by population stress.

While Goodwin's hypothesis is plausible for St. Kitts, population pressure models have always been contentious as causal explanations for human behaviour. Many non-ecological explanations for shifts in subsistence procurement patterns may be equally plausible (DeFrance 1989; Hayden 1992; Jones 1985; Keegan 1989; Rouse in press). Following Keegan's (1989:119) line of reasoning, why would a population allow itself to outgrow its subsistence base? This may seem like a convincing counter-argument but it is equally difficult to identify what measures ancient populations took to adapt or change to such demographic conditions. Would a population be capable of making these responses through infanticide, abortion, euthanasia, or improved technologies? Secondly, if the prehistoric inhabitants were primarily horticulturalists, why would such a shift occur? Would there not be enough of a subsistence base to alleviate such problems? In cases where droughts may have occurred this may not be plausible, but if the inhabitants were aware of such natural catastrophes would they not store food items in preparation for such emergencies? A decline in crab remains may be the result of cultural preferences, which could dictate the selection of an alternate food source (DeFrance 1988; Jones 1985). As Rouse (in press:30) states "Ostionoid peoples may simply have lost the Saladoid peoples' taste for crabs."

Jones' (1980, 1985) research at the Indian Creek site on Antigua offers multiple explanations for the crab-shell transition. In fact, Jones (1985:533) claimed that not one single model can be considered the ultimate explanation for this subsistence shift. Instead, a variety of cultural and non-cultural factors should be taken into consideration. Using concepts of catastrophe theory or punctuated equilibriumism, Jones (1985:533) argued that the dietary base on Antigua was in a constant state of flux. 'Exogenous' or 'endogenous' factors may have caused a change in the subsistence base, either through the immigration of new cultural preferences or climatic changes (Jones 1985:533). He also indicated that, over time, land clearing for the harvesting of Manioc or house construction may have destroyed habitats for terrestrial fauna (Land Crabs, Rice Rats, and ground nesting birds) and ultimately influenced people to move toward the coast (Jones 1985:523, 533). However, the scarcity of archaeobotanical remains at the Indian Creek site makes it difficult to subscribe to the idea that all habitable land was actually cleared for horticulture. Again, this may result from a sample bias or lack of excavation conducted during the excavations of Indian Creek, or from poor preservation.

Employing a different method for determining the Crab-Shell transition, Keegan (1985; 1989) explained the shift by using concepts from microeconomics and optimal foraging theory. He suggested that the increase in human population caused a decrease in the yield of terrestrial resources. According to Keegan's (1985; 1989) ranking of food types, lower yielding food groups, such as marine fish and shellfish, were utilized. The ranking of food types was determined by their marginal rates of currency (calories per handling hour) and this was achieved by experimental studies that ordered food types on the basis of the "amount of time required to capture, process and consume one item of each food type" (Keegan 1989:127). The ranking was also based on zooarchaeological data, ethnohistoric accounts, and ethnohistoric analogy (DeFrance 1988:24; Keegan 1985:167-168). Terrestrial foods such as mammals, crabs, cultigens and reptiles had higher return rates compared to marine organisms. Based on a number of sites in the Bahamas and in the Caribbean, Keegan (1985:172) determined that the growing population caused the overexploitation of these high ranking resources which forced the population, in turn, to exploit lower return rate organisms. Essentially, a growing population would increase its demand, and a larger supply would then be required.

To support his argument further, Keegan conducted a series of isotopic analyses on 17 Lucayan skeletons from cave sites in the Bahamas. Four consumption profiles were determined representing a shift from terrestrial to marine resources: (1) 75% terrestrial to 25% marine, (2) similar reliance between marine and terrestrial resources, but less pronounced terrestrial reliance, (3) equal contribution of both resources, (4) heavy reliance (66% to 74%) on marine resources (Keegan 1989:122). Using additional zooarchaeological evidence, Keegan (1985) argued that as terrestrial resources were depleted human populations increased their diet breadth to include lower ranked species. An isotopic study of burial remains from the Haciende Grande site in Puerto Rico indicate that the Saladoid diet there consisted primarily of terrestrial species (Keegan and DeNiro 1988:334-335). Over 93% reliance was placed on terrestrial animals. By using zooarchaeological data and isotopic analysis, Keegan (1989) has maintained that the Saladoid diet consisted primarily of a terrestrial food source, which shifted, over time, to a marine-oriented diet.

Based on human skeletal isotopic analysis and zooarchaeological data, Keegan's explanation for a crab-shell shift may appear highly plausible, however, other Caribbeanists disagree (DeFrance 1988, 1989; Stokes 1994). Many cultural factors should be weighed as alternate explanations for human behaviour, or used in conjunction with non-cultural factors. This model for ranking the return rates of animals was confined to Lucayan dietary habits and might not be applicable to the entire Caribbean. As best we know, the environmental diversity on each island did not differ substantially in antiquity, but geographic distribution and density of species probably did, and this makes the application of Keegan's model more difficult (DeFrance 1988:25). For example, the distribution and density of a rodent named Hutia (*Isolobodon portoricensis*) in the Greater Antilles was more extensive than the Hutia of the Bahamas (DeFrance 1988; Wing and Stover 1987; Wing 1993:243). Geography could determine the availability of each resource, which could alter the ranking of certain species. DeFrance (1988:26) argues that "biological data on food species should be specific to the geographical area under consideration." In addition, if lower yielding food sources, such as shellfish, were easier to acquire they should be considered higher ranked resources because large quantities of shellfish would have amounted to the same caloric value as a higher yielding food type.

The combination of zooarchaeological data and isotopic analysis of human remains from one site, on one island, is a useful method in determining subsistence patterns, but the results should not be applied uniformly as a pan-Caribbean model. The combined sample of human remains from the Lucayan site (17 individuals) and the Haciende Grande site (one individual) are insufficient to extrapolate subsistence strategies for the entire Caribbean. In addition, recent developments in bone isotopic analysis have indicated that the use of bone collagen is problematic for differentiating the isotopic signatures of various food groups (Stokes 1994). According to Ambrose and Norr (1993 cited in Stokes 1994:194), the use of carbonate from bone apatite will represent the entire isotopic signature of an individual's diet, whereas bone collagen represents the protein portion of a diet. Despite these drawbacks, the reinterpretations of the Lucayan skeletons have indicated that a large terrestrial component was present from

Saladoid and post-Saladoid occupations. Other isotopic studies from sites on Saba (Klinken 1991 cited in Stokes 1993) and Maisabel, Puerto Rico, corroborate these findings. DeFrance (1989:62) argued that the Maisabel zooarchaeological data indicated that an intensified marine procurement strategy was present, yet the isotopic data suggests that a terrestrial component of the diet was significant. Consequently, in certain areas of the Caribbean, such as the Bahamas and Puerto Rico, a true subsistence shift from crab to shell did not occur.

DeFrance (1988, 1989) analyzed the vertebrate and invertebrate remains from the Maisabel site to determine whether the crab-shell shift was present during the Ceramic Age of Puerto Rico. The zooarchaeological evidence suggests that a shift from terrestrial to marine resources did occur, and that terrestrial resources were not heavily exploited during the Ceramic Age (DeFrance 1988:103). Instead, the data suggested that a marine resource subsistence economy was extant throughout the entire Ceramic Age, "by the time Puerto Rico was colonized, the inhabitants were more skilled at the exploitation of resources within and the near shore waters...the diverse ecological zones near the site provided access to a greater range of aquatic habitats including riverine, mangrove sloughs, semi-protected marine bays, shallow water reef-type structures, and pelagic waters" (DeFrance 1988:109).

Recent isotopic analysis (Stokes 1994; Stokes and Keegan 1994; DeFrance et al. 1996) has determined that the Maisabel diet was primarily terrestrial contrary to DeFrance's (1988, 1989) zooarchaeological analysis (DeFrance et al. 1996:301; Stokes 1994:196). These results are further confirmed by the faunal data from an Early Ceramic Age occupation at Trants, Montserrat (Dukes and Reitz 1994; Reitz 1994). Though analysis has shown that the reliance of terrestrial species was a local adaptation, terrestrial resources (exotic and indigenous) were consistently used during the Saladoid period (Reitz 1994: 315; Wing 1989). Elsewhere, Stokes (1994) noted that other studies in the southern Caribbean and Saba have had mixed results. These data are used with caution, because the studies illustrate that on Saba subsistence was based equally on marine and terrestrial resources. During Saladoid and post-Saladoid occupations on Aruba, Bonaire, and Curaçao, a terrestrial subsistence orientation was prevalent (Klinken 1991 cited in Stokes 1994:196). At the moment, zooarchaeological, archaeobotanical, and bone isotopic analysis indicate that Ceramic Age subsistence entailed root crop production and home gardening, with the intensified use of marine resources and a decreased emphasis on terrestrial species. Still, the isotopic data illustrate that terrestrial species remained an important part of the Ceramic Age diet, although faunal data may indicate otherwise (DeFrance et al. 1996:302).

Historic Age

Although one would assume that ethnohistoric records from the contact period provide ample information regarding Caribbean subsistence economies, overall evidence is lacking in detail (Petersen 1997:127-129). Most ethnohistoric information is confined mainly to the contact period of Hispaniola and Puerto Rico, and little of it is available after the seventeenth century for the Island Carib groups (see Las Casas 1951; see Lovén 1935; see Oviedo y Valdes 1959; Wilson 1990:28-34; Petersen 1997:127). Accurate descriptions of traditional subsistence economies for the entire Caribbean area have been difficult to identify. The available documentation and the ongoing archaeological work for the contact period have provided some insight into contact period subsistence patterns.

Based on ethnohistorical accounts and archaeological data, the subsistence economies of the Taíno and Island Carib groups were described as broad-based with minimal change during the pre-contact and initial post-contact periods (Petersen 1997:129). These subsistence economies were probably not much different from their Ceramic Age antecedents. Horticultural practices were important for both the Taíno and Island Carib groups; especially the cultivation of Cassava. In fact, the Taíno named one of two supreme deities, *Jocahu* or *Yucahu* (lord of Cassava and sea) and his mother *Atabey* (goddess of water and fertility) after the Cassava plant (Arrom 1975 and Bourne 1907 cited in Petersen 1997:128). Furthermore, the continued procurement of marine fauna (shellfish, fish, sea mammals, and sea turtles) and terrestrial fauna (lizards, rodents, birds, and dogs) were part of this all encompassing subsistence pattern. Archaeological investigations at the En Bas Saline site in Haiti were aimed at examining the impact of European settlement for native society. This site is believed to belong to the cacique Guacancacric who helped Columbus after the destruction of the Santa Maria (Wilson 1990). Deagan's examination of the pre-contact and post-contact faunal assemblages reveals a diverse range of animals procured during both periods (Deagan 1987:348). Evidently, the initial interaction between the Spaniards and natives at this site did not have a dramatic effect upon the indigenous subsistence economy. Deagan (1987) argues that this may be due to the small post-contact sample that was used in the study. Ironically, it has been argued that the indigenous populations of the Caribbean were affected dramatically within the first twenty years of European interaction (Cook 1998:15-59).

Historic Age subsistence economies in the Caribbean have provided detailed information on European subsistence strategies. Some archaeologists claim that settlers had adjusted and adapted to new subsistence economies either through "aboriginal" or ecological influences (Deagan 1996:369; Keegan 1996:270). This argument is rooted in the idea that "different kinds of domestic animals were dominant in the colonial diet depending on their suitability for a particular region, regardless of their traditional uses in a European homeland" (Deagan 1996:368). Certain species would flourish in certain areas, whereas others would not. For example, in Haiti, cattle grew rapidly and were heavier in this new island environment, because they were not subjected to competing herbivorous animals and bovine disease (Reitz 1986; Deagan 1996:369; Keegan 1996:270). This dispels the notion that European settlers and their methods of animal husbandry were unaffected by new environments (Deagan 1996:368). Keegan (1996:270) argues that the subsistence strategies of early European colonists "mirrored" those of the indigenous population except for the use of domesticated animals as a source of meat.

Contact period studies have also shed light on the extinction and overexploitation of some of these species during the contact period. For example, the Caribbean Rice Rat (Oryzomyine sp.) probably became extinct with the introduction of the invading rodent species *Rattus rattus* from Europe. This Old World species was probably competing for the same ecological niche that the Rice Rat occupied (Steadman et al. 1984a:4449, 1984b:22). Other animals such as dogs and cats could have also been responsible for the Rice Rat's demise.

The ethnohistoric record does provide sufficient information for indigenous subsistence economies, although some of it can be considered suspect due to the misinterpretations of indigenous lifeways by Europeans. Because of the overwhelming interest in migration patterns, and the difficulty in recognizing contact-period sites, the archaeology of the contact-period is still in its infancy (Deagan 1988:200). A combination of ethnohistorical literature and continued archaeological data could provide information for subsistence economies, biogeographic questions (such as extinction and overexploitation of particular species), and socio-political practices (i.e. cultural preferences of animals for trade, ritual, political organization, iconography, etc.). The necessity for continued excavation of early contact-period sites would provide explanations for the subsistence strategies of the Taíno and the Island-Carib groups.

Biogeographic Studies

Caribbean researchers have recognized the importance of zooarchaeological analysis for determining biogeographic issues of species extinction and introduction (Morgan and Woods 1986; Steadman et al. 1984a, 1984b; Watters 1989; Watters et al. 1984). Many studies have examined the diachronic nature of extinction and the introduction of species, which have enabled archaeologists to ascertain whether these factors were human-induced or natural (Watters 1989:137). In the Lesser Antilles, Watters (1989:158-159) noted that the distinction between two periods for understanding biogeographic issues are defined as the period prior to human colonization (prehistoric - Amerindian), and after colonization (historic - European, Asian, African). Ultimately, natural deposition of fauna is present within both periods, but only cultural deposition is evidenced within the latter. A distinction should be made between the fauna and flora of these periods to create an ordering of data (Watters 1989:159).

Paleontological evidence has indicated that the extinction of West Indian fauna occurred as early as the late Pleistocene (Cunningham 1997:31; Morgan and Woods 1986:167; Pregill et al. 1994). With the arrival of humans 4500 years ago, it has been estimated that the extinction rate of animals across the entire Caribbean has been one species for every 122 years (Cunningham 1997:31). Most recent documented extinctions have been derived mainly from archaeological contexts (Morgan and Woods 1986; Olson 1982; Steadman et al. 1984a). On Antigua, research at Burma quarry (Steadman et al. 1984a; Pregill et al. 1994) uncovered extinct and extirpated fauna that were possibly overexploited by early human inhabitants. The discovery of shell remains and lithic artifacts in conjunction with the extinct fauna substantiates this conclusion (Steadman et al. 1984a:4448). These discoveries implied that overhunting and habitat alteration had tremendous effects on insular fauna throughout the history of the West Indies (Morgan and Woods 1986:196; Olson 1982; Pregill et al. 1994; Steadman et al. 1984a; Wing et al. 1968).

New animals introduced by humans also caused numerous extinctions in the Caribbean. Old World animals such as dogs, cats, Mongoose, and the genus *Rattus* had devastating effects on New World species (Cunningham 1997:33). For example, on Hispaniola the introduction of attack dogs not only decimated the indigenous people, but dogs roamed freely preying upon smaller sized endemic fauna wiping them out (Varner and Varner 1983 cited in Cunningham 1997:33). Introduced livestock had immediate ecological affects. Pigs and cattle adapted easily to the new island environment, and thousands of them were present on Hispaniola, Jamaica, Cuba, and Puerto Rico by the sixteenth century (Cunningham 1997:34; Reitz 1986; Deagan 1996:369). The rearing of livestock induced the clearing of land for pasture, ruining indigenous garden plots and destroying natural habitats of many indigenous species.

Subsistence Technology

Based on the identification of faunal remains, inferences can be drawn to determine subsistence technology. Remains of various species can help identify ecological zones most likely exploited by hunters and fishers. Ethnohistoric data that describe historic procurement patterns, may be used to reconstruct similar hunting and fishing technologies for prehistoric times. Although known implements for procurement may be recovered, zooarchaeological data may aid in determining the use of ephemeral artifacts such as traps, nets, and weirs. In addition, remains of fauna procured for consumption could have also been used to manufacture non-food implements such as shell adzes, shell beads, coral and shell sculptures (Dacal Moure and De La Calle 1996; Dacal Moure 1997:159-188; Rostain 1997:251-256; Serrand 1997:189-217). For example, *Strombus gigas* was a huge staple for the indigenous Caribbean diet during antiquity, however, the shell proved useful secondarily for the manufacture of tools and ornaments such as shell adzes, chisels/points, hammers, perforators, points, bowls, pendants, and beads (Keegan 1982:76; Serrand 1997:189-217).

According to Wing and Reitz (1982:24), fishing technology in the Caribbean is known archaeologically from very few artifacts. Most inferences about fishing technology are derived from ethnohistorical accounts and more recently, from zooarchaeology. Various species of fish suggest the tools used for fishing. For example, hooks are effective in obtaining carnivorous fish, such as jacks (*Caranx* sp.) or snappers (*Epinephelus* sp.) inhabiting bank and inshore-estuarine zones (Wing and Reitz 1982:24). Although archaeological evidence for nets is infrequent, the presence of net sinkers and spindle whorls suggests their use and manufacture at some Caribbean sites (Murphy 1996:121). Of course, spindle whorls could also have been used for the manufacture of textiles. Nets were probably used around inshore-estuarine habitats, where waters were calm and shallow, or even along riverbanks (Lovén 1935; Wing and Reitz 1982). Fish caught by net include Porgies (*Calamus* sp.), Barracuda (*Sphyraena* sp.), and Snook (*Centropomus* sp.). Other forms of fishing technology such as dip nets, seines gill nets, or weirs, have been documented in ethnohistoric accounts (Lovén 1935; Wing and Reitz 1982:24-26), but no evidence has been found at archaeological sites.

Herbivorous reef species, such as Parrotfish (*Sparisoma* and *Scarus* species), Squirrelfish (*Holocentrus* sp.), Surgeonfish (*Acanthurus* sp.), and many more, do not take a hook, and it would be difficult to use nets around jagged reef areas where they dwell (Wing and Reitz 1982:25-26). As an alternate fishing method, traps have been suggested. The archaeological evidence for traps also does not exist, but modern day use for reef fishing reminds us that traps should be taken into consideration. Because traps can be size-selective, measuring fish size may determine maximum trap size aperture (Wing and Reitz 1982:26; see Wing and Scudder 1983; Wing and Wing, in press:7). If consistent sizes of fish are present within faunal assemblages, the use and size of traps is suggested. Employing ethnographic analogy, Wing and Reitz (1982:26) argued that the anonymous accounts for the use of cylindrical traps in the Antilles may indicate that trapping was employed in prehistoric times as well. Ethnohistoric accounts indicate that cylindrical traps were used by the natives living along the Orinoco, Guiana Coast, and Rio Negro in South America. These individuals were the descendants of prehistoric peoples in the Antilles (Wing and Reitz 1982:26).

Other possible technologies include implements for hunting offshore pelagic fish or large sea mammals. Based on little archaeological data and few ethnohistoric accounts, implements made of shell and stone, such as harpoons, were probably used to hunt the large fauna (Wing and Reitz 1982:25). Furthermore, the use of poison from the manchineel tree to stun fish was common during historic times for the Taíno and Island Carib groups, but archaeological evidence is again lacking (Little and Wadsworth 1964; Stokes 1991:29). Perhaps, archaeobotanical studies and/or residue analysis of hunting implements would identify poisonous plants to substantiate these accounts during historic times, as well as during the prehistoric period.

Wing (1993:243) claims that evidence for morphological variations in animals through taming and maintenance in captivity is difficult to identify osteologically. Instead, research should focus on the history of the distribution of these animals to determine whether domestication occurred. Nevertheless, evidence of domesticated species may imply the use of technology associated with such animals. Ethnohistoric accounts of corrals or pens used to house Agouti or Hutia, have been documented, implying their possible archaeological presence (Lovén 1935:421; Rouse 1948:524).

Although the materials used to construct them were made of wood and perishable (Wing and Reitz 1982:26), investigations at waterlogged sites may yet uncover these structures (see Pendergast 1997). Most analyses have concentrated on the excavation of shell midden deposits rather than areas of primary use, which could provide archaeological evidence of these structures (Versteeg and Ruiz 1995:11; Bartone and Versteeg 1997:23).

The practice of horticulture may have attracted animals to garden plots (Linares 1976; Wing and Reitz 1982:23). Traps or snares could have been placed within the proximity of the garden plots, or individuals could have waited for the animals to come within the vicinity granting them the opportunity to catch them by hand. If middens or areas associated with garden plots can be identified archaeologically, the likelihood of associated zooarchaeological remains occurring is plausible.

Though not commonly studied, coral artifacts appear in many archaeological contexts either indirectly or directly through human procurement, animal activities (attachment to shells), or natural events (surf and erosion) (Versteeg 1992:120). At the Tanki Flip site in Aruba, coral graters, manos and metates were discovered and have been identified as tools used for processing nuts and plants (Rostain 1997:253; Versteeg 1992:122). Furthermore, artifacts employed for the manufacture of ceramics, wood and stone including polishing tools, rasps, borers, and grinders were also present in the Caribbean (Rostain 1997:251-256; Versteeg 1992:119-138). Coral was also used for the construction of art pieces; numerous Taíno idols have been recovered from archaeological sites in Cuba (see examples in Dacal Moure and De La Calle 1996:92-93). More research for the use of coral in subsistence technology is required across the entire Caribbean, especially islands that have coastal sites associated with reefs.

Social Complexity

The use of zooarchaeology as a means to interpret social complexity has recently gained attention in archaeology (see Crabtree 1990; Driver 1996; Hockett 1998; Reitz and Wing 1999:273-277; Ryan and Crabtree 1995; Welch and Scarry 1995). On occasion zooarchaeologists may use spatial distribution of animal species in socially or politically significant contexts to identify this complexity (Hockett 1998:294). Even the quantity and distribution of such remains as 'prime' cuts of meat may imply socio-political or sociocultural organization. Zooarchaeologists may be able to infer differences in social status, ethnicity, and economics in society through the distribution and concentration of faunal remains. This form of research has not been explored entirely in the Caribbean region, possibly because of the influence of the cultural-historical and processual schools of archaeological thought practiced within the last century.

Caribbeanists are beginning to use zooarchaeological data more often in an effort to explain socio-religious practices. For example, Grouard's (1997) faunal analysis of the Tanki Flip site in Aruba illustrates that animals were symbolically or socially significant in ancient Dabajuroid society. 'Special' features containing sea-turtle remains and pottery have been suggested as being sacred caches, because sea turtle remains may have had symbolic function (Grouard 1997:264). Rostain and Versteeg (1997: 343) argue that caches of animal remains were considered sacred because bones "contain the vital element of the corpse or the fundamental 'soul' of the individual." This interpretation is derived in part from modern Amerindian beliefs of Amazonian natives about the symbolic and social importance of burying the dead (Rostain and Versteeg 1997:343). In support of Grouard's assertion, at the Malmok site in Aruba, some of the Archaic Age burials were either covered with or buried underneath sea turtle carapaces (Versteeg 1991:108). The use of carapaces may be a result of the relationship between the interment area and the available resource base such as the area where sea turtles lay their eggs (Versteeg 1991:113). On the one hand, the association of sea turtles and burials on Aruba may be viewed as sacred or symbolic, representing an animistic relationship between humanity and nature, or the simple use of a resource to cover human corpses, and protect them from environmental conditions.

Grouard (1997:262-264) further argued that the discovery of 'special' non-endemic species such as fresh-water turtles (Testudinidae), deer (*Odocoileus* sp.), and felines (*Felis* sp.) support the possibility of exchange between the mainland and Tanki Flip. The exchange process could have occurred in a variety of ways: (1) mainland groups could have brought animals to Aruba; (2) Tanki Flip groups could have traveled to the mainland, hunted game, and brought it back to Aruba; or (3) Tanki Flip inhabitants could have gone to the mainland and traded for different species. Regardless of the manner in which the animals arrived at Tanki Flip, interaction between the mainland and Aruban inhabitants did occur. Grouard (1997:333) also suggested that these non-endemic animals could have had a symbolic function due to their location, since they were placed in 'special features' or caches. Although I agree that some caches could be considered sacred or 'special', others may have been interpreted as storage pits for everyday secular use. Context is important with issues of social complexity (see Driver 1996; Hockett 1998), which is why zooarchaeologists should clarify the contexts of zooarchaeological remains before designating them as symbolic or sacred.

The presence of zoomorphic idols and iconography depict the importance of fauna in the Caribbean. Endemic and imported species are present on ceramics, in the shape of idols, or on petroglyphs, also illustrating the importance they had (see plates in Dacal Moure and La Calle 1996; Petersen 1997; Rodríguez 1997; Roe 1994; Wilson 1990; Versteeg and Schinkel 1995). In fact the discovery of a possible Rice Rat statuette at the Elliot's site on Antigua illustrated in Figure 20, may indicate the prehistoric symbolic or social significance of this species as opposed to the historical interpretations of them being destructive agents of horticultural crops.

Aside from being symbolic representations, animals could have been regarded as pets and reared in captivity for that reason (see Figueredo 1978; Roe 1994; Wing 1993:247-248). Many ethnohistoric accounts and archaeological evidence indicate that dogs played an important role in indigenous society. Some chroniclers indicated that dogs were consumed, used for hunting, sacrificed, and kept as pets (Roe 1994:157-161; Wing and Reitz 1982:23).

Zooarchaeology can provide the archaeologist with an avenue for understanding the structure and formation of social and political organization. Prehistoric and historic Caribbean procurement groups such as fishing or hunting parties were possibly organized by kin groups or some socio-politically structural body (DeFrance et al. 1996:290). Zooarchaeological data may aid in the identification of this form of social organization. Additionally, ethnohistoric evidence for feasting and accounts of hospitality by the Taíno elite on Hispaniola may be inferred by the presence of faunal remains at archaeological sites. The Taíno performed *areytos* (feasts of welcome) or public rituals when entertaining elite guests. Most of the ceremonies were conducted by the elite

Figure 20. Royall's (JO-11) Site Ceramics Featuring an Adorno of a Rice Rat.

(*cacique*, male chief or *cacica*, female chief) within their various elaborate houses, ballcourts, or plazas in or just outside of the village (Alegría 1983:16-27; Wilson 1990:129-132). At these feasts, gifts or 'tribute' would be given to the elite members from neighbouring chiefdoms (*cacicazgos*), and these offerings would include bread, roots, Iguana, Hutia, crocodile, and many other things (Martyr 1970:120; Wilson 1990:129). Thus, if concentrations of these remains were identified archaeologically within the proximity of these socio-political locations, it would lend credence to the existence of feasts or public rituals. Of course, research of this sort has more potential with Historic Age sites because of historical documents. However, with rigorous sampling methods, identifications of sites as ceremonial or political centres for prehistoric times should be possible.

Discussion and Future Research

It must be noted that the sampling procedures practiced by past Caribbeanists may have dictated the types of interpretations for subsistence models, paleoenvironmental reconstruction, subsistence technology, and social complexity. Most Caribbean archaeology has concentrated on settlement survey, small-scale excavation or midden analysis; large-scale excavations were never conducted in the past. Only recently have Caribbeanists realized the potential large-scale analysis can yield (Schinkel 1992:143; Watters and Petersen 1994; Versteeg et al. 1993:139). Shell middens have always been viewed as most suitable for constructing chronologies or cultural taxonomies through artifactual analysis. The depositional (natural and cultural) and taphonomic problems alone hinder the interpretations for determining the depositional process of a shell midden. This will have adverse affects when forming chronologies and classifications using artifacts. Although primary context finds are rare in the Caribbean (Versteeg and Ruiz 1995:11), emphasis should also be placed in those areas with potential social significance, such as burials, houses, or caches.

In addition, recovery methods have probably limited the interpretation of zooarchaeological remains at Caribbean sites. Obviously, the use of 1/4 in. or 6 mm mesh would reduce the number of smaller species and broken elements recovered within those past studies. The lack of flotation methods would have done the same. With the use of smaller fine mesh (less than 2 mm) and flotation, detailed interpretations about the exploitation of resources has become possible and will continue to be so. Furthermore, zooarchaeological studies cannot be the sole contributor for the explanation of subsistence economies, biogeographical concerns, sociopolitical customs, and cultural adaptations. The incorporation of more detailed paleobotanical research and bone isotopic analysis is required. Although the bone isotopic research conducted in the Caribbean has shed light on Caribbean subsistence strategies (see DeFrance et al. 1996; Keegan 1992; Keegan and Stokes 1994; Keegan and DeNiro 1988; Klinken 1991; Stokes 1998), larger sample sizes of human remains from the entire Caribbean are required, especially in the Lesser Antilles. A larger sample size will enable a more comprehensive study of subsistence strategies and information on the types of food being consumed in the Lesser Antilles.

More use of pictorial or artistic representations in conjunction with zooarchaeological studies should be used to gain knowledge of animal use. Analysis of pictographs, petroglyphs or statuettes may reveal the importance the fauna had in Caribbean prehistoric and historic society. Furthermore, pictorial representations may depict fauna contemporaneously available at the time that is not present at later archaeological sites. With this information, archaeologists of the future may be able to identify extinct, extirpated, or non-endemic species. The depiction of non-endemic species may indicate the importance of trade and exchange processes in the Caribbean or specifically at that site for prehistoric occupants.

Though research in Caribbean zooarchaeology has become more diverse within the last thirty years, research interests still lie primarily in determining traditional subsistence studies and environmental use. Studies have not focused on the role animals play in interpreting sociopolitical variation (Deagan 1996:366). Ethnohistoric literature does indicate the potential for determining aspects of the importance of certain animals in ritual such as the lizard as being an important delicacy for the Taíno (Rouse 1948:524). Even further the use of ethnographic analogy may answer or aid in the interpretation of past human behaviour. If historical sources are used rigorously to identify patterns of subsistence, development of subsistence technology, animal use for trade and social inequality, patterns may emerge, and may be detectable in the prehistoric record. However, as indicated earlier caution should be taken into consideration when using these sources because of the possible misinterpretation of indigenous lifeways by European chroniclers.

As far as research for the interpretation of social complexity using zooarchaeological remains is concerned, marginal research in this area has been accomplished. Ideas of feasting or the importance of food items in ritual has hardly been examined. Ethnohistoric accounts do indicate the importance of animals in sociopolitical customs (Las Casas 1951; Rouse 1948:522-528). Petersen (1997:125) argues that the indigenous inhabitants of the Caribbean may have selected fauna for certain economic uses aside from subsistence, "[it] is clear that native and imported mammals as well as fish, bird, and reptile species were important in Amerindian iconography, as ceramics and other material cultures testify." Archaeologists have not searched for these examples or at least have not made these interpretations. This failure is because these contexts have not been identified, probably resulting from poor sampling strategies, ignorance, or poor preservation. However, ethnohistorical and archaeological evidence from the Ceramic Age, especially the late Ceramic and Historic Ages, reveal that Caribbean (Taíno) chiefdoms were socio-politically organized complex societies (Curet 1997; Keegan 1997; Rouse 1948:528-531; Wilson 1990). Most recently at the Society for American

Archaeology meetings in Philadelphia during the spring of 2000, Antonio Curet presented a paper concerning the social significance animals played in Taíno society during the contact period through archaeological and ethnohistoric evidence. Continued research by Curet on this topic should prove to be engaging. By using zooarchaeological information with respect to identifying examples of social complexity (feasting, prime cuts of meats, and the abundance of remains in 'social' contexts) sociopolitical and socioeconomic complexity status may be identified even further.

Zooarchaeology has aided in the understanding of many aspects of the past lifeways of Caribbean peoples. Although archaeological research in the Caribbean spans over three centuries, the interest in zooarchaeology is recent. Zooarchaeology has spanned most spectrums of archaeology, and has been an important contribution to the understanding of Caribbean prehistory and history. Most of the research has provided an understanding for subsistence, settlement adaptations, migration patterns, paleoecological reconstruction, and sociopolitical complexity. Zooarchaeological research is at the point in its development where refined methods and analysis can enable archaeologists to answer more complex questions. With the addition of large-scale excavations, and an emphasis on searching for 'socially significant' areas, archaeologists will be able to answer such diverse and complex questions. Furthermore, integrating archaeobotanical, human bone isotopic analysis, and zooarchaeology will provide a clearer understanding of prehistoric Caribbean native dietary practices.

Summary

In accordance with Rouse's (in press) historiography of Caribbean archaeology, a brief history of Caribbean zooarchaeology has been presented to provide an understanding of the development of this branch in archaeology and for the research objectives of this project. On the basis of the archaeological excavations and recovery practices for the Muddy Bay and Royall's projects, my research is concerned with determining the factors that shaped the subsistence economies during the Ceramic Age on Antigua. Some of these factors include physiographic island features; geographic location; population pressure; environmental stress; subsistence technology; and cultural preferences

CHAPTER V

METHODOLOGY

Identification Procedures

The methodology employed for this research project consists primarily of the analysis, identification, and quantification of faunal remains with the use of a comparative reference collection built by myself, together with the paleo-vertebrate collection at the Royal Ontario Museum. I intended to analyze each specimen to the lowest taxonomic level possible. Rather than sampling, I decided to identify as many recovered remains as I could, considering the good preservation of zooarchaeological assemblages from the Muddy Bay and Royall's sites. The relative completeness of the remains made identification easy compared to specimens from other archaeological sites. As mentioned before the bones from Royall's were covered with a calcium carbonate/soil conglomeration, which prevented the identification of some of the specimens. Faunal remains that were not identifiable to the taxonomic level of Order were identified to Class and catalogued as unidentifiable (e.g. Unidentifiable (UID) Fish). Site, level and artifact numbers were inscribed on each specimen that could be written upon, and placed within labeled plastic bags and paper envelopes.

The Royall's and Muddy Bay faunal assemblages were treated as discrete aggregations, each from a single component site, Saladoid and post-Saladoid periods respectively. Units 4 from the Royall's and Muddy Bay sites do have discrete layers of cultural deposition, which may indicate dumping episodes. However, on the basis of the ceramic assemblage there was no temporal differentiation in either style or form for the Royall's site (Healy et al. 1999, 2000), but this does not rule out the possibility that the layers of cultural deposition could have been discrete faunal dumping episodes. If excavation units were excavated in transects at each site determination of stratigraphic processes could have been achieved more accurately. Of further importance for the Muddy Bay (PH-14) site, is that the general porosity of a shell matrix made it difficult to establish the contemporaneity of faunal deposits in relation to cultural layers. The porosity of a shell deposit may allow various animals ('faunalturbators') and other debris to penetrate the matrix, sometimes badly mixing cultural layers (Claassen 1998:85-87). The author recognizes the potential problems with the use of such an aggregation of faunal material. Such an exercise may lead to an overly conservative estimate for the tabulation of MNI counts of animals within a zooarchaeological assemblage (Grayson 1984:31; James 1997; Reitz and Wing 1999:197). This occurrence was inevitable, given the site matrix and excavation methods. Nevertheless, caution should be addressed when discussing the subsistence economies at both sites due to the fact that the analysis and interpretations are from single units, which may not be completely representative of the past subsistence economies for each site.

Measures of Relative Frequency: MNI and NISP

The zooarchaeological remains from the Muddy Bay and Royall's sites were quantified by the standard methods for determining relative frequencies of taxa. This procedure can include the measurement of the number of identified specimens (NISP) and the minimum number of individuals (MNI) from zooarchaeological assemblages. NISP is the actual description of the individual number of specimens present in a faunal assemblage including unidentified individuals. MNI is the determination of the smallest number of individuals necessary to account for all skeletal element/specimens of a species found in a deposit (Klein and Cruz-Uribe 1984; Grayson 1984; Lyman 1994; Reitz and Wing 1999: 191-202; White 1952, 1953). MNI was determined by using paired elements. Size and age of specimens were not incorporated into the calculations.

Although most zooarchaeologists and archaeologists use these methods to quantify their data, both methods do have limitations which can drastically alter interpretations from the same database. For NISP, a number of criticisms are possible: (1) Recovery or collection techniques may alter the number of bones present at a site (Brewer 1992:211; Casteel 1972, Payne 1972; Thomas 1969). Both the Muddy Bay and Royall's faunal assemblages were screened through 2 mm sized screen mesh, which may have improved the recovery of fauna. (2) NISP values are interdependent units. That is, the identification of which element belongs to a specific individual cannot be ascertained (Brewer 1992:211; Wing and Reitz 1999:192). (3) Post-depositional processes, scavenging activities, butchering patterns can each alter specimen counts drastically (Binford 1978, 1981; Brewer 1992:210; Grayson 1973, 1979; Perkins and Daly 1968; Reitz and Wing 1999:192). In fact, NISP counts may reflect such activities solely and they may not be able to determine the relative frequency of taxa in assemblages at all. (4) The ability of a zooarchaeologist to identify specimens and the availability of reference collections may also alter the number of NISP recorded. Obviously, a seasoned zooarchaeologist will find it easy identifying faunal remains, especially if a suitable reference collection is available (Brewer 1992:210-211).

For MNI, one major dilemma stems from the depositional history of a faunal assemblage and the method of dividing or grouping recovered faunal material into study units (Brewer 1992:212-213; Grayson 1979, 1984:27-34). Several zooarchaeologists have argued that for MNI to be a valid measure of abundance, the remains of fauna should be distributed evenly across a site, but this is rarely the case (Brewer 1992: 212; Chaplin 1971). Variations in MNI values may occur according to how faunal remains have been analytically aggregated. Consequently, MNI measurements calculated for an entire site "...will differ from MNI values created from a series of natural or arbitrary strata" (Brewer 1992:212). Other problems arise when species are identified from non-paired elements. Because MNI tabulations are based on paired elements the use of non-paired elements (e.g. vertebrae or scales) to identify specimens may underestimate the number of individuals within a given assemblage (Watters et al. 1984:395). Also, in Caribbean faunal assemblages sample size may effect interpretation if an assemblage consists of less than 200 individuals or 1400 bones (Grayson 1984:17; Watters et al. 1984:395). Nevertheless, NISP and MNI are by far the most common methods for quantifying remains and are probably best used in conjunction with one another.

Other data typically recorded by zooarchaeologists include age, portion of the element, modifications (natural and culturally induced) and various osteometric measurements for the determination of body or weight dimensions, in addition to general comments. All of these forms of data were recorded for this study to provide information for later interpretations.

For both sites, two methods for the enumeration of molluscs were used. The MNI for gastropods was calculated by the completeness of the shell, which entailed the presence of the apex and column (Figure 21). Fragments of gastropods were not included in the computations unless they could be identified to species. Bivalves were counted then divided into two to get an initial assessment and only the hinged areas were used (Figure 21).

In this study, comparison of fauna is based on relative frequencies of NISP and MNI between animal classes and in habitats occupied by fauna. Royall's and Muddy Bay faunal assemblages will also be compared to other assemblages from contemporaneous sites on Antigua using a percentage similarity index. This measure is effective for comparing the distributions of fauna in different communities (Krebs 1989:304-305; Reitz and Wing 1999:107-108), and it is calculated by totaling the lowest MNI percentages of representation within each category for pairs of sites (Wing 1999:56; Krebs 1989:293-309). The category in this case will be the habitats exploited (non-overlapping) by fauna for prehistoric Antiguans. For those who wish to conduct further research with the faunal assemblages from Royall's and Muddy Bay, identified remains and recorded data in Microsoft® Excel 98 will be housed within the Department of Anthropology at Trent University, Peterborough, Ontario.

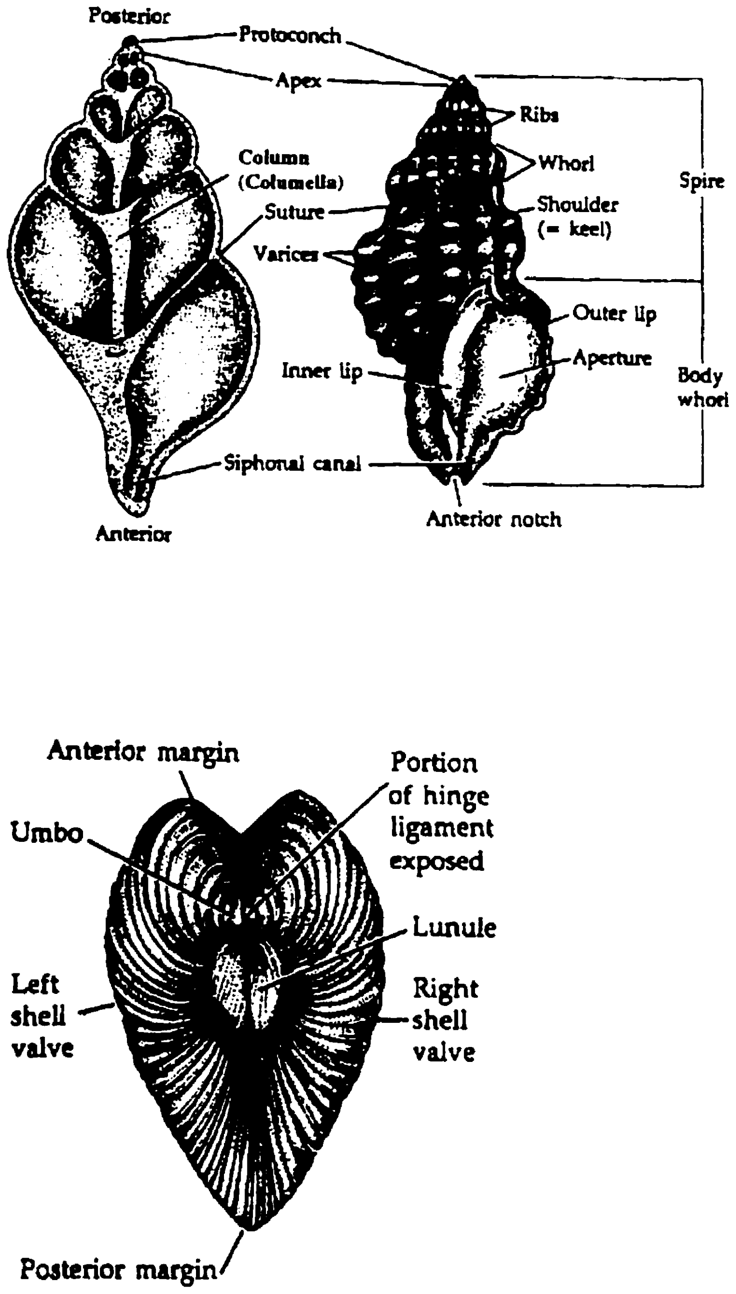


Figure 21. Internal and External Features of a Gastropod and Dorsal View of a Bivalve (Reitz and Wing 1999:Figures A2.15 and A2.16).

Subsistence Technologies

Aside from using faunal remains to identify subsistence economies at Muddy Bay and Royall's, zooarchaeological analysis was also implemented to describe subsistence technologies. As discussed earlier, such studies have been done in the past by Wing and Reitz (1982) and Wing and Scudder (1983), providing an in-depth perspective of different forms of subsistence technologies applicable to capturing and hunting various taxa. One of the objectives of my research is to establish whether technological changes took place at Royall's during the Saladoid period. Is there an increase or decrease in forms of technologies through the identification of specific fauna?

Skeletal Element Frequency Analysis

The determination of skeletal element frequencies and portions were investigated in order to provide information regarding hunting/fishing practices, food preparation, and processing practices (Reitz and Wing 1999:202). Skeletal element frequency may determine which part of the animal was important or valuable either as a food or non-food resource. Such analysis may also shed light upon taphonomic processes. Although these methods can be effective for determining the aforementioned activities, caution should be addressed. It must also be noted that taphonomic processes and the structural density of bone or a combination of the two may hinder interpretations. Certain fauna may have skeletal elements that will withstand taphonomic forces or culturally induced processing activities such as cooking or butchering (see Lyman 1994). If only those elements are present in a zooarchaeological assemblage, a biased perspective of the actual number of identified elements will result. Furthermore, distinguishing between which part of the body was deemed useful or prestigious by prehistoric occupants must be taken into consideration as well (Reitz and Wing 1999:204). Finally, sampling procedures may also complicate the representation of an entire animal excluding some elements.

To determine skeletal frequencies and portions, skeletal elements were tabulated through NISP counts and divided into anatomical regions according to sorting and identification procedures used by Reitz and Wing (1999:Table A4.3) for vertebrate and invertebrate fauna, and by Leach (1986) for fish. For vertebrate taxa such as mammals and reptiles, skeletal elements were assigned to the following anatomical regions: head (skull, mandible/dentary, and teeth fragments); axial (vertebrae, and ribs); forequarter (scapula, humerus, ulna, and radius); hindquarter (innominate, sacrum, femur, patella, tibia or tibio-fibula); forefoot (carpal and metacarpal elements); hindfoot (tarsal, metatarsal, phalanges and metapodial elements). For turtle species, shell elements such as carapace and plastron fragments were assigned to "other anatomical regions". Anatomical regions for birds include the head (skull and mandible elements); axial (vertebral, sternal, and rib elements); forequarter (clavicle, coracoid, scapula, humerus, ulna and radius); hindquarter (innominate, femur, tibiotarsus, fibula, and patella); wing (carpometacarpus, carpals, and digit/phalanges); and hindfoot regions (tarsometatarsus and phalanges). Fish elements were divided into the head (skull, dentary and teeth elements) and axial regions (vertebral, ray, spine, and pterygiophore elements) (Leach 1986; Leach and Davidson 1977). Invertebrate taxa such as crabs had their anatomical regions assigned to head (mandible, rostrum and antennule elements) and axial regions (carapace, dactylus, immovable finger, carpus, merus, cheliped, abdomen, and thoracic sterna).

CHAPTER VI

RESULTS AND DISCUSSION

Royall's (JO-11) and Muddy Bay (PH-14) Zooarchaeological Remains

Zooarchaeological assemblages from both sites include an assortment of marine and terrestrial fauna from various habitats characteristic of the island environment of Antigua, as described in the Appendix (Tables A1 and A2). A total of 41 genera have been identified for the Royall's zooarchaeological assemblage, drawn from 5 classes of vertebrate and invertebrate taxa, and at Muddy Bay 54 genera were identified from 9 classes of vertebrate and invertebrate taxa. In addition, judging from the species represented, exploited ecological zones include the Terrestrial habitat; Inshore, Estuarine and Tidal Flats habitat; and the Coral Reefs and Rocky Banks habitat. It must be noted that some of the identified animals may occupy more than one habitat. Consequently, animals identified to Family, Genus or Species were classified according to the most frequently occupied habitat (Reitz 1994:302). For example, the Offshore Pelagic habitat is not represented by fauna at the Royall's and Muddy Bay sites, but bony fish such as Barracuda are present, and these fish can reside within this habitat and also in estuarine and mangrove swamp locations (Wing 1999:55). In addition, MNI totals for animals that could not be grouped into specific habitats, such as animals identified to Class and Order, were not included in my total calculations for species identified to habitats (see below). This study also includes mollusc remains, which have been neglected in past zooarchaeological studies on Antigua and across the Caribbean for a variety of reasons (Reitz 1994; Wing et al 1968; Wing 1999).

Unit 4 at the Royall's site produced 4221 identified specimens and a minimum number of 434 individuals (Table 8). Unit 4 at Muddy Bay had an NISP of 4458 and an MNI of 5250 (Table 9). At the Royall's site, a NISP of 3246 and a MNI of 217 was identified for vertebrate fauna, and a NISP of 975 and MNI of 217 was calculated for invertebrate taxa (Table 10). On the basis of MNI percentages (Table 8), the Royall's assemblage is dominated by molluscs (38.6%), followed by mammals (32.5%), crustaceans (11.5%), fish (8.3%), birds (5.9%), and reptiles (3.2%). Alternatively, NISP percentages (Table 8) indicate that mammals (33.5%) and fish (32%) are relatively equal in representation followed by crustaceans (23.1%), reptiles (7.7%), and birds (3.7%). Unfortunately, NISP percentages for molluscs are not available which may alter the distribution of utilized fauna for each site. Because many vertebrate animals such as fish have great numbers of vertebrae within them, a large number of vertebrae do not necessarily mean that a great number of species is present. In fact, some elements may be identified in large numbers and some not at all which will have an effect on the number of fauna identified (Reitz and Wing 1999:192).

For the Muddy Bay site, a NISP of 3786 and a MNI of 338 was recorded for vertebrate fauna, and a NISP of 672 and MNI of 4912 was calculated for invertebrate taxa (Table 11). Using MNI percentages (Table 9), the majority of the Muddy Bay assemblage is dominated by molluscs (92.4%), especially bivalves (74%) followed by bony and cartilaginous fish (5%), and crustaceans (1.12%). Birds, mammals and reptiles are each under 1% respectively (Table 11). MNI totals for the Muddy Bay faunal

Table 8. Summary Table of Fauna from Unit 4 Royall's, Antigua.

Taxa	NISP	%	MNI	%
Vertebrate				
Mammal	1416	33.5	141	32.5
Bird	154	3.7	26	5.9
Reptile	325	7.7	14	3.2
Fish	1351	32	36	8.3
Invertebrate				
Crustacean	975	23.1	50	11.5
Gastropod			150	34.6
Bivalve			12	2.8
Polyplacophora			5	1.2
Total	**4221**	**100**	**434**	**100**

assemblage exceed NISP totals, because NISP tabulations for mollusc remains were not recorded in the field (Arthur R. Murphy, personal communication 1998). The calculation of the MNI for molluscs compared to the MNI of vertebrate species may be skewed, because mollusc shells have a tendency to be better preserved than vertebrate bones. Shells are composed of hard tissues that can endure various taphonomic processes, leaving them virtually intact (Reitz and Wing 1999:192).

Table 9. Summary Table of Taxa from Unit 4, Muddy Bay, Antigua.

Taxa	NISP	%	MNI	%
Vertebrate				
Mammal	421	9.5	30	.59
Bird	271	6	28	.55
Reptile	246	5.5	9	.17
Fish	2847	64	270	5.1
Crustacean	672	15	59	1.12
Invertebrate				
Gastropod			952	18.1
Bivalve			3888	74
Polyplacophora			13	.25
Total	**4457**	**100**	**5249**	**100**

Mammal

For the Royall's zooarchaeological assemblage, a NISP of 1416 and a MNI of 141 was recorded for mammals (Table 10) with 3 genera represented. These include the domestic dog (N=1), Agouti (N=1), and Rice Rat (N=134) with the latter species dominating the mammalian portion of the assemblage. For Muddy Bay an MNI of 30 was calculated from an NISP of 421 mammalian remains (Table 11) with 3 genera present. Mammalian species include the Rice Rat (N=24), and the Agouti (N=3). At Muddy Bay, the presence of human remains may imply that a burial was located near to or partially within Unit 4 from which the zooarchaeological material was excavated.

Table 10. Total NISP and MNI of Vertebrate and Invertebrate Fauna from Unit 4 Royall's, Antigua (UID - Unidentified).

Taxon	NISP	%	MNI	%
Mammal				
Canis familiaris	1	.024	1	.23
Oryzomyine sp.	1330	31.5	134	30.9
Muridae sp.	41	.97	4	.92
Dasyprocta cf. *aguti*	6	.142	1	.23
UID Mammalia sp.	38	.9	1	.23
	1416	**33.5**	**141**	**32.5**
Bird				
Columba squamosa	10	.237	4	.92
Columba sp.	2	.047	1	.23
Zenaidura sp.	25	.592	5	1.2
Columbidae sp.	40	.947	7	1.6
Laridae sp.	1	.024	1	.23
Athene cf. *cunicularia*	3	.071	2	.46
Strigidae sp.	1	.024	1	.23
UID Aves sp.	72	1.71	5	1.2
	154	**3.7**	**26**	**5.9**
Reptile				
Chelonia myadas	5	.118	2	.46
Chelonia sp.	10	.237	1	.23
Cheloniidae sp.	23	.544	1	.23
Testudines sp.	9	.213	1	.23
Iguana sp.	222	5.25	6	1.4
Iguanidae sp.	9	.213	1	.23
UID Reptilia sp.	47	1.11	2	.23
	325	**7.7**	**14**	**3.2**
Fish				
Epinephelus sp.	2	.047	2	.46
Serranidae sp.	4	.095	2	.46
Caranx hippos	3	.071	1	.23
Lutjanus sp.	11	.261	8	1.8
Lutjanidae sp.	1	.024	1	.23
Haemulon sp.	4	.095	3	.69
Haemulidae sp.	2	.047	1	.23
Halichoeres sp.	3	.071	2	.46
Scarus sp.	3	.071	2	.46
Sparisoma sp.	7	.166	2	.46
Scaridae sp.	1	.024	1	.23
Sphyraena sp.	68	1.61	2	.46
Acanthurus sp.	4	.095	4	.92
Balistidae sp.	2	.047	1	.23
Tetraondontiformes sp.	3	.071	1	.23
UID Osteichthyes sp.	1233	29.2	3	.46
	1351	**32**	**36**	**8.3**
Polyplacophora				
Chitodnidae sp.			5	1.2
			5	**1.2**

Table 10. Continued.

Taxon	NISP	%	MNI	%
Gastropod				
Cittarium pica			66	15.2
Murex brevifrons			4	.92
Nerita sp.			26	6
Oliva reticularis			3	.69
Strombus gigas			5	1.2
Tectarius muricatus			36	8.3
Nerita peloronta			3	.69
Cassis tuberosa			1	.23
Cymphoma gibbosum			1	.23
Cypraeacea sp.			1	.23
Astrea coelata			4	.92
			150	**34.6**
Bivalve				
Arca zebra			3	.69
Donax sp.			1	.23
Phacoides pectinata			4	.92
Pinctada radiata			2	.46
Spondylus americanus			1	.23
Modiolus americanus			1	.23
			12	**2.8**
Crustacean				
Cardisoma guanhumi	13	.308	1	.23
Gecarcinidae sp.	480	11.37	46	10.6
Menippe cf. *merceneria*	1	.024	1	.23
UID Decapoda sp.	481	11.4	2	.46
	975	**23.1**	**50**	**11.5**
Total	**4221**		**434**	

All identified specimens would have occupied the terrestrial habitat (Tables 12 and 13). Even further, some of the faunal remains can be divided into endemic terrestrial fauna, such as the Rice Rat (from the rodent tribe Oryzomyini, probably *Megalomys* sp.), and introduced terrestrial fauna, such as the Dog and the Agouti (Wing 1999:57).

Table 11. Total NISP and MNI of Vertebrate and Invertebrate Fauna from Unit 4, Muddy Bay, Antigua (UID - Unidentified).

Taxon	NISP	%	MNI	%
Mammal				
Oryzomyine sp.	317	7.11	24	.457
Muridae sp.	2	.045	1	.019
Dasyprocta cf. *aguti*	15	.336	3	.057
Rodentia sp.	37	.83	1	.019
UID Mammalia	50	1.12	1	.019
	421	**9.5**	**30**	**.6**
Bird				
Columba squamosa	10	.224	5	.095
Zenaidura sp.	32	.718	5	.095
Columbidae sp.	40	.695	6	.114
Larus sp.	2	.045	1	.019
Strigidae sp.	3	.067	2	.038
Puffinus cf. *lherminieri*	11	.247	2	.019
Procellariidae sp.	2	.045	1	.019
UID Aves sp.	171	3.84	6	.114
	271	**6**	**28**	**.5**
Reptile				
Chelonia myadas	1	.022	1	.019
Testudines sp.	3	.067	1	.019
Colubridae sp.	6	.135	1	.019
Iguana sp.	167	3.75	3	.057
Iguanidae sp.	8	.157	1	.019
UID Reptilia sp.	61	1.17	2	.04
	246	**5.5**	**9**	**.2**
Fish				
Epinephelus sp.	21	.471	9	.171
Serranidae sp.	1	.022	1	.019
Caranx hippos	2	.045	1	.019
Carangidae sp.	1	.022	1	.019
Lutjanus sp.	15	.336	7	.133
Lutjanidae sp.	1	.022	1	.019
Haemulon sp.	26	.583	12	.228
Halichoeres sp.	37	.30	9	.171
Holocentrus sp.	2	.045	1	.019
Scarus sp.	220	4.93	41	.856
Sparisoma sp.	394	8.84	56	1.07
Scaridae sp.	6	.135	1	.019
Sphyraena sp.	255	5.72	7	.133
Acanthurus sp.	421	9.44	99	1.88
Balistidae sp.	2	.045	1	.019
UID Osteichthyes sp.	1430	32.08	22	.419
Orectolobidae sp.	13	.292	1	.019
	2847	**64**	**270**	**5**
Polyplacophora				
Chitodnidae sp.			13	.25
			13	**.25**

Table 11. Continued.

Taxon	NISP	%	MNI	%
Crustacean				
Coenobita clypeatus	54	1.21	8	.152
Cardisoma guanhumi	158	3.54	35	.666
Gecarcinidae sp.	254	5.70	7	.133
Mithrax spinossimus	11	.247	5	.095
Menippe cf. *mercenaria*	1	.022	1	.019
UID Decapoda sp.	194	4.35	3	.057
	672	**15**	**59**	**1.12**
Gastropod				
Acmaea leucopleura			29	.552
Astrea brevspina			1	.019
Cittarium pica			50	.951
Fissurella nodosa			25	.476
Murex brevifrons			43	.818
Nerita sp.			563	10.7
Oliva sp.			3	.057
Strombus gigas			122	2.32
Strombus pugilis			40	.761
Tectarius muricatus			76	1.45
			952	**18.1**
Bivalve				
Anadara brazilansis			1	.019
Anadara notabilis			161	3.06
Arca zebra			1467	27.9
Brachidontes sp.			509	9.69
Chama macerophylla			202	3.84
Codakia obicularis			144	2.74
Crassotrea rhizophorea			121	2.30
Crepidula sp.			58	1.10
Donax sp.			1	.019
Isognomon alatus			266	5.06
Isognomon radiata			48	.913
Lucina pennsylvanica			41	.780
Modiolus americanus			35	.666
Ostrea frons			16	.305
Pinctada radiata			818	15.6
			3888	**74**
Total	**4457**		**5249**	

Table 12. Habitats Represented by Identified Fauna (NISP and MNI) from Unit 4 Royall's, Antigua.

Habitat	**NISP**	**MNI**
Terrestrial		
Canis familiaris	1	1
Oryzomyini sp.	1330	134
Muridae sp.	41	4
Dasyprocta cf. *aguti*	6	1
Columba squamosa	10	4
Columba sp.	2	1
Zenaidura sp.	25	5
Columbidae sp.	40	7
Athene cf. *cunicularia*	3	2
Iguana sp.	222	6
Iguanidae sp.	9	1
Cardisoma guanhumi	13	1
Gecarcinidae sp.	480	46
	2182	**213**
Inshore, Estuarine, Tidal Flats		
Chelonia myadas	5	2
Chelonia sp.	10	1
Cheloniidae sp.	23	1
Laridae sp.	1	1
Lutjanus sp.	11	8
Lutjanidae sp.	1	1
Menippe cf. *mercenaria*	1	1
Cittarium pica		66
Murex brevifrons		4
Nerita sp.		26
Oliva reticularis		3
Strombus gigas		5
Tectarius muricatus		36
Nerita peloronta		3
Cassis tuberosa		1
Cymphoma gibbosum		1
Cypraeacea sp.		1
Astrea coelata		4
Arca zebra		3
Donax sp.		1
Phacoides pectinata		4
Pinctada radiata		2
Spondylus americanus		1
Modiolus americanus		1
Chitodnidae sp.		5
	52	**182**

Table 12 Continued.

Habitat	**NISP**	**MNI**
Coral Reef and Rocky Banks		
Epinephelus sp.	2	2
Serranidae sp.	4	2
Caranx hippos	3	1
Haemulon sp.	4	3
Haemulidae sp.	2	1
Halichoeres sp.	3	2
Scarus sp.	3	2
Sparisoma sp.	7	2
Scaridae sp.	1	1
Sphyraena sp.	68	2
Acanthurus sp.	4	4
Balistidae sp.	2	1
Tetraodontiformes sp.	3	1
	106	**24**

According to Wing (1989:139; 1993:244), abundant representations of native terrestrial species such as Oryzomyine rodents are present within Lesser Antillean sites (Antigua, Marie Galante, St. Martin, St. Eustatius, St. Lucia and Martinique). The abundant number of Oryzomyine remains at Royall's (33% or a MNI of 134) confirms this assertion. Other factors should be taken into consideration regarding the high abundance of Rice Rats at the Royall's site. Wing (1993:244–247) estimates that the extant species of Oryzomyine rodents produces an average of 5-6 litters per year with 2-5 young per litter, whereas the Agouti produces 2-3 litters per year with one young per litter. Consequently, the abundance of Oryzomyine remains at Royall's may have been a result of such a high reproductive cycle. In addition, rodents have a tendency to be attracted to cultivated fields and the proximity of one to the site may explain the large number of remains at Royall's (Wing and Reitz 1982:23). A form of garden hunting could have also been employed to capture these animals (Linares 1976). The occupants

Table 13. Habitats Represented by Identified Fauna (NISP and MNI) from Unit 4, Muddy Bay, Antigua.

Habitat	NISP	MNI
Terrestrial		
Oryzomyine sp.	317	24
Muridae sp.	2	1
Dasyprocta cf. *aguti*	15	3
Rodentia sp.	37	1
Columba squamosa	10	5
Zenaidura sp.	32	5
Columbidae sp.	40	6
Strigidae sp.	3	2
Colubridae sp.	1	1
Iguana sp.	167	3
Iguanidae sp.	8	1
Coenobita clypeatus	54	8
Cardisoma guanhami	158	35
Gecarcinidae sp.	254	7
	1098	**102**
Inshore, Estuarine, Tidal Flats		
Chelonia myadas	1	1
Testudines sp.	3	1
Larus sp.	2	1
Lutjanus sp.	15	7
Lutjanidae sp.	1	1
Menippe cf. *mercenaria*	1	1
Mithrax spinossimus	11	5
Acmaea leucopleura		29
Astrea brevspina		1
Cittarium pica		50
Fissurella nodosa		25
Murex brevifrons		43
Nerita sp.		563
Oliva sp.		3
Strombus gigas		122
Strombus pugilis		40
Tectarius muricatus		76
Anadara brazilansis		1
Anadara notabilis		161
Arca zebra		1467
Brachidontes sp.		509
Chama macerophylla		202
Codakia obicularis		144
Crassotrea rhizophorea		121

Table 13 Continued.

Habitat	NISP	MNI
Crepidula sp.		58
Donax sp.		1
Isognomon alatus		266
Isognomon radiata		48
Lucina pennsylvanica		41
Modiolus americanus		35
Ostrea frons		16
Pinctada radiata		818
Chitodnidae sp.		13
	34	**4870**
Coral Reef and Rocky Banks		
Epinephelus sp.	21	9
Serranidae sp.	1	1
Caranx hippos	2	1
Carangidae sp.	1	1
Haemulon sp.	26	12
Halichoeres sp.	37	9
Holcentrus sp.	2	1
Scarus sp.	220	41
Sparisoma sp.	394	56
Sphyraena sp.	255	7
Scaridae sp.	6	1
Acanthurus sp.	421	99
Orectolobidae sp.	13	1
Puffinus cf. *lherminieri*	11	2
Procellariidae sp.	2	1
	1412	**242**

could have set up traps around agricultural plots in anticipation that these animals would be attracted to the crops.

Introduced fauna, such as the Agouti and Dog, are represented by a small number of specimens, less than 1% each at both sites (Tables 10 and 11). The scarcity of introduced fauna at Royall's and Muddy Bay may result from a number of factors including sampling and recovery strategies that limited their visibility within the archaeological context (burials vs. middens). Alternatively, the scarcity may reflect the role these animals played in society. Ethnohistoric accounts indicate that dogs were used both as a food source (Sauer 1966:59) and for hunting (Roe 1994; Lovén 1935:433-434). Examples of dog burials or artistic depictions of dogs may suggest their importance in society, which may be the cause for their scarcity in midden refuse (Roe 1994). Even further, although Agouti remains are rarely found in midden contexts, some have been reported to be found in burials. This could mean that the Agouti might have had even more social significance with humans than dogs did (Wing and Wing, in press:6; Wing 1993:247).

For terrestrial mammals such as Rice Rats, the use of baited traps would have probably been applied at both sites, especially at the Royall's site with its large number of rodent remains (Table 12). As indicated before traps baited with Cassava would have attracted these rodents facilitating the ease of their capture (Stokes 1991: 45). At Muddy Bay, the representation of Rice Rats as summarized in Table 13, diminishes suggesting the decreased use of traps in comparison to the Saladoid period at Royall's with an increased emphasis on marine fishing and mollusc gathering. Again, the ephemeral nature of traps or snares precludes their preservation at either site, because they were made of wood and/or rope. The appearance of Agouti remains at both sites may suggest captive control of this species because this animal was initially brought over to the Antilles from South America. As such corrals or pens may have been used to hold Agouti, but none have been found at both sites, and the small number of Agouti remains may dismiss this possibility.

Bird

At Royall's a NISP of 154 and a MNI of 26 was recorded for the class Aves (Table 10). Avian remains are represented by the Scaled Pigeon (N=4); the Zenaida Dove (N=5); gull (N=1); indeterminate dove and pigeon specimens (N=8); the extinct Burrowing Owl (N=2); indeterminate owl species (N=1); and unidentified avian species (N=5). For the Muddy Bay site, a NISP of 271 and a MNI of 28 was identified (Table 11). Identified avian remains include the Scaled Pigeon (N=5); the Zenaida Dove (N=5); indeterminate dove and pigeon specimens (N=6); gull (N=1); indeterminate owl species (N=2); Audubon's Shearwater (N=2); indeterminate Shearwater specimens (N=1); and unidentified birds (N=6). Aside from the gull and Audubon's Shearwater specimen residing within a coastal and inshore habitat, the remainder of the avian species are from the Terrestrial habitat (Tables 12 and 13) and can be classified as ground dwelling or nesting birds facilitating the procurement of them (Stokes 1991:45; Wing 1989:140, 1999:53). Such bird species were probably caught by hand and killed by wooden clubs (Stokes 1991:45). Stone-tipped arrows or spears may also have been used to hunt these birds.

Reptile

For Royall's, a NISP of 325 and a MNI of 14 was established for the class Reptilia (Table 10). Representatives of this class include Iguana (N=6) and Iguanid species (N=1), Green Sea Turtle (N=2), turtle specimens (N=3), and unidentified reptiles

(N=2). At the Muddy Bay site NISP of 246 and a MNI of 9 was identified for reptiles (Table 11). Identified reptiles include the Iguana (N=3) and Iguanids (N=1); the Green Sea Turtle (N=1); sea turtle specimens (N=1); a non-poisonous Colubrid snake (N=1) and unidentified reptiles (N=2). Although sea turtles in the Caribbean occupy a marine habitat for most of their lives, they were probably caught when nesting on sandy beaches in the Inshore and Estuarine habitat (Tables 12 and 13). Consequently, they can be regarded as occupants of the Terrestrial habitat (Reitz 1994:305). Historic accounts report that great sea turtles were also taken at sea by harpoon (Sauer 1966:192). This practice may have occurred during the Saladoid period as well. Iguana and members of the Colubridae family also inhabit the Terrestrial habitat and can be classified as an endemic terrestrial taxon. Iguanids were probably caught by hand in trees or lying about in grassy areas (see Rouse 1948). The small Colubrid snakes were unlikely used as a food source and were probably deposited naturally.

Terrestrial reptiles such as Iguanids could have been captured by hand or hunted by bow and arrow or spear (Keegan 1985; Stokes 1991:46). Lithic industries of chipped stone are represented by a number of utilized flakes at Royall's and Muddy Bay, which could have been easily hafted to make spears or arrows, serving as the subsistence technology required to procure this particular taxon (Murphy 1999:158-160,234-238). The same may apply for marine reptiles such as sea turtles that could have been taken by harpoon in open water, or when nesting, they could also be turned on their backs and butchered (Stokes 1991:51; Wing et al. 1968). Again, both sites illustrate the use of lithic material to create tools for such hunting and processing methods.

Bony and Cartilaginous Fish

At Royall's an MNI of 36 was calculated from an NISP of 1351 for bony fish (Table 10). Ten genera of fish are represented. Nine species are from the Coral Reefs and Rocky Banks habitat, which include the most abundant parrotfish (*Scarus* sp. and *Sparisoma* sp. N=4), followed by Surgeonfish (N=4), Grunts (N=3), Groupers (N=4), Barracuda (N=2), Wrasses (N=2), Triggerfish (N=2) and Jackfish (N=1) with a total MNI of 24 (Table 12). From the Inshore, Estuarine and Tidal Flats habitat the Snapper (N=9) is the lone representative with a total MNI of 9, however, Snapper can also reside in the Coral Reef and Rocky Banks habitat (Table 12). Unidentified fish (N=3) are also present in the assemblage.

For Muddy Bay, an MNI of 270 was recorded from an NISP of 2847 for bony fish (Table 11). Chondrichthyes or cartilaginous fish are represented by a NISP of 13 and a MNI of 1. Nine genera of bony fish have been identified and one cartilaginous fish. Of the bony fish, the Snapper (N=8) represents the Inshore, Estuarine and Tidal Flats habitat with a MNI of 8 (Table 13). From the Coral Reefs and Rocky Banks habitat, 8 species are present. These include Parrotfish (N=101), Surgeonfish (N=99), Grunts (N=12), Groupers (N=10), Wrasses (N=9), Barracuda (N=7), Jackfish (N=2), Squirrelfish (N=1), and with one indeterminate shark totaling a MNI of 241 (Table 13). Unidentified fish total an MNI of 22.

For both sites, the procurement of Coral Reef and Rocky Bank fish was an important part of the subsistence economy. Muddy Bay totals for fish (NISP=1412 and MNI=242) from this habitat outnumber those at Royall's (NISP=106 and MNI=24) implying that the use of traps increased to accommodate the capture of reef fish for Muddy Bay (Tables 12 and 13). Also, the increased procurement of carnivorous fish at Muddy Bay would have increased the need for hook and line, although nets and weirs could have been as effective (Stokes 1991:49-50). Because of Muddy Bay's coastal occupation, the increased need for traps and nets was a likely outcome, but not for the Royall's site. Spindle whorls found at Muddy Bay could have also been utilized for the manufacturing of nets and lines (see Murphy 1996). Unfortunately, evidence for traps and weirs were not present at either site probably because their organic composition precluded preservation.

Crustacean

For the class Malacostraca, a NISP of 975 and a MNI of 50 was tallied at the Royall's site (Table 10). This class is represented by the Great Land Crab (N=1); land crabs (N=46); the Florida Stone Crab (N=1); and unidentified crab specimens (N=2). At Muddy Bay, a NISP of 672 and a MNI of 59 was determined for crabs (see Table 11). This class is represented by 5 genera, which can be further subdivided into land and marine crabs. Land crabs are represented by the Great Land Crab (N=35); the Land Hermit Crab (N=8); and other possible land crab species (*Gecarcinus lateralis* and *Gecarcinus ruricola*, N=7). Marine crabs consist of the Florida Stone Crab (N=1) and the more abundant Spiny Spider Crab (N=5). The Great Land Crab and the Land Hermit Crab occupy mainly a terrestrial habitat, whereas the Florida Stone Crab and Spiny Spider Crab inhabit the sublittoral shallow reef areas in the Inshore, Estuarine and Tidal

Flats habitat (Tables 12 and 13). The great number of crab remains at both sites is a probable reflection of this species' ability to reproduce large numbers of offspring (Wing 1997:3). Crabs, especially the Great Land Crab, were probably harvested at night by hand by humans, because of their nocturnal foraging behavior. Most of the time land crabs stay in their burrows to avoid the heat of the sun and to protect themselves when they are in the process of molting during the day, which can be a very vulnerable period in their lives (Wing 1997:4). They were probably driven out of their burrows by spears, crabbing sticks or torches and then grabbed from behind (Reitz and Wing 1999:263; Stokes 1991:47; Wing 1997:4). The appearance of Land Hermit Crabs may result from their scavenging activities (Wing 1997:5). Marine crabs are present at both sites, but are higher at Muddy Bay most likely as a result from the site's proximity to the sea, which may have facilitated the procurement of such an animal. Marine crabs may have been captured by hand or in traps along with other marine fauna. The technology required to procure such fauna is minimal, aside from the use of spears, and both sites show evidence of lithic industries capable of creating created these tools (see Murphy 1999). Of importance is that lithic tools may have been used for hunting a variety of aquatic and terrestrial species at both sites.

Mollusc

From the phylum Mollusca, an MNI of 167 was recorded for the Royall's site (Table 10). Mollusc remains are represented by three classes Gastropoda, MNI of 150; Bivalvia, MNI of 12; and Polyplacophora, MNI of 5, with a total genera of 18. At the

Muddy Bay Site, a MNI of 4853 was recorded for the phylum Mollusca (Table 11). Three classes represent 26 genera within the Muddy Bay faunal assemblage. These include Gastropoda, MNI of 952; Bivalvia, MNI of 3888; and Polyplacophora, MNI of 13. For both sites, molluscs are from the Inshore, Estuarine and Tidal Flats habitat illustrating a similar procurement strategy (Tables 12 and 13). At Royall's the use of gastropods outnumbers all classes with the West Indian Topshell, *Cittarium pica* (N=66) being the most abundant. Increased numbers of the West Indian Topshell may result from the Land Hermit Crab's occupation of the mollusc shell (Wing 1997:5). Typically, these shells have their outer whorls worn in by Land Hermit Crabs using them as shelter. Alternatively, the Topshell's inshore location makes it easily attainable, which could have also increased their numbers. At the Muddy Bay site bivalves outnumber the other classes at the site and shells from Royall's, particularly the Turkey Wing Shell (MNI=1467) and the pearly oyster (MNI=818). Evidently, the close proximity of the site to the inshore area facilitated the procurement of shellfish along the splash zone and the grassy bottom areas of Muddy Bay.

Subsistence technologies employed for the collection of marine molluscs are minimal, taking into account that most of the species could have been easily collected by hand within the Inshore and Tidal Flats habitat, especially at Muddy Bay (Tables 12 and 13). Stokes (1991:48) argues that the Queen Conch (*Strombus gigas*) could have been collected either by diving for it in deep waters where it resides, or with a two pronged hook attached to a pole – a prehistoric gaff. The hook was most likely made of worked shell, coral, wood, or bone. Hooks of this material have not yet been identified at either Royall's or Muddy Bay.

Skeletal Element Frequency Analysis of Royall's (JO-11) and Muddy Bay (PH-14)

Skeletal element frequency analysis was conducted to determine site activities, mainly food preparation, for vertebrate and invertebrate species. Through the analysis, skeletal elemental frequencies determining the relative completeness of skeletons varied amongst the identified taxa for both sites. A number of factors should also be considered when using skeletal element frequencies. A relatively complete skeleton may indicate the following: (1) a species could have died naturally without post-mortem disturbance before deposition (Reitz and Wing 1999:203); (2) animals that live in close proximity to a site can also be skeletally complete because elements would not be lost during the transportation from kill or collecting sites; and (3) skeletons belonging to animals not considered food sources may also be found whole in deposits, experiencing very little post-mortem disturbance (Reitz and Wing 1999:204). On the other hand, animals used for food and tool purposes that are subjected to post-mortem disturbance are less skeletally complete (Reitz and Wing 1999:203). With this in mind, the following discussion will reveal that most of these occurrences were present for each of the zooarchaeological assemblages.

Mammalian element frequencies at both sites are comparable. For the Rice Rat, most if not all of the remains are represented at both sites especially the larger bones from the hindquarter and forequarter regions. For Royall's, skeletal frequencies for the Rice Rat include: head N=358 (27%), axial N=71 (5.3%), forequarter N=298 (22%), hindquarter N=592 (45%), forefoot N=1 (0.1%), hindfoot N=7 (0.5%) and indeterminate elements N=3(0.2%). At Muddy Bay skeletal frequencies for the Rice Rat include head=62 (19.6%), axial=62 (19.6%), forequarter N=60 (18.9%), hindquarter N=119 (37.5%), and hindfoot N=14 (4.42%). Although the Royall's site has a larger number of Rice Rats, skeletal frequencies for this animal indicate a relative skeletal completeness for both faunal assemblages. For both assemblages maxillae elements are low which may have resulted from the opening of the cranium to extract the brain of the Rice Rat (Jones 1985:524).

These findings may result from a number of reasons. Cutmarks or scrape marks indicative of skinning or disarticulation of an animal are not visible on Rice Rat remains at both sites, which suggests that the animal may have been cooked whole either boiled or roasted on a spit, and possibly undrawn and unskinned (Gullick 1980; Jones 1985:524). This is evidenced by 2 burnt elements (mandible N=1 and humerus N=1) from Royall's. At Muddy Bay 11 burnt elements are present (humerus N=1, tibio-fibula N=1, lumbar vertebra N=4, sacral vertebra N=4, and caudal vertebra N=1). It should also be noted that skeletal elements with fleshy areas such as femurs, tibia, and humeri may reduce the charring and burning of bone by being exposed first to heat. However, DNA testing of stone implements from the Elliot's site, a contemporaneous site with Royall's, revealed that Rice Rat DNA was present upon them, possibly suggesting that disarticulation occurred prior to cooking at Royall's and Muddy Bay. However, this does not rule out that the stone implements were also used to disarticulate the animal after cooking. There is no doubt that Rice Rats were consumed at both sites, especially Royall's, but their overabundance could have also resulted from their association with refuse areas and agricultural plots, and their intense reproductive cycle.

Other mammals such as the Agouti and dog are represented by smaller skeletal element frequencies at each site. For Royall's, Agouti skeletal element frequencies include: head N=5 (83%) and hindquarter N=1 (17%), and for the dog, only one skeletal element from the head is present. For Muddy Bay, Agouti is represented by head N=4 (30.8%), axial N=5 (38.5%), forequarter N=3 (23.1%), and hindquarter N=1 (7.69%) elements. This occurrence suggests the possibility that extensive butchering occurred. Alternatively, the scarcity of dogs and Agouti implies that they were used for non-food purposes such as pets or as sacrificial items for ritual purposes and deposited elsewhere. However, sampling strategies may be another argument for the lack of an abundance of these animal remains at each site.

At Royall's and Muddy Bay, birds are mainly represented by skeletal elements from the forequarter and hindquarter regions. At Royall's, skeletal element frequencies for the Scaled Pigeon are represented by the forequarter N=10 (100%); the Zenaida dove: forequarter N=12 (48%), hindquarter N=8 (32%), and wing N=5 (20%) regions; Columbid species: forequarter N=29 (73%), hindquarter N=7 (18%), wing N=1 (3%), and hindfoot N=3 (8%); Burrowing Owl and owl specimens: forequarter N=1 (25%), hindquarter N=1 (25%) and hindfoot N=2 (50%). At Muddy Bay skeletal element frequencies for the Zenaida Dove consist of the forequarter N=9 (90%) and wing N=1 (10%); the Scaled Pigeon: forequarter N=23 (72%), hindquarter N=6 (18%) and wing (10%); Columbid species: forequarter N=34 (85%), hindquarter N=3 (7.5%), and hindfoot N=3 (7.5%); the Audobon Shearwater: forequarter N=7 (54%), hindquarter N=4 (31%), wing N=1 (8%) and hindfoot N=1 (8%); gull hindfoot N=2 (100%); and owl forequarter N=3 (100%). Because these portions of birds tend to be more structurally dense, their chances of preservation are increased. Some elements from the axial region (sternum, furculum, and ribs), forequarter (radius) and hindquarter (fibula) are more fragile and may not withstand taphonomic forces and even post-mortem processing activities such as cooking or butchering. If so, the frequencies of forequarter and hindquarter portions of the avian body may be biased. On the other hand, as these parts of the body tend to be meaty areas, the occupants may have selected them for consumption.

For Royall's and Muddy Bay similar skeletal element frequencies are present for reptiles. Iguanids (*Iguana* sp. and Iguanidae sp.) are represented by all remains at both sites especially the axial, hindquarter, and hindfoot regions. At Royall's, skeletal frequencies include: head N=14 (7%), axial N=113 (55%), forequarter N=6 (3%), hindquarter N=26 (13%), forefoot N= 5 (2%), hindfoot N=23 (11%), and indeterminate skeletal elements N=20 (10%). And at Muddy Bay skeletal element frequencies for Iguanids are represented by: head N=13 (7.8%), axial N=84 (50%), forequarter N=2 (1.2%), hindquarter=21 (13%), forefoot N= 1 (0.6%), hindfoot N=32 (19%), and indeterminate skeletal elements N=14 (8.4%). Like the Oryzomyine rodents, Iguanids may have been cooked whole with a possible preference for the hindquarter portion, possessing the greater amount of meat. Axial portions are numerous, which also indicates that the animal may also been cooked entirely. At Royall's 1 burnt bone fragment and Muddy Bay and 3 burnt elements (indeterminate long bone fragment N=1, caudal vertebra N=2) were identified respectively.

Based on the skeletal frequencies of forequarter and hindquarter elements, and carapace fragments, sea turtles were probably butchered near nesting areas by the mouth of watercourses at Royall's and on sandy beaches or in mangrove areas at Muddy Bay.

Because of their large size, only those elements with the most amount of meat or used for non-food purposes were probably brought back to site. The expenditure of energy and time to transport entire turtle carcasses may not have been worthwhile for the prehistoric Antiguans at Royall's, but it may have been for Muddy Bay occupants. Marine Turtles could have also been captured for their eggs and the protein rich oil within them (Stoke 1991:51). The presence of axial elements from non-poisonous snakes at Muddy Bay may be considered intrusive, and not for the use as a food source.

The identification of fish remains for this analysis was limited due to the difficulty in determining a number of fish elements to Family or Genus, particularly vertebrae. In line with Leach's (1986:151-154) methods for examining osteological assemblages of fish, identification for most of the fish specimens at Royall's and Muddy was ascertained through cranial elements such as dentaries, premaxillae, and maxillae. Certain fish could also be identified to Family or Genus by axial elements, such as the Barracuda and the Wrasse by their vertebrae, and the anal and dorsal pterygiophores for Surgeonfish. In fact both assemblages are dominated by skeletal elements from the axial region such as vertebrae, especially for unidentified fish (axial=1022 for Royall's and axial=954 for Muddy Bay). It must also be noted that unidentified vertebrae may belong to identifiable fish and may add or subtract to the number of fish recorded. However, this information is not available and interpretations will be based upon which elements I have identified to taxa for this project.

For both sites, axial remains for fish are most likely present because bones that are buried deeply in soft tissues do not show signs of burning. This in turn may mean that bones not buried deeply in soft tissue, such as cranial elements, are susceptible to burning and may deteriorate more easily (Butler 1987, 1990, 1993; Lyman 1994: 439, 442-443). However, this does not rule out that fish heads could have been removed prior to cooking or even at the time when they were caught and discarded at a different location from the site, particularly at the Royall's site. In total 34 burnt fish remains were identified at Muddy Bay and the majority of them are from the axial region, mainly vertebra for unidentified fish (indeterminate vertebrae N=6, thoracic vertebrae N=10, precaudal vertebrae N=3, indeterminate bone fragment N=8, and spine fragment N=2). Other species with burnt elements from head and axial regions include Parrotfish (*Sparisoma* sp., lower pharyngeal grinding mill N=2, and *Scarus* sp., upper pharyngeal grinding mill N=1) and surgeonfish (pterygiophore N=2). Burnt fish elements were not identified at Royall's. The most likely scenario for both sites was that fish were caught and cooked whole. And judging from the short distance of both sites to sources for these animals, this line of reasoning is most suitable.

For both sites land (*Cardisoma guanhumi*, *Coenobita clypeatus* and Gecarcinidae sp.) and marine crabs (*Menippe* cf. *mercenaria* and *Mithrax spinossimus*) are represented by axial elements, primarily the immovable finger and dactylus. These parts are structurally dense and are more capable of surviving taphonomic and cooking processes. Rather than the palm of a claw, which is where meat is usually extracted for consumption, destroying it in the process. Other areas of the crab covered by the carapace may have been consumed, as evidenced by the presence of mandibles from Great Land Crab specimens. However, the carapace area for most crab species is fragile, which may imply that it could have fallen prey to taphonomic and/or cooking processes, explaining the absence of the entire carapace elements and the presence of the more structurally dense mandible.

The zooarchaeological assemblages indicate that most of the skeletal element frequencies for each class are relatively the same with slight variations between each site. For the Royall's and Muddy Bay skeletal element frequencies for mammals, reptiles and birds are mainly from the forequarter and hindquarter regions. Their presence may imply a preferential selection for these meaty areas; however, these anatomical areas tend to preserve better because of their structural density. For fish, both assemblages axial elements dominate, especially the unidentified specimens. In terms of processing activities, both sites indicate that processing and cooking was on site, specifically of Oryzomyine rodents, lizards, some fish, birds and crab. The only exception may be large animals such as sea turtles, which could have been processed at the point of capture. It must only be noted that similar representations of skeletal elements for each site may result from similar environmental factors. Both sites are located in the limestone district and this may have had similar preservational effects upon animal remains, which might explain the greater presence of skeletal elements from the forequarter and hindquarter regions as well.

Discussion: Subsistence Economies at the Royall's (JO-11) and Muddy Bay (PH-14) Sites

For the purposes of this research project, most of my interpretations will be made using percentages of MNI counts, since fauna from all the habitats are included in these totals, even those that occupy more than one habitat. Most zooarchaeological research in the Caribbean has been conducted with this method of quantification, which is what I have based most of my interpretations upon (Deagan 1996; DeFrance 1988, 1989; DeFrance et al. 1996; Dukes and Reitz 1994; Goodwin 1980; Jones 1980, 1985; 1989; Klift 1992; Morse 1989; Petersen 1997; Reitz 1994; Wing 1990, 1994, 1999; Wing and Scudder 1980; Wing and Stover 1987; Wing et al. 1968). Percentages of NISP counts were also included, but as mentioned earlier these counts were not recorded in the field for the Class Mollusca, which may skew some of my interpretations. Furthermore, NISP calculations are not available for the zooarchaeological assemblages from Indian Creek, Elliot's, Winthorpes Bay, Mill Reef, and Black Man's Point on Antigua and other elsewhere in the Caribbean, which prohibits an in-depth comparison of animal exploitation to the assemblages from Royall's and Muddy Bay. By using solely one of these methods, I may have a different conception of what subsistence strategies were practiced. Thus, the application of both methods for measuring relative abundances will provide further insight into the subsistence strategies practiced by the prehistoric occupants at both sites.

Royall's (JO-11)

Based on the MNI percentages for the Royall's site, the zooarchaeological analysis indicates that roughly 51% of the identified remains belong to fauna from the Terrestrial habitat (50.3% endemic and 0.5% introduced), followed by fauna from the Inshore, Estuarine, and Tidal Flats habitat including inshore molluscs (39.9%) and without molluscs (3.6%), and then by animals from the Coral Reef and Rocky Banks habitat (5.7%). Additionally, percentages based on NISP counts reveal that fauna from the Terrestrial habitat (93%) dominate followed by fauna from the Inshore, Estuarine, and Tidal Flats habitat (43%) and lastly by fauna from the Coral Reef and Rocky Banks habitat (6%). See Table 12 for further details. Using percentages based on NISP counts the distribution of fauna throughout Unit 4 illustrates an intense exploitation of terrestrial fauna (specifically Rice Rats and crabs) for most of the levels, especially between levels 3 to 5 (Table 14). Based on MNI counts, the most abundant terrestrial fauna include Rice Rats (N=134), land crabs (N=47), and nesting birds such as doves and pigeons (N=17). Even further, the great abundance of terrestrial fauna corresponds with the thick layer of artifacts identified as the second occupation (Figure 19). Although the lower levels yield higher concentrations of gastropods (topshells, nerites, and periwinkles) within the first occupation based on MNI counts (Table 14). The number of gastropods (N=151) is noticeably higher than bivalves (N=13) reflecting the ease of collecting gastropods from the Inshore, Estuarine, and Tidal Flats habitat. Gastropods such as the West Indian Topshell (N=66), periwinkles (N=36), and nerites (N=26) were easily obtained from the rocky shoreline rather than bivalves from grassy bottom areas, and are extant throughout each level in Unit 4 (Table 14). Of special interest at Royall's is the relative higher concentration of shellfish in the earlier stages of the site's occupation. An increase in the concentration of terrestrial fauna took place near the end of the sequence. It appears that the exploitation of terrestrial fauna may have increased as the exploitation of shellfish diminished. One possible reason for this may have been caused by the occupants' overexploitation of shellfish forcing them to rely more on terrestrial fauna.

In terms of the percentage for terrestrial fauna from early sites across the Lesser

Table 14. Distribution of Vertebrate and Invertebrate Taxa Levels 3-9, Unit 4, Royall's (JO-11), Antigua.

Level #	3		4		5		6		7		8		9	
Taxa	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**
Mammal														
Oryzomyine sp.	6	13.3	75	47.4	30	37	9	36	11	18	3	4		
Muridae sp.			3	1.9										
Dasyprocta cf. *aguti*							1	4						
Canis familiaris									1	1.64				
Mammalia sp.			1	0.63										
Bird														
Columba squamosa			4	2.53										
Columba sp.			1	0.63										
Zenaidura sp.			2	1.27	3	3.7								
Columbidae sp.			4	2.53	2	2.47					1	1.64		
Laridae sp.			1	0.63										
Athene cf. *cunicularia*			2	1.27										
Strigidae sp.			1	0.63										
Aves sp.			2	1.27	3	3.7								
Fish														
Caranx hippos			1	0.63										
Epinephelus sp.					2	2.47								
Serranidae sp.			1	0.63							1	1.64		
Haemulon sp.					2	2.47	1	4						
Haemulidae sp.	1	2.22												
Halichoeres sp.			1	0.63					1	1.64				
Lutjanus sp.			3	1.9	4	4.94			1	1.64				
Lutjanidae sp.			1	0.63										
Scarus sp.			1	0.63	1	1.23								
Sparisoma sp.			1	0.63	1	1.23								
Scaridae sp.			1	0.63										
Sphyraena sp.			1	0.63			1	4						
Acanthurus sp.			4	2.53										
Perciformes sp.	1	2.22												
Osteichthyes sp.			2	1.27										
Balistidae sp.	1	2.22												
Tetraondontiformes sp.	1	2.22												
Reptile														
Chelonia myadas			1	0.63					1	1.64				
Chelonia sp.			1	0.63										
Cheloniidae sp.			1	0.63										
Testudines sp.									1	1.64				
Iguana sp.			3	1.9	2	2.47					1	1.64		
Iguanidae sp.					1	1.23								
Squamata sp.											1	1.64		

Table 14. Continued.

Level #	**3**		**4**		**5**		**6**		**7**		**8**		**9**	
Taxa	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**
Reptilia sp.					1	1.23								
Polyplacophora														
Chitonidae sp.	2	4.44					1	4						
Gastropod														
Astrea coelata											3	4.92	1	16.7
Cassis tuberosa					1	1.23								
Cittarium pica	4	8.89	2	1.27	25	30.9	4	16	14	23	15	24.6	2	33.3
Cymphoma gibbosum									1	1.64				
Cymphoma sp.					1	1.23								
Murex brevifrons											4	6.56		
Nerita peloronta			3	1.9										
Nerita sp.	4	8.89					2	8	6	9.84	14	23		
Oliva reticularis	1	2.22							1	1.64			1	16.7
Strombus gigas	2	4.44					1	4			1	1.64	1	16.7
Tectarius murictaus	4	8.89					1	4	16	26.2	14	23	1	16.7
Gastropoda sp.	1	2.22												
Bivalve														
Arca zebra	2	4.44							1	1.64				
Donax sp.											1	1.64		
Modiolus americanus					1	1.23								
Phacoides pectinata							2	8	1	1.64	1	1.64		
Pinctada radiata									2	3.28				
Spondylus americanus					1	1.23								
Bivalvia sp.	1	2.22												
Mollusca sp.							1	4						
Crustacean														
Cardisoma guanhumi	1	2.22												
Gecarcinidae sp.	11	24.4	34	21.5					1	1.64				
Menippe cf. *merceneria*	1	2.22												
Decapoda sp.	1	2.22							1	1.64				
Total	**45**		**158**		**81**		**25**		**61**		**61**		**9**	

Antilles and Antigua, the Royall's zooarchaeological assemblage is above the 38% MNI average for Early Ceramic Age sites documented by Wing (1989:Table 7). Unfortunately, only MNI counts were employed in Wing's study, eliminating the valuable information NISP counts provide when comparing zooarchaeological assemblages. The large abundance of terrestrial remains (51% MNI) at Royall's is comparable to early sites such as Pearls, Grenada (32.8%), Cayon, St. Kitts (58.6%), Trants, Montserrat (57.1% for 1/4 in. or 6mm screen test and 44.4% for 1/8 in. or 4 mm screen test; Reitz 1994:Table 8) and Hope Estate, St. Martin (62% for excavation Unit T20 levels 3A and 6, and Excavation Unit A3 levels 3, 4,and 5; Wing 1994:Table 3). For example, Hope Estate is located two km inland from the north coast of St. Martin and exhibits an intense exploitation of terrestrial resources (Wing 1993:248), especially Oryzomyine rodents (MNI of 183 out of a total MNI 489; Wing 1994:222). However, the Oryzomyine remains from Hope Estate span over a thousand years, whereas the remains from the Royall's site span over four hundred years. This implies that intense exploitation of Oryzomyine rodents was more prevalent at Royall's within a confined period.

On Antigua, similarities for the procurement of terrestrial fauna are present amongst Royall's, Elliot's, and Indian Creek. Like Royall's, the Indian Creek site (Figure 12 and 22) is located relatively inland adjacent to a dry streambed, approximately 800 m from a rocky cove (Rouse and Morse 1999:7). Based on contemporaneous excavation units from the late Saladoid period (Unit 1, A.D. 1-600) with Royall's (Unit 4, A.D. 250-630), the Indian Creek occupants relied heavily on terrestrial species as part of their diet, with 61% from excavation 1 (Jones 1989:48; Wing 1999:64). This MNI percentage is close to the range of terrestrial dependence at Royall's (51%). Otherwise, dependence upon Inshore, Estuarine, and Tidal Flats species (43%) at Royall's outnumbers Indian Creek reliance of animals from this habitat, 5% for Excavation Unit 1, whereas the Indian Creek site has more representatives from the Coral Reef and Rocky Bank, and Offshore

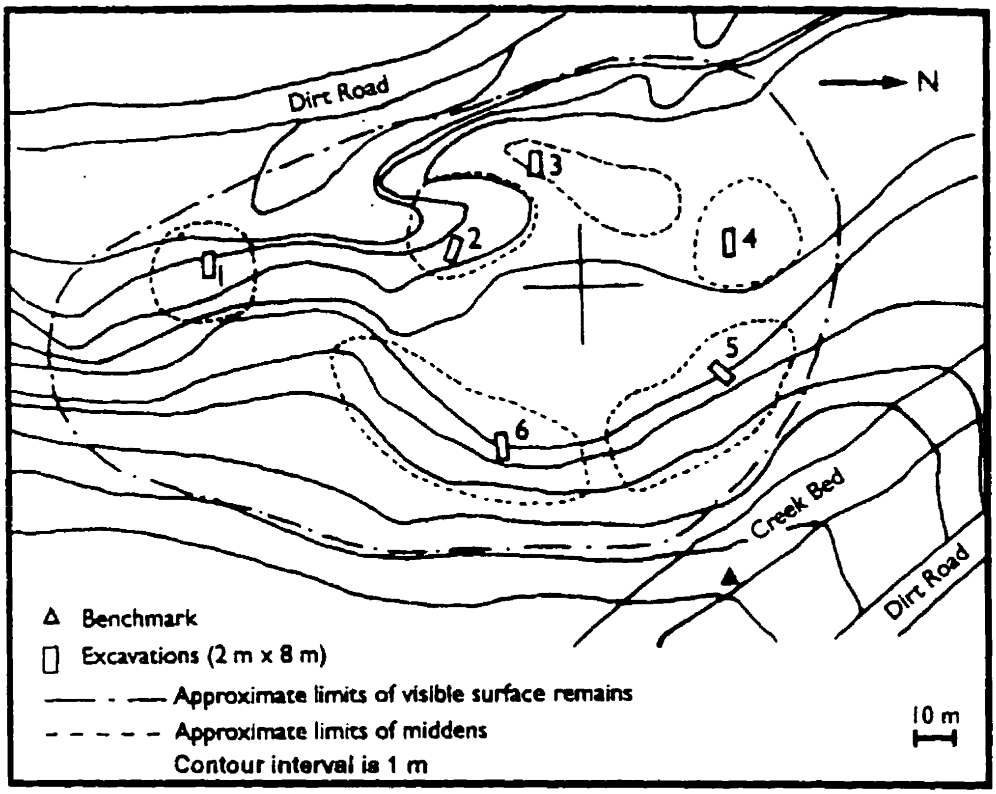


Figure 22. Map of Indian Creek Site Showing Excavations 1 through 6
(Rouse and Morse 1999:Figure 3).

Pelagic species, 29% and 5 % respectively for Excavation Unit 1 (Table 15).

It must be noted that molluscs were not included in Wing's study. However Jones' research indicates that their presence is relatively low during the early stages of occupation at Indian Creek, as evidenced by two pits dating between A.D. 185-280 and A.D. 445 (Jones 1989:45). Furthermore, the sample size from Wing's (1999:52, 56) analysis is relatively small in comparison to Royall's with a MNI of 434 to a MNI 21 for Excavation Unit 1. Also, totals for the relative abundance (MNI or NISP) of fauna from Jones zooarchaeological research was not included due to its unavailability.

Table 15. Comparison of the Relative Frequency (MNI and %MNI) of Vertebrate and Invertebrate Taxa from Royall's, Elliott's, Indian Creek, Blackman's Point, Mill Reef, and Muddy Bay[a].

Habitat	**Royall's**		**Elliott's**		**Indian Creek**						**Blackman's Point**	**Mill Reef**	**Muddy Bay**	
	Unit 4		**Unit 1 & Surface Collection**		**Excavation 1**		**Excavation 2**		**Excavation 3**					
	MNI	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**%**	**%**	**MNI**	**%**
Endemic terrestrial	211	50.3	26	11	11	52	64	29	10	36	25	29	100	1.9
Introduced terrestrial	2	0.5	6	3	2	9	11	5	2	7	3	2	3	0.1
Inshore, Estuarine and Tidal Flats[b]	167	39.9	170	71	1	5	24	11	6	21	11	3	4853	93
Inshore, Estuarine and Tidal Flats[c]	15	3.6											17	0.4
Coral Reef and Rocky Banks	24	5.7	37	15	6	29	108	49	9	32	58	64	242	4.6
Pelagic					1	5	12	6	1	4	2	3		
Total	**419**	**100**	**239**	**100**	**21**	**100**	**219**	**100**	**28**	**100**	**99**	**100**	**5215**	**100**

(a) From Wing 1999:Table 7.
(b) MNI counts including molluscs.
(c) MNI counts excluding molluscs.

The Elliot's site is located 2 km inland in the northeastern region of Antigua along the Ayre's Creek and Collin's Stream drainage system (Figure 23). The site is named after a Historic Age sugar estate within close proximity (Murphy 1999:84-86; Figure 24). The zooarchaeological material is from a surface collection and from one excavation unit, located in an area that may have been an isolated midden or a shallow mound (Figure 24). Archaeological remains were sifted 2 mm mesh screen. These areas were possibly leveled or plowed for the cultivation of sugar during the historic period (Murphy 1999:129). Based upon the ceramic assemblage at Elliot's, the site can be dated to the later phase of the Saladoid period (Murphy 1999:93); radiometric dates for the Elliot's site were not obtained.

The Elliot's zooarchaeological assemblage consists of a mixed economy of inshore molluscs, terrestrial fauna, coral reef and rocky bank fish (Murphy 1999:129). Because the zooarchaeological assemblage is from a small area of the site, Murphy (1999:129) made a conservative estimate for possible utilized fauna. According to Murphy (1999:131-133), terrestrial fauna (14%) played a prominent role in the diet at Elliot's, because shellfish diversity was low with only ten species (5 gastropods, 4 bivalves and 1 chiton) combining for a meat yield of 592.87 gm (Murphy 1999:Table: 10). In terms of meat weights, terrestrial species would have possibly offered a greater combined meat total than molluscs at Elliot's. Based on Wing's (1999:57) average weight for Rice Rats (406 gm) on Antigua from Indian Creek, the contribution of meat at Elliot's could have been 7,308 gm; an obvious larger contribution to the diet even without the inclusion of meat from birds, reptiles, crustaceans, and fish. Complete conch shells may also be low because this animal could have been solely procured for the

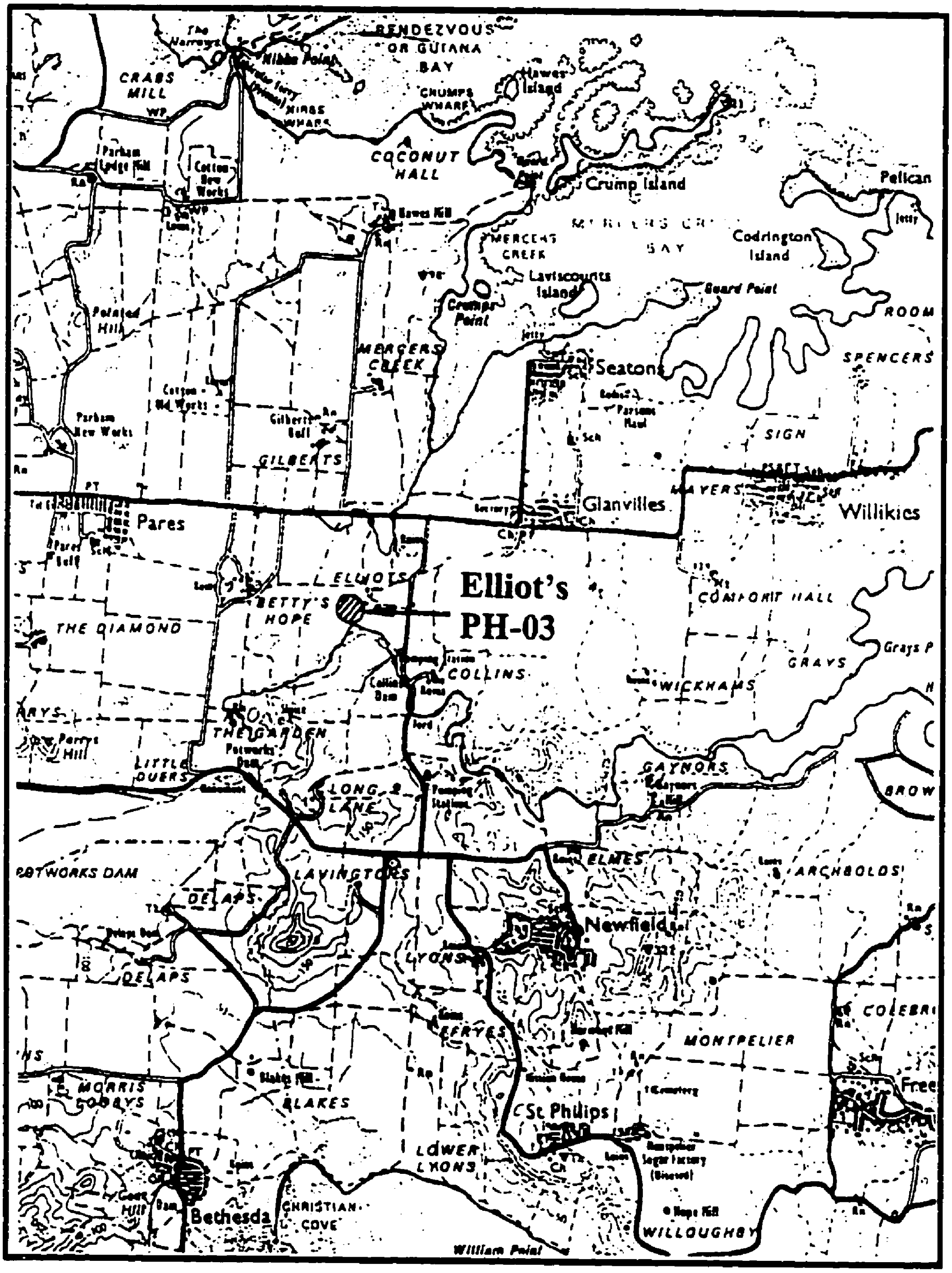


Figure 23. Location Map of the Elliot's (PH-03) Site (Murphy 1999:Figure 14).

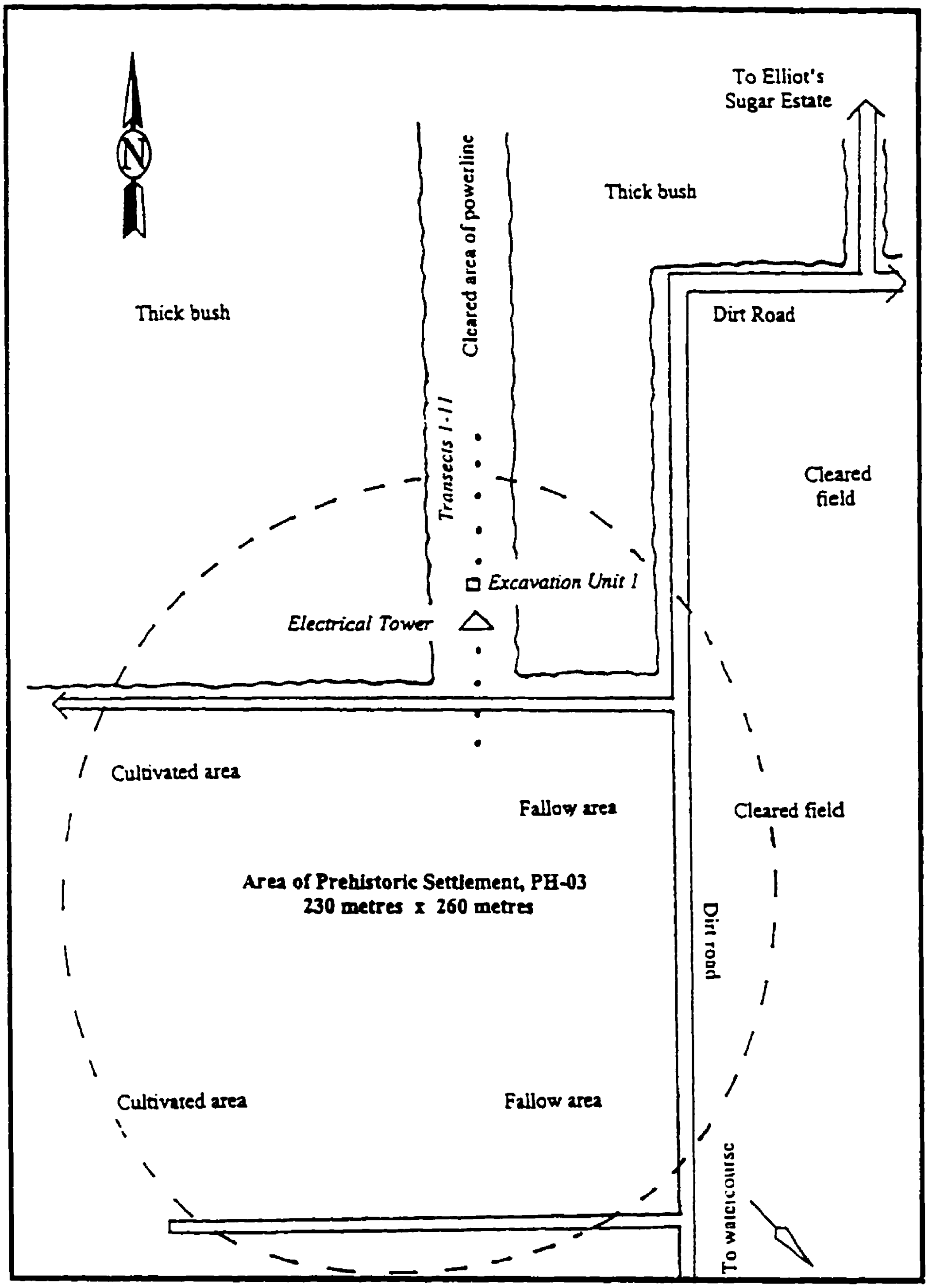


Figure 24. Map of Elliot's (PH-03) Site, Excavation Unit 1 (Murphy 1999:Figure 15).

manufacture of shell tools and ornaments, with the occupants taking what was necessary and leaving the rest of the shell at its source (Murphy 1999:131). Compared to Royall's, species utilized from all habitats at Elliot's are similar, but in terms of exploitation, there are differences. Shell diversity is higher at Royall's with 11 gastropods, 6 bivalves and 1 chiton (N=182), but similar in MNI totals at Elliot's (N=170). Major differences occur with totals for endemic and introduced terrestrial fauna with Royall's (N=213, 51%) outnumbering Elliot's (N=32, 14%); and totals for Inshore and Estuarine and Tidal Flats and Coral Reef and Rocky Banks fauna are greater (71% and 15% respectively) at Elliot's than Royall's (Table 15). In comparison to Royall's, reliance on terrestrial fauna at Elliott's may not be as significant as Murphy (1999:131) advocates. However, if meat weights are used to compare groups of animals within the Elliott's zooarchaeological assemblage a case may be made in favor of Murphy's argument. Nevertheless, further sampling and identification is required at Elliot's to make concrete statements concerning the dietary practices at this site.

Muddy Bay (PH-14)

A subsistence economy highly centred on marine fauna especially molluscs with relatively minimal use for terrestrial fauna is present at Muddy Bay. Using MNI percentages most of the taxa are from the Inshore, Estuarine and Tidal Flats habitat including inshore molluscs (93%) and excluding them (0.4%); followed by animals from the Coral Reef and Rocky Banks habitat (4.6%), and then by fauna from the Terrestrial habitat (2%). Alternatively, using percentages of NISP counts, fauna from the Coral Reef and Rocky Banks habitat (56%) are predominantly followed by fauna from the Terrestrial habitat (43%) and then by animals from the Inshore, Estuarine and Tidal Flats habitat (1%). Such drastic differences occur between these two measures of relative frequency because of the inclusion and exclusion of molluscs in MNI and NISP counts. Again, for the purposes of this research project, most of my interpretations will be made using the percentages of the MNI from the Muddy Bay assemblage since. Furthermore, determining discernable cultural layers for Unit 4 may be difficult, because of the mixing of cultural layers by formation processes and the taphonomic factors associated with a shell midden (Claassen 1998:70-98).

As far as relative frequencies for taxa are concerned, the use of shellfish is steady throughout each level in Unit 4 (Table 16). The most abundant marine species are molluscs, particularly bivalves (N=3888) followed by gastropods (N=952) both from the Inshore, Estuarine and Tidal Flats habitat. In fact, heavier concentrations for most of the shellfish occur between levels 2-5, which is also the thickest deposit in Unit 4 (Table 16; Figure 16). The most abundant bivalves are the Turkey Wing (N=1467), followed by the Atlantic Pearl Oyster (N=818), and two species of mussels (N=544). The most abundant gastropods are nerites (N=563) and the Queen Conch (N=122). Bivalves, specifically mussel and oyster species, are found in mangrove environments, which are located within the Muddy Bay ecosystem. Also, the Turkey Wing can be found in grassy bottom environments, which are also in close proximity to the site (Murphy 1996; Stokes 1991). Heavy concentrations of reef fish, primarily Parrotfish (*Scarus* sp. and *Sparisoma* sp., N=101) and Surgeonfish (*Acanthurus* sp., N=99), are present in levels 1-7, with the latter present in lesser quantities at lower levels (Table 16). The procurement of other species

Table 16. Distribution of Vertebrate and Invertebrate Taxa Levels 1-9, Unit 4, Muddy Bay (PH-14), Antigua.

Level #	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**8**		**9**	
Taxa	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**
Bivalve																		
Anadara brazilansis									1	0.17								
Anadara notabilis	7	1.69	11	1.67	13	1.62	26	2.12	10	1.7	18	3.84	11	2.34	65	11		
Arca zebra	196	47.3	161	24.5	217	27	430	35.1	186	31.6	106	22.6	81	17.2	90	15.2		
Brachiodontes sp.	1	0.24	45	6.85	61	7.59	104	8.48	53	9.01	64	13.6	80	17	101	17		
Chama macerophylla	35	8.45	19	2.89	30	3.73	51	4.16	20	3.4	18	3.84	13	2.77	16	2.7		
Codakia obicularis	16	3.86	34	5.18	48	5.97	28	2.28	7	1.19	5	1.07	3	0.64	3	0.51		
Crassotrea rhizophorea	7	1.69	13	1.98	16	1.99	29	2.37	26	4.42	13	2.77	11	2.34	6	1.01		
Crepidula sp.			5	0.76	14	1.74	17	1.39	7	1.19	8	1.71	4	0.85	3	0.51		
Donax sp.											1	0.21						
Isognomon alatus			16	2.44	38	4.73	129	10.5	43	7.31	21	4.48	14	2.98	5	0.84		
Isognomon radiata			4	0.61			11	0.9	18	3.06	6	1.28	4	0.85	5	0.84		
Lucina pennsylvanica	9	2.17	11	1.67	4	0.5	2	0.16	1	0.17	6	1.28	6	1.28	2	0.34		
Modiolus americanus			1	0.15	19	2.36	1	0.08	5	0.85	5	1.07	3	0.64	1	0.17		
Ostrea frons	1	0.24	6	0.91	5	0.62			1	0.17			2	0.43	1	0.17		
Pinctada radiata	23	5.56	132	20.1	148	18.4	216	17.6	111	18.9	87	18.6	67	14.3	34	5.73		
Crustacean																		
Cardisoma guanhumi													12	2.55			23	85.2
Gecarcinidae sp.													7	1.49				0
Coenobita clypeatus													4	0.85			4	14.8
Menippe cf. *mercenaria*	1	0.24																
Mithrax spinossimus					2	0.25			1	0.17	1	0.21			1	0.17		
Decapoda sp.													3	0.64				
Total	**413**		**657**		**804**		**1226**		**588**		**469**		**470**		**593**		**27**	

Table 16. Continued.

Level #	1		2		3		4		5		6		7		8		9	
Taxa	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**
Sparisoma sp.	9	2.17	14	2.13	15	1.87	12	0.98	3	0.51	1	0.21	1	0.21	1	0.17		
Scaridae sp.			1	0.15														
Sphyraena sp.					5	0.62	1	0.08	1	0.17								
Acanthurus sp.	13	3.14	29	4.41	25	3.11	15	1.22	6	1.02	5	1.07	5	1.06			1	3.45
Osteichthyes sp.	2	0.48	10	1.52	6	0.75			4	0.68								
Balistidae sp.			1	0.15														
Reptile																		
Chelonia myadas													1	0.21				
Testudines sp.							1	0.08										
Colubridae sp.					1	0.12												
Iguana sp.	1	0.24			2	0.25												
Iguanidae sp.	1	0.24																
Squamata sp.					1	0.12												
Reptilia sp.			1	0.15														
Polyplacophora																		
Chitonidae sp.	1	0.24	1	0.15	2	0.25	2	0.16	1	0.17	1	0.21	2	0.43	3	0.51		
Gastropod																		
Acmaea leucopleura	2	0.48	4	0.61	4	0.5	4	0.33	7	1.19	7	1.49			1	0.17		
Astraea brevspina													1	0.21				
Cittarium pica	14	3.38	7	1.07	5	0.62	11	0.9	5	0.85	1	0.21			7	1.18		
Fissurella nodosa	3	0.72	4	0.61	5	0.62	3	0.24	1	0.17	3	0.64	3	0.64	3	0.51		
Murex brevifrons	8	1.93	4	0.61	4	0.5	7	0.57	3	0.51	2	0.43	8	1.7	7	1.18		
Nerita sp.	25	6.04	26	3.96	46	5.72	53	4.32	51	8.67	71	15.1	100	21.3	191	32.2		
Strombus gigas	3	0.72	61	9.28	33	4.1	4	0.33							21	3.54		
Strombus pugilis			1	0.15	2	0.25	7	0.57	2	0.34	6	1.28	7	1.49	15	2.53		
Tectarius muricatus	4	0.97	12	1.83	4	0.5	26	2.12	8	1.36	6	1.28	7	1.49	9	1.52		

Table 16. Continued.

Level #	1		2		3		4		5		6		7		8		9	
Taxa	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**	**MNI**	**%**
Mammal																		
Oryzomyine sp.			7	1.07	5	0.62	4	0.33	1	0.17	3	0.64	2	0.43	1	0.17	1	3.45
Muridae sp.									1	0.17								
Dasyprocta cf. *aguti*	2	0.48											1	0.21				
Rodentia sp.					1	0.12												
Mammalia sp.	1	0.24																
Bird																		
Columba squamosa					2	0.25	2	0.16	1	0.17								
Zenaidura sp.					1	0.12			2	0.34	1	0.21			1	0.17		
Columbidae sp.					1	0.12	5	0.41										
Larus sp.					1	0.12												
Strigidae sp.					2	0.25												
Puffinus cf. *lherminieri*			1	0.15									1	0.21				
Procellaridae sp.													1	0.21				
Aves sp.	1	0.24			2	0.25	3	0.24										
Fish																		
Orectolobidae sp.			1	0.15														
Caranx hippos	1	0.24																
Carangidae sp.							1	0.08										
Epinephelus sp.	4	0.97	1	0.15	1	0.12	2	0.16					1	0.21				
Serranidae sp.			1	0.15														
Haemulon sp.	3	0.72	6	0.91	1	0.12	2	0.16										
Holocentrus sp.	1	0.24																
Halichoeres sp.	4	0.97	1	0.15	2	0.25	2	0.16										
Lutjanus sp.	3	0.72	2	0.3			2	0.16										
Lutjanidae sp.	1	0.24																
Scarus sp.	10	2.42	3	0.46	9	1.12	12	0.98	1	0.17	3	0.64	3	0.64				

such as nesting birds, Iguanas, and Rice Rats is also represented in the Muddy Bay faunal assemblage. However, the overwhelming abundance of molluscs and fish through MNI and NISP counts illustrates that the occupants clearly took advantage of their surroundings and were in complete control of their subsistence economy strategies.

Of comparable interest to Muddy Bay is Winthorpe's West, a coastal settlement on the waterfront of Winthorpe's Bay in the northeast of Antigua (Figure 25 and Table 17). Based on several excavation units (dug in 10 cm arbitrary levels and screened with 2 mm mesh screen) the site was occupied during the Late Saladoid period and more extensively during the post-Saladoid period (Murphy 1999:198-199). The subsistence economy at Winthorpe's West during the post-Saladoid period is marine oriented with emphasis upon the procurement of bivalves (Murphy 1999:Table 25). From Unit 10, 21 species of molluscs have been identified along with nesting birds, Iguana, sea turtle, Rice Rat, Agouti, dog and reef fish, primarily Parrotfish and Doctorfish (Murphy 1999:Tables 24 and 25). Exact frequencies for the preceding taxa are not available, but Murphy (1999:193) does indicate that their presence was minimal compared to molluscs.

At Winthorpe's West, Murphy (1999:196) notes an increasing dependence upon bivalves from the Saladoid levels to the post-Saladoid levels with species such as the Turkey Wing, Lucines (*Codakia orbicularis*), Arks (*Andara notabilis*) and Atlantic Thorny Oyster (*Spondylus americanus*). MNI totals for gastropods at Winthorpe's West

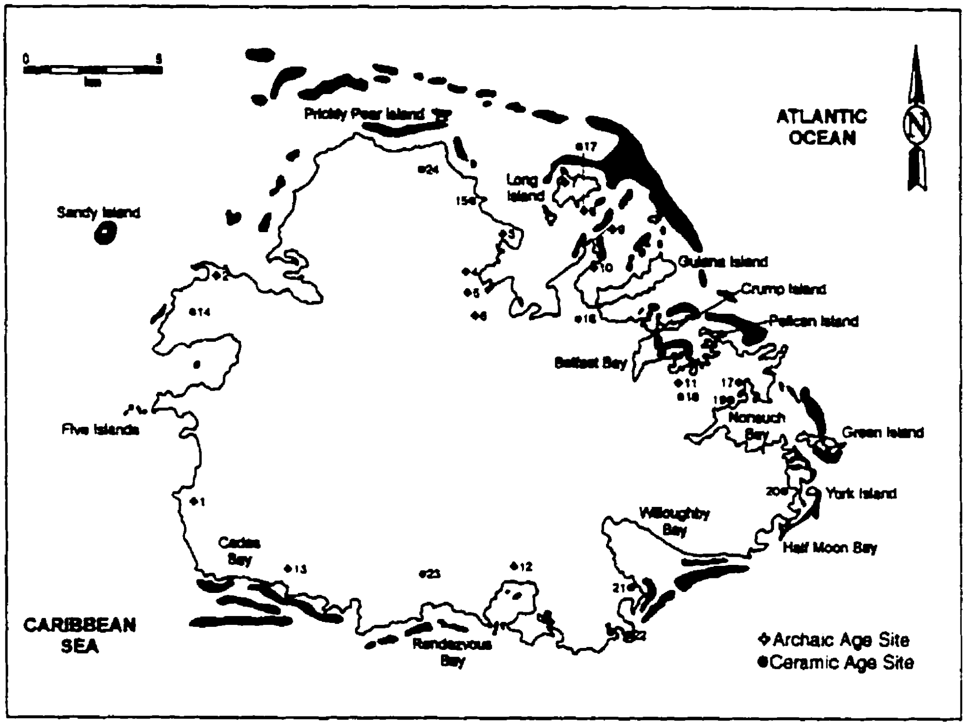


Figure 25. Archaic and Ceramic Ages Sites of Antigua (Nicholson 1992:13).

are low in comparison to Muddy Bay with the West Indian Topshell (N=42) present in all six levels (Murphy 1999:Table 25). The subsistence economy at Winthorpe's West is similar to Muddy Bay in terms of the increased procurement of bivalves, which illustrates the expansion of habitats used for resource procurement (Table 15). Both sites reveal that during the post-Saladoid period prehistoric Antiguans exploited all of the marine biotopes available on the island (Murphy 1999:198).

On Antigua, sites from the Terminal Saladoid (600 to 900 A.D.,) a period between the Saladoid and the post-Saladoid (see Table 4), indicate relative increases in the procurement of marine fauna. Mill Reef, Blackman's Point, and Excavation 3 at Indian Creek reveal that similar procurement strategies to Muddy Bay were practiced

Table 17. Archaic and Ceramic Age Sites of Antigua.

Archaic Age	**Ceramic Age**
1. Jolly Beach, MA-31	14. Hawksbill, JO-02
2. Deep Bay, JO-04	15. Winthorpe's West, GE-06
3. Crabb's, PE-21	16. Coconut Hall, PE-15
4. Blackman's, GE-04	17. Nonsuch Bay, PH-11
5. Parham Road, PE-23	18. Ant. Horizons, PH-02
6. Twenty Hill, PE-19	19. Muddy Bay, PH-14
7. Flinty Bay, GE-L3	20. Mill Reef, PH-01
8. Buckley Bay, GE-L4	21. Mamora Bay, PA-02
9. Magazine, PE-02	22. Indian Creek, PA-04
10. South Pier, PE-04	23. Doig's, PA-15
11. Clover Leaf W., PH-12	24. Royall's, JO-11
12. Cobb's Cross, PA-07	
13. Clairmont W., MA-02	

(Wing 1999:51). Research indicates that reliance upon marine fauna (67-70%) far exceeds that of terrestrial animals (31-34%) at Mill Reef (Wing 1999:Table 7). The data also suggests that the occupants caught fish far more with the use of traps because of the large number of reef fish (64%) present within the assemblages (Wing et al. 1968:133-134; Wing 1999:Table 7), which may also apply to the Muddy Bay site. More recently, zooarchaeological analysis by Murphy (1999:246) at the Mill Reef site identified 21, 898 molluscs, which are mostly bivalves implying that Mill Reef occupants also relied heavily on shellfish as part of their diet. Between four units, Murphy (1999:246) found 15 species of bivalves, 14 gastropods, and 1 polyplacophora. Located on a limestone bedrock peninsula in north central Antigua as a coastal settlement (Fuess 1993:4) the Blackman's Point site reveals a high reliance upon marine fauna (60-71%) and a lower dependence upon terrestrial and inshore-estuarine fauna (28-39%) (Table 15). Finally, analysis of the faunal assemblage from Excavation Unit 3 (900 to 1100 A.D.) at Indian

Creek discloses that the procurement of marine fauna (36%) is lower than terrestrial fauna (43%) (Table 15). According to Wing, the faunal assemblages from these sites represent a transitional stage between a terrestrial based subsistence economy to a localized/insular marine oriented subsistence economy. Caution should be taken into consideration when comparing Mill Reef to Muddy Bay, because Muddy Bay was occupied between 1100 to 1300 A.D. just at the end of the occupation of the Mill Reef site, making interpretations weak.

What may be more important at these sites and elsewhere in the Caribbean, is that excessive changes do not occur in the resource base, but rather in the degree of the exploitation of particular species (Petersen 1997; Wing 1999:64). In the case of Royall's and Muddy Bay, a gradual expansion towards marine fauna from the Saladoid to post-Saladoid on Antigua occurred as an adaptive response to local conditions. The faunal assemblages at Royall's and Muddy Bay have roughly the equivalent collection of animal resources, but differ considerably in the distribution of animals per habitat and animal classes (see Appendix Tables A1 and A2), particularly molluscs (as discussed below). Percentage similarity comparisons exhibit a low similarity (51%), between both sites, possibly because the procurement of shellfish and reef fish is far more substantial at Muddy Bay (Table 18). For the late Saladoid (1-600 A.D.) occupations of Royall's, Elliot's, and Excavation 1 from Indian Creek, percentages of similarity indices exhibit relative similarities of animal exploitation with 59-62% (Table 18). When Royall's is compared to Terminal Saladoid (600-900 A.D.) sites such as Mill Reef, Blackman's Point and Excavation Units 2 and 3 from Indian Creek, indices between 45-71% are represented. Finally, when the post-Saladoid Muddy Bay site is compared to the above

Table 18. Percentage Similarity Indices of Vertebrate and Invertebrate Taxa of Ceramic Age Sites from Five Habitats on Antigua.

Sites or excavation units compared	Percentage Similarity Index
Royall's Unit 4 and Elliot's Unit 1/Surface collection	62
Royall's Unit 4 and Indian Creek Excavation 1	59
Royall's Unit 4 and Indian Creek Excavation 2	45
Royall's Unit 4 and Indian Creek Excavation 3	62
Royall's Unit 4 and Black Man's Point	41
Royall's Unit 4 and Mill Reef	71
Royall's Unit 4 and Muddy Bay	51
Muddy Bay Unit 4 and Elliot's Unit 1/Surface collection	78
Muddy Bay Unit 4 and Indian Creek Excavation 1	12
Muddy Bay Unit 4 and Indian Creek Excavation 2	18
Muddy Bay Unit 4 and Indian Creek Excavation 3	28
Muddy Bay Unit 4 and Black Man's Point	18
Muddy Bay Unit 4 and Mill Reef	10

Saladoid and Terminal Saladoid sites, a diverse range of similarity and dissimilarity from 10-78% is present.

The diversity in indices for sites during the Ceramic Age on Antigua may arise from the fact that different subsistence economies were practiced, or that collection, sampling and excavation methods, and screening processes differed at each site. At the Indian Creek and Mill Reef sites, excavated material was screened through 1/4 in. or 6 mm mesh from single excavation units screen reducing the recovery of smaller-sized fauna such as small-sized fish, lizards, mammals, and birds (Wing 1999:52; Wing et al. 1968:125). While excavated remains from Blackman's Point, Elliott's, Muddy Bay, Royall's, and Winthorpe's West were screened through 1/16 in. or 2 mm screen-sized mesh from single excavation units increasing the recovery rate of smaller sized fauna and smaller broken elements. Analysis may have been more accurate if large-scale excavations were employed such as long transects or units greater than 1 m^2(Schinkel

1992:143; Watters and Petersen 1994; Versteeg et al. 1993:139). Also, for the earlier sites, the lack of flotation methods prohibited the collection of smaller sized fauna and, smaller or broken elements that may also shed light upon processing and cooking patterns. Consequently, comparisons between Royall's and Muddy Bay to Indian Creek and Mill Reef may be inaccurate because of absent fauna, while comparisons to the remainder of the sites may be more reliable. Nevertheless, the following discussion will examine possible factors that could have influenced the exploitation of certain fauna from both sites, to provide an understanding of the subsistence economies practiced during the Ceramic Age.

Factors for Subsistence Economies at Royall's and Muddy Bay

Establishing which factor is solely responsible for shaping the subsistence economies at Muddy Bay and Royall's may not be an attainable goal. Instead, a number of possible factors will be addressed and it may be that a combination of these factors influenced the formation of subsistence economies on Antigua. These factors include sampling procedures, preservation of faunal remains, zooarchaeological analysis, physiographic island features, geographic location, population pressure, environmental stress, subsistence technology, and cultural preferences.

As discussed in Chapter III, the recovery and sampling methods for the zooarchaeological material was thorough at Royall's and Muddy Bay. Material was excavated in well defined levels and sifted though fine mesh screen, enabling the collection of small and large skeletal elements of animals. Good preservation of faunal material facilitated the identification of taxa for over 4000 specimens from each site (Grayson 1984:117; Watters et al. 1984:395), which in my opinion is sufficient for the evaluation of a subsistence economy from an archaeological site. However, there may be some bias regarding the representation of fauna, especially those with robust skeletal elements, such as mammals and reptiles; as tabulated earlier in this chapter by skeletal element frequency analysis for each faunal assemblage. This in turn may have adverse effects upon calculating relative frequencies of taxa, but this was inevitable. There may also be food items such as eggs, oils, and agricultural products, that might have been a substantial part of the prehistoric subsistence Antiguan diet but cannot be recovered due to their ephemeral composition. In addition, the Royall's zooarchaeological assemblage did not include remains from the three initial levels (0-30 cm) in Unit 4 because of past horticultural and landscaping activities, reducing the overall numbers of fauna in the assemblage. Furthermore, measures of relative abundance such as NISP and MNI can prove to be problematic because of interpretative problems as discussed in Chapter IV. As a result, both methods were used in conjunction to solve these issues, providing a more accurate assessment of the zooarchaeological assemblages, which should prove to be useful for future research (Reitz and Wing 1999:200-201).

As discussed in Chapter II, climatic factors or seasonal changes, such as storms, waves, changes in sea temperature, rainfall (wet and dry seasons) and sea level fluctuations, may drastically affect island environments, altering species diversity, and natural habitats (Murphy 1999:277; Petersen 1997:125). Differences or similarities between the subsistence economies of Royall's and Muddy Bay may have resulted from such climatic factors. For example, fluctuations in sea levels may have effected the formation of estuaries within the vicinity of Royall's where most shellfish reside, which in turn may have prevented the procurement of them. Or such action could have increased the formation of marine habitats such a shellfish beds, mangrove and reef systems, increasing marine resources, which may have occurred at Muddy Bay (Murphy 1999:277). Furthermore, identification of physiological events (i.e. epiphyseal bone fusion, tooth eruption, and incremental growth of shell layers) associated with seasonal change through specific faunal elements and through the presence of seasonal fauna (migratory birds) may determine reasons for settlement patterns and the selection of certain fauna on Antigua (Reitz and Wing 1999:257). Unfortunately, seasonal periodicity of animal use was not included in the scope of this research project. Nonetheless, the location of both sites may be associated with seasonal cycles. However, the enormity of each faunal assemblage, the large areas for each site (see Chapter II), and the large shell midden at Muddy Bay may indicate that the sites were occupied over longer periods of time with very little seasonal movement. Until further research in this area is conducted seasonal occupations of Royall's and Muddy Bay cannot be determined.

The physiographic features and environmental conditions of Antigua have played a prominent role in dictating which forms of fauna were available to the prehistoric occupants. According to Murphy (1999:311), Antigua has Saladoid settlements associated with fresh water sources, and post-Saladoid settlements on the east coast with the exception of a few sites located on the south coast such as the Claremont and Cades Bay sites. As such is the case, Royall's inland location (1.5 km) promoted the capture of terrestrial fauna, but it does not exclude the procurement of marine fauna, especially marine gastropods. Alternatively, the immediate coastal location of the Muddy Bay site provided opportunity for the procurement of marine fauna, especially reef fish and marine bivalves. Both sites are located in the limestone district of Antigua, an area rich in terms of species diversity especially aquatic fauna from the Inshore, Estuarine, and Tidal Flats habitat and the Coral Reef and Rocky Banks habitat. Evidently, the resources from this part of the island were very attractive for settlement during prehistoric times as evidenced by the numerous sites (Figure 25 and Table 17). It must be noted that small islands such as Antigua tend to have a low diversity regarding terrestrial animals, which could have made the prehistoric occupants more prone to subsist upon marine resources during the post-Saladoid period (Stokes 1998:252-253). The farther away an island is from the donor source the fewer species will exist. Furthermore, the smaller an island is the fewer species will proliferate because there is less diversity. Furthermore, Stokes' (1998) isotopic studies of human osteological material in the Caribbean studies reveal that a shift from a terrestrial oriented diet during the Saladoid period to one based on marine fauna during the Terminal Saladoid and post-Saladoid period did not occur. Instead, she maintains that physiographic characteristics of islands such as island size, age, geology and isolation were more influential on Ceramic Age diet than cultural changes (Stokes 1998:247-248).

On the other hand, subsistence economies on Antigua could have also been governed by cultural influences in response to environmental factors. Zooarchaeological analysis of Royall's and Muddy Bay reveals that the prehistoric subsistence economies conform to the general Caribbean pattern (Wing 1989), where most of the exploited resources are from the nearest habitats – a reflection of adaptive strategies to local environmental variability (Petersen 1997:125). The Royall's and Muddy Bay occupants did practice a terrestrial and marine based subsistence economy respectively, but to varying degrees. The occupants may have transplanted a 'Tropical Forest Economy' during the initial stages of colonization, as evidenced by the ubiquitous nature of Cassava griddles implying the cultivation of root crops (Petersen 1997:124-126), and a terrestrial oriented and mollusc gathering subsistence economy at Royall's, but a localized adaptation may have also been established. A colonizing population cannot reside on an island without shifting their settlement and subsistence strategies to a certain extent, and this is evidenced on Antigua. The argument of a complete transplantation of a mainland subsistence economy is difficult to substantiate, because Antigua would have presented a vast new way of life for these colonizers, inducing different adaptive strategies (Watters and Rouse 1989). The adaptation continued during the Terminal Saladoid period, during which emphasis was placed on the procurement of marine fauna. By the post-Saladoid period most of the subsistence economy for these sites was entirely marine oriented as evidenced by the Muddy Bay and Winthorpe's West zooarchaeological assemblages.

Looking at the zooarchaeological assemblages from Royall's and Muddy Bay we do see a gradual expansion of the diet from one site to the other, but a complete terrestrial to marine based shift in subsistence economy did not occur. Species diversity is practically the same at both sites with Muddy Bay outnumbering Royall's by one species each for mammals, birds and reptiles (see Appendix 1: Tables A1 and A2). The most noticeable increase is with shellfish, from 18 species at Royall's to 26 species at Muddy Bay, and higher quantities and numbers of fish species are also present at Muddy Bay. It has been suggested that subsistence expansion between the Saladoid to post-Saladoid period may have resulted from population expansion, as can be seen by the increase in the number of sites during the post-Saladoid period (Goodwin 1979, 1980:47, 1987; Murphy 1999:280; Petersen 1997:124; Stokes 1998:63; Versteeg et al. 1993; Wilson 1989). Only eight of 60 Ceramic Age sites have been identified from the early Saladoid period on Antigua, further suggesting a later population expansion on the island (Murphy 1999:280). At Muddy Bay, population pressure may have intensified the exploitation of terrestrial fauna such as the Rice Rat, forcing the occupants to subsist heavily upon fauna such as shellfish from marginal habitats. Additionally, initial farming of inland sites during the Saladoid period on Antigua may have put a strain on the fertile inland river valleys, forcing populations to relocate to the coast. However, a number of terrestrial remains such as terrestrial crabs are present at the Muddy Bay site, implying that terrestrial animals were just as important to post-Saladoid occupants. It may also suggest that the occupants relied on fauna in close proximity to the site, which would entail the consumption of available terrestrial fauna, as well as marine fauna.

The innovations and intensification of subsistence technologies are for the most part similar at Royall's and Muddy Bay, based on the species represented. The only differences between the subsistence technologies of each site would have been the degree of usage of a particular technology for a specific animal. At Muddy Bay the use of traps and nets to capture reef dwelling fish appears to have intensified, and at Royall's the construction of traps and use of snares may have been the cause for the large number of rodent remains. Increased use of fishing technologies at Muddy Bay may have resulted from post-Saladoid human expansion – more individuals would require more implements for fishing. Many marine vertebrates may also suggest overexploitation, which does not necessarily mean an increase in population but perhaps an enhancement in fishing technology due to prolonged occupation and adaptive strategies to an island environment enabling the capture of large numbers of fish (Murphy 1999:281-282).

Cultural preferences for specific fauna at each site may have also been a factor for shaping the different subsistence economies at Royall's and Muddy Bay. As indicated previously, iconographic depictions of animals on ceramic vessels or as figurines indicate the importance certain fauna had in Amerindian society. The presence of a possible Rice Rat or Agouti adorno from Royall's exemplifies the importance this animal meant as a resource or for other ritualistic reasons (Figure 20). Ties to the mainland by trade or through cultural persistence may have still been strong throughout the Ceramic Age and is represented through the subsistence economies practiced on Antigua (Jones 1985:532). It is also plausible that prehistoric Antiguans may have intensified and diversified their diet because a particular food item might have been preferable during the post-Saladoid period when it was not during the Saladoid. Although, a simplistic reason Muddy Bay occupants may have preferred marine fauna over terrestrial fauna because they enjoyed eating mollusc and reef fish.

CHAPTER VI

CONCLUSIONS

The goals of this thesis were to determine whether the zooarchaeological assemblages exhibit changes in the degree and intensity of animal exploitation; changes in the resource base; and to identify the attributes that comprise and define a subsistence economy. All of these goals would determine whether the subsistence practices at Royall's and Muddy Bay were 'Tropical Forest' economies transplanted from the mainland, or arose from local adaptations to an insular environment. Some of these goals were achieved but discrepancies did arise from this research.

Some may argue that since Royall's and Muddy Bay are different temporally and spatially, comparisons between subsistence strategies would be difficult to ascertain. Ideally, if Royall's and Muddy Bay were multi-component sites I might have been able to make clearer interpretations as far as the differences and similarities were concerned. Nevertheless, zooarchaeological analysis of the Royall's and Muddy Bay sites has provided information for reconstructing diet during the Ceramic Age on Antigua.

Based on the zooarchaeological evidence, both sites reveal that two different subsistence economies were present compared to each other and contemporaneous sites on Antigua. Although both sites were located in the limestone district, each had access to different resources. Terrestrial animal species such as rodents, crabs, reptile, and nesting birds, ample use of mollusc (especially gastropods) and minimal use of fish were clearly part of the food quest for the inland Royall's site during the Saladoid period, whereas at the coastal Muddy Bay site the procurement of molluscs, mainly bivalves, and reef fish during the post-Saladoid period was emphasized. Initial Saladoid settlements such as Royall's were inland, next to watercourses and springs, ideal for the production of agricultural or horticultural crops (Murphy 1999:309), which can be seen as a transplantation of a 'Tropical Forest' economy. However, the identified animals from Royall's also reflects the environment inhabited by the occupants suggesting an adaptation to local conditions. By the post-Saladoid period, settlements appeared more in coastal locations such as Muddy Bay, and could be described as seafront villages with subsistence economies that were marine oriented with agricultural practices (Murphy 1999:310). Although marine resources were heavily sought during this period terrestrial species were also incorporated into subsistence strategies as can be seen with terrestrial fauna such as land crabs and rodents at Muddy Bay. Post-Saladoid inhabitants maintained a somewhat modified Saladoid subsistence economy, but adapted readily to the marine setting with a gradual expansion of the resource base. This suggests that an adaptation to local conditions did occur. Nonetheless, the culmination of environmental variability, cultural preference, population pressure, technological innovations, the introduction of new species along with site location are but a few factors that may have been responsible for determining the diets at Royall's and Muddy Bay.

In addition, the diet of prehistoric Antiguans will not be fully understood until further archaeobotanical and isotopic bone analysis of humans is accomplished. Additionally, large-scale excavations of areas with potential social significance, such as burials, houses, village site, or caches should be emphasized on Antigua and in the Caribbean. With this form of excavation large amounts of data could be gathered so that zooarchaeological data could be used to answer questions of a social significance. Consequently, forthcoming isotopic analysis of skeletal remains from Muddy Bay and Royall's in the fall of 2000 by Tamara Varney (University of Calgary, Ph.d. candidate) will provide more information concerning the subsistence practices of the occupants, expanding upon my research. In conclusion, the zooarchaeological research I conducted at Royall's and Muddy Bay has helped understand the Ceramic Age subsistence economies of Antigua, and future investigations in this research area will provide new insights into the dietary practices of prehistoric Antiguans.

REFERENCES CITED

Alegría, R. E.

1983 *Ball Courts and Ceremonial Plazas in the West Indies*. Yale University Publications in Anthropology No. 79. New Haven.

1997 The Study of Aboriginal Peoples Multiple Ways of Knowing. In *The Indigenous People of the Caribbean*, edited by S. M. Wilson p.11-19. University of Florida Press, Gainesville.

Allaire, L.

1987 Some Comments on the Ethnic Identity of the Taíno-Carib Frontier. In *Ethnicity and Culture*, edited by R. Auger, M.F. Glass, S. MacEachern and P.H. McCartney, pp. 127-133. Archaeological Association, University of Calgary, Calgary.

1997 The Lesser Antilles Before Columbus. In *The Indigenous People of the Caribbean*, edited by S. M. Wilson, pp. 20-28. University of Florida Press, Gainesville.

Ambrose, S.H., and L.C. Norr

1993 Experimental Evidence for the Relationship of the Carbon Isotope Ratios of Whole Diet and Dietary Protein to those of Bone Collagen and Carbonate. In *Prehistoric Human Bone: Archaeology at the Molecular Level*, edited by J. B. Lambert and G. Grupe, pp. 1-37. Springer-Verlag, New York..

Armstrong, D.V.

1980 Shellfish Gatherers of St. Kitts A Study of Archaic Subsistence Patterns. In *Proceedings of the Eighth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*, edited by S.M. Lewenstein, pp. 152-167. Arizona State University, Anthropological Research Papers No. 22. Tempe.

Arrom, J.J.

1975 *Mitología y Artes Prehispánicas de las Antilas*. Siglo XXI, Mexico.

Barlow, V.

1993. *The Nature of the Islands*. Cruising Guide Publications, Dunedin.

Bartone, R.N., and A.H. Versteeg

1997 The Tanki Flip Features and Structures. In *The Archaeology of Aruba: The Tanki Flip Site*, edited by A.H. Versteeg and S. Rostain, pp. 331-346. Publications of the Archaeological Museum of Aruba No. 8. Oranjestad, Aruba; and the Foundation for Scientific Research in the Caribbean Region, Publication No. 141, Amsterdam.

Binford, L. R.

1993 *Nunamiut Ethnoarchaeology*. Academic Press, New York.

1981 *Bones: Ancient Men and Modern Myths*. Academic Press, New York.

Bond, J.
1985 *Birds of the West Indies*. Houghton Mifflin Co., Boston.

Bourne, E.G.
1907 Columbus, Ramón Pané, and the Beginnings of American Anthropology. *Proceedings of the American Antiquarian Society* 17:310-48.

Brewer, D.J.
1992 Zooarchaeology: Method, Theory, and Goals. *Archaeological Method and Theory*, Vol. 4:195-244.

Bruhns, K.O.
1994 *Ancient South America*. Cambridge University Press, New York.

Carbone, V.A.
1980 Some Problems in Cultural Paleoecology in the Caribbean Area. In *Proceedings of the Eighth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*, edited by S.M. Lewenstein, pp. 98-126. Arizona State University, Anthropological Research Papers No. 22. Tempe.

Casteel, R.W.
1972 Some Biases in the Recovery of Archaeological Faunal Remains. *Proceedings of the Prehistoric Society* 36:382-388.

Chanlatte Baik, L.A. and Y. M. Narganes Storde
1984 *Catálogo Arqueolgía de Vieques*. 2nd ed. Río Pedras: Centro de Investigaciones Arqueológicas, Universidad de Puerto Rico.

1989 "La Nueva Arqueología de Puerto Rico (su Proyección en las Antilas)." *Boletín Museo del Hombre Dominicano* 22: 9-49.

Chaplin, R.E.
1971 *The Study of Animal Bones from Archaeological Sites*. Seminar Press, New York.

Charter, C.F.
1937 *Soil Survey of Antigua and Barbuda*. Crown Agents, London.

Claassen, C.
1998 *Shells*. Cambridge University Press, New York.

Cook, N, D.
1998 *Born to Die: Disease and New World Conquest, 1492-1650*. Cambridge University Press, Cambridge.

Cope, E.D.
1869 Synopsis of the Extinct Mammalia of the Cave Formations in the United States, with Observations on Some Myriapoda Found in and Near the Same, and on Some Extinct Mammals of the Caves of Anguilla, W.I., and of Other Localities. *Proceedings of the American Philosophical Society* 11:171-192.

1883 On the Contexts of a Bone Cave in the Island of Anguilla (West Indies). *Smithsonian Contributions to Knowledge* 25(2): 1-30.

Crabtree, P.J.

1990 Zooarchaeology and Complex Societies: Some Uses of Faunal Analysis for the Study of Trade, Social Status, and Ethnicity. *Archaeological Method and Theory*, 2:155-206.

Crock, J.G., J.B. Petersen, and N. Douglas

1994 Preceramic Anguilla: A View from the Whitehead's Bluff Site. In *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*, edited by R. E. Alegría and M. Rodríguez, pp. 283-292. Centro de Estudios Avanzados Puerto Rico y el Caribe, San Juan.

Cruz D.M. and V.L. La Rose

1995 *Muddy Bay Site, PH-14: Final Faunal Report*. Manuscript on file at the Faunal Osteo-Archaeology Laboratory, University of Toronto, Toronto.

Cruxent, J.M., and I. R. Rouse

1969 Early Man in the West Indies. *Scientific American* 221(5): 42-52.

Cunningham, R.L.

1997 The Biological Impacts of 1492. In *The Indigenous People of the Caribbean*, edited by S. M. Wilson, pp. 29-35. University of Florida Press, Gainesville.

Curet, L.A.

1992 House Structure and Cultural Change in the Caribbean: Three Case Studies from Puerto Rico. *Latin American Antiquity* 3: 160-174.

1997 The Chief is Dead, Long Live...Who? Descent and Succession in The Protohistoric Chiefdoms of the Greater Antilles. Paper presented at the *63rd Annual Meeting of the Society for American Archaeology*. Seattle.

Dacal Moure, R.

1997 The Recurrent Forms in Tanki Flip. In *The Archaeology of Aruba: The Tanki Flip Site*, edited by A.H. Versteeg and S. Rostain, pp. 159-188. Publications of the Archaeological Museum of Aruba No. 8, Oranjestad, Aruba, and the Foundation for Scientific Research in the Caribbean Region, Publication No. 141, Amsterdam.

Dacal Moure, R., and M.R. De La Calle

1996 *Art and Archaeology of Pre-Columbian Cuba*, edited by D.H. Sandweiss and D.R. Watters. University of Pittsburgh Press, Pittsburgh.

Davis, D.D.

1982 Archaic Settlement and Resource Exploitation in the Lesser Antilles: Preliminary Information from Antigua. *Caribbean Journal of Science* 17(1-4): 107-22.

1988a Calibration of the Ceramic Period Chronology for Antigua, West Indies. *Southeastern Archaeology* 7(1): 52-60.

1988b Coastal Biogeography and Human Subsistence: Examples from the West Indies. *Archaeology of Eastern North America* 16: 177-185.

2000 *Jolly Beach and the Preceramic Occupation of Antigua, West Indies.* Yale University Publications in Anthropology No. 84, Department of Anthropology, Yale University, Division of Anthropology, Peabody Museum of Natural History, New Haven.

Deagan, K.A.

1987 Initial Encounters: Arawak Responses to European Contact at the En Bas Saline Site, Haiti. In *Proceedings, First San Salvador Conference: Columbus and His World*, edited by D.T. Gerace, pp. 341-359. Bahamian Field Station, San Salvador, Bahamas.

1996 Environmental Archaeology and Historical Archaeology. In *Case Studies in Environmental Archaeology*, edited by E.J. Reitz, L.A. Newsom, and S.J. Scudder, pp. 359-376. Plenum Press, New York.

DeFrance, S.D.

1988 *Zooarchaeological Investigations of Subsistence Strategies at the Maisabel Site, Puerto Rico.* M.A. thesis, Department of Anthropology. University of Florida, Gainesville.

1989 Saladoid and Ostionoid Subsistence Adaptations: Zooarchaeological Data from a Coastal Occupation on Puerto Rico. In *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*, edited. P.E. Siegel, pp. 57-78. BAR International Series 506, Oxford.

DeFrance, S.D., W.F. Keegan, and L.A. Newsom

1996 The Archaeobotanical, Bone Isotope, and Zooarchaeological Records From Caribbean Sites in Comparative Perspective. In *Case Studies in Environmental Archaeology*, edited by E.J. Reitz, L.A. Newsom, and S.J. Scudder, pp. 289-304. Plenum Press, New York.

Driver, J.C.

1996 Social Complexity and Hunting Systems in Southwestern Colorado. In *Debating Complexity*, edited by D.A. Meyer, P.C. Dawson, and D.T. Hanna, pp. 364-374. Archaeological Association of the University of Calgary, Calgary.

Dukes, J.A., and E.J. Reitz

1994 Use of Vertebrate Resources at Trants, a Saladoid Site on Montserrat. *Proceedings of the Fifteenth International Congress of Caribbean Archaeology*, edited by R. E. Alegría and M. Rodríguez, pp. 201-208. Centro de Estudios Avanzados Puerto Rico y el Caribe, San Juan.

Figueredo, A.E.

1978 Prehistoric Ethnozoology of the Virgin Islands. In *Proceedings of the Seventh International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*, edited by J. Benoist and F. M. Mayer, pp. 39-46. Université de Montréal. 46, Centre de Recherches Caraïbes, Université de Montréal, Montréal.

Fuess, M.T.

1993 Preliminary Archaeological Research of Prehistoric Amerindian Sites on Antigua, Northern Lesser Antilles. In *Proceedings of the Fifteenth*

International Congress for Caribbean Archaeology, edited by R. E. Alegría and M. Rodríguez, pp. 1-8. San Juan, Puerto Rico.

Goodwin, R.C.

1979 *The Prehistoric Cultural Ecology of St. Kitts, West Indies: A Case Study in Island Archaeology*. Ph.d. dissertation, Department of Anthropology, Arizona State University, Tempe.

1980 Demographic Change and the Crab-Shell Dichotomy. In *Proceedings of the Eighth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*, edited by S.M. Lewenstein, pp. 45-68. Arizona State University, Anthropological Research Papers No. 22. Tempe.

1987 Archaeomalacology on A Small West Indian Island. In *Coasts, Plains and Deserts: Essays in Honour of Reynold J. Ruppe*, edited by S.W. Gaines, pp. 71-86. Arizona State University Anthropological Papers, no. 38. Tempe.

Grayson, D.K.

1973 On the Methodology of Faunal Analysis. *American Antiquity* 38:432-439.

1979 On the Quantification of Vertebrate Archaeofaunas. In Advances in Archaeological Method and Theory, vol. 2, edited by M.B. Schiffer, pp. 199-237. Academic Press, New York.

1984 *Quantitative Zooarchaeology: topics in the analysis of archaeological faunas*. Academic Press, Orlando.

Grouard, S.

1997 Tanki Flip Faunal Remains. In *The Archaeology of Aruba: The Tanki Flip Site*, edited by A.H. Versteeg and S. Rostain, pp. 257-264. Publications of the Archaeological Museum of Aruba No. 8, Oranjestad, Aruba, and the Foundation for Scientific Research in the Caribbean Region, Publication No. 141, Amsterdam.

Gullick, M.I.

1980 Changing Carib Cookery. *Proceedings of the Eighth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*, edited by S.M. Lewenstein pp. 481-487. Arizona State University, Anthropological Research Papers No. 22. Tempe.

Haviser, J.B.

1991 Preliminary Results from Test Excavations at the Hope Estate Site (SM-026), St. Martin. In *Proceedings of the Thirteenth Congress of the International Association for Caribbean Archaeology*, edited by E. N. Ayubi and J. B. Haviser, pp. 647-66. Anthropological Institute of the Netherlands Antilles, Curaçao.

1997 Settlement Strategies in the Early Ceramic Age. In *The Indigenous People of the Caribbean*, edited by S. M. Wilson, pp. 118-130. University of Florida Press, Gainesville.

Harris, D.R.

1965 *Plants Animals and Man in the Outer Leeward Islands, West Indies: An Ecological Study of Antigua, Barbuda and Anguilla.* University of California Publication in Geography, No. 18. Berkeley.

Hayden, B.

1992 Models of Domestication. In *Transitions to Agriculture in Prehistory*, edited by 1A.B. Gebauer and T.D. Price, Monographs in World Archaeology No. 4., pp. 11-19. Prehistory Press, Madison.

Healy, P.F. and A.R. Murphy

1995 Excavations at the Muddy Bay (Ph-14) Site, Antigua, West Indies: Preliminary Report on the 1994 Investigations. In *Proceedings of the Sixteenth International Congress for Caribbean Archaeology*, pp. 287-299. Basse-Terre, Guadeloupe.

Healy, P. F., A.R. Murphy, and D.M. Cruz

1999 Excavations at the Royall's Site (JO-11) Antigua: An Inland Saladoid Settlement. Paper in press for the *Proceedings of the Seventeenth International Congress for Caribbean Archaeology*, in press. Grenada.

2000 Preliminary Investigations of the Royall's Site, Antigua, W.I. Paper presented at the *65th Annual Meeting of the Society of American Archaeology*, Philadelphia.

Hedges, S.B.

1996 Historical Biogeography of West Indian Vertebrates. *Annual Review of Ecological Systems* 27:163-196.

Hemphill, A.

1993 *Ecology of Lesser Antillean Rainforests and Comparison Through Quadrat Sampling of Forest Types on the Island of Antigua.* A senior research project, Palm Beach Atlantic College, Palm Beach.

Hockett, B.S.

1998 Sociopolitical Meaning of Faunal Remains From Baker Village. *American Antiquity* 63 (2):289-302.

Hoffman, C.A.

1963 *Archaeological investigations on Antigua, West Indies.* Unpublished M.A. Thesis, Department of Anthropology, University of Florida, Gainesville.

Hofman, C.L.

1993 *In Search of the Native Population of Pre-Columbian Saba (400-1450 A.D.). Part One. Pottery Styles and Their Interpretations.* Ph.d., Leiden University.

Hoogland, M.L.P

1996 *In Search of the Native Population of Pre-Columbian Saba (400-1450 A.D.). Part Two. Settlements in their natural and social environment. Ph.D.* Dissertation, Leiden University, Leiden.

James, S.R.

1997 Methodological Issues Concerning Screen Size Recovery Rates and their Effects on Archaeofaunal Interpretations. *Journal of Archaeological Science* 24:385-397.

Jones, A.R.

1980 Animal Food and Human Population at Indian Creek, Antigua. In *Proceedings of the Eight International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*, edited by S.M. Lewenstein, pp. 264-273. Arizona State University, Anthropological Research Papers No. 22. Tempe.

1985 Dietary Change and Human Population at Indian Creek, Antigua. *American Antiquity* 50:518-536.

1989 The Dating of Excavation Levels Using Animal Remains. In *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*, edited. P.E. Siegel, pp. 147-168. BAR International Series 506, Oxford.

Keegan, W.F.

1982 A Biological Introduction to the Prehistoric Procurement of the Strombus Gigas. *The Florida Anthropologist* 35 (2): 76-88.

1985 *Dynamic Horticulturalists: Population Expansion in the Prehistoric Bahamas*. Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.

1989 Transition from a Terrestrial to a Maritime Economy: A New View of the Crab/Shell Dichotomy. In *Early Ceramic Population Lifeways and Adaptive Strategies In the Caribbean*, edited. P.E. Siegel, pp. 119-128. BAR International Series 506, Oxford.

1992 *The People Who Discovered Columbus: The Prehistory of the Bahamas*. University Press of Florida, Gainesville.

1994 West Indian Archaeology. 1. Overview and Foragers. *Journal of Archaeological Research* 2 (3): 255-284.

1995 Modeling Dispersal in the Prehistoric West Indies. *World Archaeology*, 26: 400-420.

1996 West Indian Archaeology. 2. After Columbus. *Journal of Archaeological Research* 4 (4): 265-294

1997 "No Man [or Woman] Is an Island": Elements of Taíno Social Organization. In *The Indigenous People of the Caribbean*, edited by S. M. Wilson, pp. 109-117. University of Florida Press, Gainesville.

Keegan, W.F., and M.J. DeNiro

1988 Stable Carbon and Nitrogeon-Isotope Ratios of Bone Collagen Used to Study Coral-Reef and Terrestrial Components of Prehistoric Bahamian Diet. *American Antiquity* 53:320-336.

Keegan, W.F., and J.M. Diamond
1987 Colonization of Islands: A Biogeographical Perspective. *Advances in Archaeological Method and Theory*, Vol. 10:49-92.

Keegan, W.F., M. MacLachlan, and B. Byrne
1998 Social Foundations of Taino Caciques. In *Chiefdoms and Chieftancy in the Americas*, edited by E. M. Redmond, pp. 217-244 University Press of Florida, Gainesville.

Klein, R. G. and K. Cruz-Uribe,
1984 *The Analysis of Animal Bones from Archeological Sites*. University of Chicago Press, Chicago.

Klift, H.V.
1992 Faunal Remains of Golden Rock. In *The Archaeology of St. Eustatius: The Golden Rock Site*, edited by A.H. Versteeg and K. Schinkel, pp. 74-83. Foundation for the Scientific Research in the Caribbean Region No. 131, Amsterdam.

Klinken, G.J. van
1991 *Dating and Dietary Reconstruction by Isotopic Analysis of Amino Acids in Fossil Bone Collagen - With Special Reference to the Caribbean.* Publications Foundation for Scientific Research in the Caribbean Region, Amsterdam.

Kozlowski, J.K.
1974 *Preceramic Cultures in the Caribbean*. Prace Archeologienze 20. Uniwersyletu Jagielownkiego, Warsaw.
1980 In Search of the Evolutionary Pattern of the Preceramic Cultures of the Caribbean. *Boletín del Museo del Hombre Dominicano* 9(13): 61-79.

Krebs, J.R.
1989 *Ecological Methodology*. Harper and Row, New York.

Las Casas, B de.
1951 *Historia de las Indias*. 3 vols. Edited by A.M. Carlos. Fondo de Cultura Económica, Mexico.

Lathrap, D.W.
1970 *The Upper Amazon*. Thames and Hudson, London.

Leach, B.F.
1986. A method for analysis of Pacific island fishbone assemblages and an associated database management system. *Journal of Archaeological Science* 13(2):147-159.

Leach, B.F. and J.M Davidson
1977. Fishing methods and seasonality at Paremata (N160/50). *New Zealand Archaeological Association Newsletter* 20(3):166-175.

Levin, S.
1983 Food Production and Population Size in the Lesser Antilles. *Human Ecology* 11(3):321-338.

Little E.C. Jr., and F. Wadsworth

1964 *Common Trees of Puerto Rico and the Virgin Islands.* USDA Agricultural Handbook No. 249, Washington, D.C.

Linares, O.

1976 "Garden Hunting" in the American Tropics. *Human Ecology* 4(4) 331-349.

Loveless, A.R.

1960 The Vegetation of Antigua, West Indies. *Journal of Ecology* 48: 495-527.

Lovén, S.

1935 *Origin of the Tainan Culture, West Indies.* Elanders Bokfryckeri Akfiebolag, Goteberg.

Lundberg, E.

1989 *Preceramic Procurement Patterns at Krum Bay, Virgin Islands.* Ph.D. dissertation, Department of Anthropology, University of Illinois, Urbana.

Lyman, R.L.

1994 *Vertebrate Taphonomy.* Cambridge University Press, New York.

Martin-Kaye, P.H.A.

1959 *Reports on the Geology of the Leeward and British Virgin Islands.* Government Report. Voice Publishing Co., Ltd., St. Lucia.

Martyr D'Anghera, P.

1970 *De Orbe Novo: The Eight Decades of Peter Martyr D'Anghera.* Translated by Francis Augustus MacNutt. Burt Franklin, New York.

Morgan, G.S. and C.A. Woods

1986 Extinction and the Zoogeography of West Indian Land Mammals. *Biological Journal of the Linnean Society* 28:167-203.

Morse, B.F.

1989 Saladoid Remains and Adaptive Strategies in St. Croix, Virgin Islands. In *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*, edited. P.E. Siegel, pp. 29-42. BAR International Series 506, Oxford.

Multer, H.G., M.P. Weiss, and D.V. Nicholson

1986 *Antigua: Reefs, Rocks & Highroads of History.* Contribution Number 1-Leeward Islands Science Associates (L.I.S.A.), Antigua.

Murphy, A.R.

1996 *Archaeological Investigations at Muddy Bay (PH-14), Antigua, West Indies: A Post-Saladoid Settlement.* M. A. thesis, Department of Anthropology, Trent University, Peterborough.

1999 *The Prehistory of Antigua, Ceramic Age: Subsistence, Settlement, Culture and Adaptation Within an Insular Environment.* Ph.D. dissertation, Department of Archaeology, University of Calgary, Calgary.

Newsom, L.A.
1992 Wood Exploitation at Golden Rock. In *The Archaeology of St. Eustatius: The Golden Rock Site*, edited by A.H. Versteeg and K. Schinkel, pp. 213-227. Foundation for the Scientific Research in the Caribbean Region No. 131, Amsterdam.

1993 *Native West Indian Plant Use*. Ph.D. dissertation, Department of Anthropology, University of Florida, Gainesville.

Nicholson, D.V.
1976 The Importance of Sea Levels – Caribbean Archaeology. *Journal of Virgin Islands Archaeological Society* 3: 19-23.
1992 *The Archaeology of Antigua and Barbuda*. Museum of Antigua and Barbuda, St. John's, Antigua.

Nunn. P.D.
1994 *Oceanic Islands*. Blackwell, Cambridge.

Olson. S.L.
1982 Biological Archaeology in the West Indies. *The Florida Anthropologist* 35 (4):162-168.

Ortiz, F.
1935 Historia de la Arquéologia Indocubana. In *Cuba antes de Colón*, edited by M. Harrington, Vol. 2, pp. 13-457. Colección de Libros Cubanos 33, Cultural, Havana.

Ortiz Aguilu, J.J., J. Rivers Melendez, A. Principe Jacome, M. Melendez Maiz and M. Lavergne Colberg
1991 Intensive Agriculture in Pre-Columbian West Indies. The case for terraces. In *Proceedings of the Fourteenth International Congress of Caribbean Archaeology*, edited by A. Cummins and P. King, pp. 278-285. Barbados Museum and Historical Society, St. Ann's Garrison.

Osgood, C.
1946 *British Guiana Archaeology to 1945*. Yale University Publications in Anthropology 36, New Haven.

Oviedo y Valdes, G. F de.
1959 *Historia General y Natural de Las Indias*. 4 Vols. Imprenta de la Real Academia de la Historia, Madrid.

Payne, S.B.
1972 On the interpretations of bone samples from archaeological sites. In *Papers in Economic Prehistory*, edited by E.S. Higgs, pp. 65-81, Cambridge University Press, Cambridge.

Pendergast, D.M.
1997 Up from the Shallows. In *Rotunda*. 30 (3):28-35.

Perkins D. Jr. and P. Daly
1968 A hunter's village in Neolithic Turkey. *Scientific American* 219 (5):96-106.

Petersen, J.B.
1997 Taíno, Island Carib, and Prehistoric Amerindian Economies in the West Indies. In *The Indigenous People of the Caribbean*, edited by S. M. Wilson, pp. 118-130. University of Florida Press, Gainesville.

Petersen, J.B. and D.R. Watters
1991 Amerindian Ceramic Remains from Fountain Cavern, Anguilla, West Indies. *Annals of Carnegie Museum* 60 (4):321-357.

Pinsky, V.
1989 Introduction: Historical foundations. In *Archaeological Thought in America*, edited by C.C. Lamberg-Karlovsky, pp. 19-34. Cambridge University Press, New York.

Pregill, G.K., D.W. Steadman, and D.R. Watters
1994 Late Quaternary Vertebrate Faunas of the Lesser Antilles: Historical Components of Caribbean Biogeography. *Bulletin of Carnegie Museum of Natural History* 30 (8):1-51.

Randall, J.E.
1983 *Caribbean Reef Fishes*. T.F.H. Publications, Inc. New Jersey.

Rainey, F.G.
1940 Porto Rican Archaeology. In *Scientific Survey of Porto Rico and the Virgin Islands*. vol. 18 (1), New York Academy of Sciences, New York.

Record, S.J. and R.W. Hess
1943 *Timbers of the New World*. Yale University Press, New Haven.

Reitz, E.J.
1986 Vertebrate Fauna from Locus 39, Puerto Real, Haiti. *Journal of Field Archaeology* 13(3): 317-328.

1994 Archaeology of Trants, Montserrat. Part 2. Vertebrate Fauna. *Annals of Carnegie Museum* Vol. 63(4): 297-317.

Reitz, E.J. and E.S. Wing,
1999 *Zooarchaeology*. Cambridge University Press, New York.

Rodríguez, M.
1997 Religious Beliefs of the Saladoid People. In *The Indigenous People of the Caribbean*, edited by S. M. Wilson, pp. 80-87. University of Florida Press, Gainesville.

Roe, P. G.
1994 Eternal Companions: Amerindian Dogs From Tierra Firme to the Antilles. *Proceedings of the Fifteenth International Congress of Caribbean Archaeology*, edited by R. E. Alegría and M. Rodríguez, pp. 155-172. Centro de Estudios Avanzados Puerto Rico y el Caribe, San Juan

Roosevelt, A.C.
1980 *Parmana: Prehistoric Subsistence Maize and Manioc Subsistence along the Amazon and Orinoco*. Academic Press, New York.

Rostain, S.R.
1997 Tanki Flip Coral Material. In *The Archaeology of Aruba: The Tanki Flip Site*, edited by A.H. Versteeg and S. Rostain, pp. 251-256. Publications of the Archaeological Museum of Aruba No. 8, Oranjestad, Aruba; and the Foundation for Scientific Research in the Caribbean Region, Publication No. 141, Amsterdam.

Rostain, S.R., and A.H. Versteeg
1997 Special Features, Spatial Patterns and Symbolism at Tanki Flip. In *The Archaeology of Aruba: The Tanki Flip Site*, edited by A.H. Versteeg and S. Rostain, pp. 331-346. Publications of the Archaeological Museum of Aruba No. 8, Oranjestad, Aruba; and the Foundation for Scientific Research in the Caribbean Region, Publication No. 141, Amsterdam.

Rote. D.J.
1991 *Shellfish Gatherers of Nonsuch Bay, A Case Study in Subsistence Strategies*. M.A. thesis, Department of Anthropology, Tulane University, New Orleans.

Rouse, I.
1939 *Prehistory in Haiti: A Study in Method.* Yale University Publications in Anthropology, no. 21, New Haven.

1941 *Culture of the Ft. Liberté Region, Haiti.* Yale University Publications in Anthropology, No. 24, New Haven.

1948 The Arawak. In *Handbook of South American Indians*, edited by J.H. Steward, Vol. 4: 507-546. Bureau of American Ethnology No. 143. Smithsonian Institution, Washington, D.C.

1952 *Porto Rican Prehistory*. Academy of Sciences, Scientific Survey of Porto Rico and the Virgin Islands, vol. 18 (3, 4), New York.

1974 The Indian Creek Excavations. *Proceedings of the Fifth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*, edited by R.P. Bullen, pp. 166-176. Gainesville, Florida.

1976 The Saladoid Sequence on Antigua and Its Aftermath. In *Proceedings of the Sixth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*, edited by R.P. Bullen, pp. 35-41. Gainesville, Florida.

1986 *Migrations in Prehistory: Inferring Population Movements from Cultural Remains*. Yale University Press, New Haven.

1992 *The Tainos: Rise and Decline of the People Who Greeted Columbus*. Yale University Press, New Haven.

In Press *History of Archaeology in the Caribbean Area*. Prepared for the History of Archaeology: An Encyclopedia, edited by T. Murray, Garland Publishing Inc., New Haven.

Rouse, I. and R.E. Alegría
1990 *Excavations at Maria de la Cruz Cave and Hacienda Grande Village Site Loiza Puerto Rico*. Yale University Publications in Anthropology No. 80.

Department of Anthropology, Yale University, Division of Anthropology, Peabody Museum of Natural History, New Haven.

Rouse, I. and L. Allaire
1978 Caribbean. In *Chronologies in New World Archaeology*, edited by R. E. Taylor and C.W. Meighan, pp. 431-81. Academic Press, New York

Rouse, I. and B.F. Morse
1999 *Excavations at the Indian Creek Site, Antigua, West Indies*. Yale University Publications in Anthropology No. 82, Department of Anthropology, Yale University, Division of Anthropology, Peabody Museum of Natural History, New Haven.

Ryan, K., and P.J. Crabtree (editor)
1995 *The Symbolic Role of Animals in Archaeology*. MASCA, vol. 12, Museum of Archaeology and Anthropology University of Pennsylvania, Philadelphia.

Sauer, C.O.
1966 *The Early Spanish Main*. University of California Press, Berkeley.

Schinkel, K.
1992 The Golden Rock Features. In *The Archaeology of St. Eustatius: The Golden Rock Site*, edited by A.H. Versteeg and K. Schinkel, pp. 143-212. Foundation for the Scientific Research in the Caribbean Region No. 131, Amsterdam.

Schmitt D. N. and K.D. Lupo
1995 On Mammalian Taphonomy, Taxonomic Diversity, and Measuring Subsistence Data in Zooarchaeology. *American Archaeology* 60 (3):496-514.

Schwartz, A. and R. W. Henderson
1991 *Amphibians and Reptiles of the West Indies*. University Press of Florida, Gainesville.

Serrand, N.
1997 Tanki Flip Shell Artefacts With A Relatively High Level of Modification. In *The Archaeology of Aruba: The Tanki Flip Site*, edited by A.H. Versteeg and S. Rostain, pp. 189-217. Publications of the Archaeological Museum of Aruba No. 8, Oranjestad, Aruba, and the Foundation for Scientific Research in the Caribbean Region, Publication No. 141, Amsterdam.

Siegel, P.E.
1991 Migration Research in Saladoid Archaeology: A Review. *The Florida Anthropologist* 44 (1): 79-91.

1992 *Ideology, Power, and Social Complexity in Prehistoric Puerto Rico*. Ph.D. dissertation, Department of Anthropology, State University of New York, Binghamton.

1996 An Interview with Irving Rouse. *Current Anthropology* 37 (4): 671-689.

Steadman, D.W., G.K. Pregill, and S.L. Olson
1984*a* Fossil Vertebrates from Antigua, Lesser Antilles: Evidence for Late Holocene Human-caused Extinctions in the West Indies. *Proceedings of the National Academy of Sciences* 81: 4448-4451.

Steadman, D.W., D.R. Watters, E.J. Reitz, and G.K. Pregill
1984*b* Vertebrates from Archaeological Sites on Montserrat, West Indies. *Annals of Carnegie Museum of Natural History* 53: 1-30.

Stein, J.
1992 Interpreting Stratification of a Shell Midden. In *Deciphering a Shell Midden*, edited by J. Stein, pp. 71-94. Academic Press, San Diego.

Steward, J.H.
1955 *Theory of Cultural Change: the Methodology of Multilinear Evolution.* University of Illinois Press, Urbana.

Stokes, A.V.
1991 *A Settlement Survey of Nonsuch Bay: Implications for Prehistoric Subsistence in the Caribbean.* M.A., thesis, Department of Anthropology, University of Florida, Gainesville.

1994 Understanding Prehistoric Subsistence in the West Indies Using Stable Isotope Analysis. In *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*, edited by R. E. Alegría and M. Rodríguez, pp. 191-200. Centro de Estudios Avanzados Puerto Rico y el Caribe, San Juan.

1998 *A Biogeographic Survey of Prehistoric Human Diet in the West Indies Using Stable Isotopes.* Ph.D. dissertation, Department of Anthropology University of Florida, Gainesville.

Stokes, A.V., and W.F. Keegan
1994 Stable Isotopes versus Environmental Archaeology in Reconstructing West Indian Diets, paper presented at the *59th Annual Meeting of the Society for American Archaeology*, Anaheim, California.

Taylor, W.W.
1948 A Study of archeology. Memoirs of the American Anthropological Association 69, Washington, DC.

Thomas, D.H.
1969 Great Basin Hunting Patterns: A Quantitative Method for Treating Faunal Remains. *American Antiquity* 34:393-401.

Trigger, B.G.
1989 *A History of Archaeological Thought*.. Cambridge University Press, New York.

Varner, J.G., and J.J. Varner
1983 *Dogs of the Conquest.* University of Oklahoma Press, Norman.

Veloz Maggiolo, M., and E. Ortega
1976 The Preceramic of the Dominican Republic: Some New Finds and their Possible Relationships. In *Proceedings of the First Puerto Rican Symposium in Archaeology*, edited by L.S. Robinson, pp. 147-201.

Fundación Arqueológica, Anthropológica e Histórica de Puerto Rico, San Juan.

Veloz Maggiolo, M., and B. Vega
1982 The Antillean Preceramic: A New Approximation. *Journal of New World Archaeology* 5:33-44.

Versteeg, A.H.
1987 Report of a Visit to Nonsuch Bay Pre-Columbian Sites, PH-11, PH-14, and PH-18, on 10 January 1987. Report submitted to Museum of Antigua, West Indies.

1991 A Preceramic Burial Site at Malmok (Aruba). In *Proceedings of the Thirteenth International Congress for Caribbean Archaeology*, pp. 105-26. Archaeological-Anthropological Institute of the Netherlands Antilles, Willemstad.
1992 Golden Rock Coral. In *The Archaeology of St. Eustatius: The Golden Rock Site*, edited by A.H. Versteeg and K. Schinkel, pp. 119-138. Foundation for the Scientific Research in the Caribbean Region No. 131, Amsterdam.

Versteeg, A.H., and A.C. Ruiz
1995 *Reconstructing Brasilwood Island: The Archaeology and Landscape of Indian Aruba*. Publications of the Archaeological Museum Aruba 6, Oranjestad.

Versteeg, A.H., and K. Schinkel (editor)
1992 *The Archaeology of St. Eustatius: The Golden Rock Site*, Foundation for the Scientific Research in the Caribbean Region No. 131, Amsterdam.

Versteeg, A.H., K. Schinkel, and S.M. Wilson
1993 Large-scale excavations versus surveys: examples from Nevis, St. Eustatius and St. Kitts in the Northern Caribbean. *Analecta Praehistorica Leidensia* 26: 139-161.

Vescelius, G.
1980 A Cultural Taxonomy for West Indian Archaeology. *Journal of the Virgin Islands Archaeological Society* 10: 36-39.

Voss, G.L.
1980 *Seashore Life of Florida and the Caribbean*. Banyan Books, Inc, Miami.

Watters, D.R.
1980 *Transect Surveying and Prehistoric Site Locations on Barbuda and Montserrat, Leeward Islands, West Indies*. Ph.D. dissertation, Department of Anthropology, University of Pittsburgh, Pittsburgh.

1982 Relating Oceanography to Antillean Archaeology: Implications from Oceania. *Journal of New World Archaeology* 5(2):3-12.

1983 Assessing the Ocean's Roles in Antillean Prehistory. In *Proceedings of the Ninth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*, edited by L. Allaire, Centres de Recherche Caraïbes, pp. 531-542, Université de Montréal, Montréal.

1989 Archaeological Implications for Lesser Antilles Biogeography: The Small Island Perspective. In *Biogeography of the West Indies*, edited by C.A Woods, pp. 153-165. Sandhill Crane Press, Gainesville.

Watters, D.R., J. Donahue, and R. Stuckenrath
1992 Paleoshorelines and the Prehistory of Barbuda, West Indies. In *Paleoshorelines and Prehistory: An Investigation of Method*, edited by L.L. Johnson, pp. 15-51. CRC Press, Boca Raton.

Watters, D.R., and J.B. Petersen
1994 Spatial Analysis at Trants, Montserrat. In *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*, edited by R. E. Alegría and M. Rodríguez, pp. 15-26. Centro de Estudios Avanzados Puerto Rico y el Caribe, San Juan.

Watters, D.R., E.J. Reitz, D.W. Steadman, and G.K. Pregill
1984 Vertebrates from Archaeological Sites on Barbuda West Indies. *Annals of Carnegie Museum* 53 (13): 383-412.

Watters, D.R., and I. R. Rouse
1989 Environmental Diversity and Maritime Adaptations in the Caribbean Area. In *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*, edited P.E. Siegel, pp. 129-144. BAR International Series 506, Oxford.

Watkins, F.
1924 Handbook of the Leeward Islands. West India Committee, London.

Watts, D.
1987 *The West Indies: Patterns of Development, Culture and Environmental Change Since 1492*. Cambridge University Press, Cambridge.

Welch, P.D., and C.M. Scarry
1995 Status-Related Variation in Foodways in the Moundville Chiefdom. *American Antiquity* 60:397-419

White, T.E.
1952 Observations on the Butchering Techniques of Some Aboriginal People. *American Antiquity* 17 (4):337-338.

1953 A Method of Calculating the Dietary Percentage of Various Food Animals Utilized by Aboriginal Peoples. *American Antiquity* 18 (4): 396-398.

Willey, G.R., and J.A. Sabloff
1994 *A History of American Archaeology*. W.H. Freeman and Company, third edition, New York.

Wilson, S.M.
1989 The Prehistoric Settlement Patterns of Nevis, West Indies. *Journal of Field Archaeology* 16 (4) 427-450.

1990 *Hispaniola: Caribbean Chiefdoms in the Age of Columbus*. The University of Alabama Press, Tuscaloosa.

1993 Current Research: Caribbean. American Antiquity 58(1):151.

Wing, E. S.
1962 *Succession of Mammalian Faunas on Trinidad, West Indies.* Ph.D. dissertation, Department of Biology, University of Florida, Gainesville.

1989 Human Exploitation of Animal Resources in the Caribbean. In *Biogeography of the West Indies*, edited by C.A. Woods, pp. 137-152. Sandhill Crane Press, Gainesville.

1990 Animal Remains from the Hacienda Grande Site. In *Excavations at Maria De La Cruz Cave and Hacienda Grande Village Site*, edited by I. R. Rouse and R.E. Alegría, pp. 87-101. Yale University Publications in Anthropology No. 80, New Haven.

1993 The Realm Between Wild and Domestic. In *Skeletons in her Cupboard: Festschcrift for Juliet Clutton-Brock*, edited by A. Clason, S. Payne, and H. Uerpmann. Oxbow monograph 34, pp. 243-250, Oxford.

1994 Rice Rats and Saladoid People at Hope Estate. In *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*, edited by R. E. Alegría and M. Rodríguez, pp. 219-231. Centro de Estudios Avanzados Puerto Rico y el Caribe, San Juan.

1997 Land Crab Remains in Caribbean Sites. In *Proceedings of the Seventeenth International Congress for Caribbean Archaeology*, pp.105-112. Conseil Regional de la Guadeloupe Mission Archéologique et du Patrimoine, Guadeloupe.

1999 Animal Remains from the Indian Creek Site, Antigua. *Indian Creek*, edited by I. Rouse and B. Faber Morse, pp. 51-56. Yale University Publications in Anthropology No. 82, Department of Anthropology, Yale University, Division of Anthropology, Peabody Museum of Natural History, New Haven

Wing, E.S., C.A. Hoffman Jr., and C.E. Ray
1968 Vertebrate Remains from Indian Sites on Antigua, West Indies. *Caribbean Journal of Archaeological Science* 8 (3-4):123-129.

Wing, E.S., and E.J. Reitz
1982 Prehistoric Fishing Communities of the Caribbean. *Journal of New World Archaeology* 5: 13-32.

Wing, E.S., and S.J. Scudder
1980 Use of Animals by Prehistoric Inhabitants of St. Kitts, West Indies. In *Proceedings of the Eighth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*, edited by S.M. Lewenstein, pp. 237-245. Arizona State University, Anthropological Research papers No. 22, Tempe.

1983 Animal Exploitation by Prehistoric People Living on a Tropical Marine Edge. In *Animals and Archaeology: 2. Shell Middens, Fishes and Birds*, edited by C. Grigson and J. Clutton-Brock, pp. 197-210. BAR International Series 183. Oxford.

Wing, E.S., and C. Stover
1987 *Animal Remains from the Hacienda Site*. Ms. on File with senior author, Florida State Museum, Gainesville.

Wing, E.S., and S.R. Wing
1995 Prehistoric Ceramic Age Adaptation to Varying Diversity of Animal Resources Along the West Indian Archipelago. *Journal of Ethnobiology* 15 (1): 119-148.

In Press Overexploitation and Its Consequences on the Prehistoric Leeward and Virgin Islands. *Man and Animals in the Past: a Festschrift in Honor of A. T. Clason*. Edited by Hijlke Buitenhuis, pp. 1-22.

Woods, C.A.
1986 The Fossil and Recent Land Mammals of the West Indies: An Analysis of the Origin, Evolution, and Extinction of an Insular Fauna. *Biogeography of the West Indies*, edited by C.A. Woods, pp. 641-680. Sandhill Crane Press, Gainesville.

Woods, C.A. (editor)
1989 *Biogeography of the West Indies*. Sandhill Crane Press, Gainesville

Wylie, A.
1989 Introduction: socio-political context. In *Archaeological Thought in America*, edited by C.C. Lamberg-Karlovsky, pp. 93-95. Cambridge University Press, New York.

APPENDIX

Table A1. Species List of Identified Vertebrate and Invertebrate Fauna from Unit 4 Royall's (JO-11), Antigua

Scientific Name	Common Name	Habitat
Mammal (Woods 1989)		
Muridae		
Oryzomyine sp.	Rice Rat	extinct, terrestrial
Dasyproctidae		
Dasyprocta sp	Agouti	introduced, terrestrial
Canidae		
Canis familiaris	Dog	terrestrial
Bird (Bond 1985)		
Laridae sp.	Gull	coastal, inshore
Columbidae		
Columba squamosa	Red Necked pigeon	woodland and dry lowland
Columba sp.	Pigeons	woodland
Zenaidura sp.	Zenaida Dove	open lowlands
Strigidae		
Athene cf. *cunicularia*	Burrowing Owl	semi-open scrub-covered land
Reptile (Schwartz and Henderson 1991)		
Cheloniidae		
Chelonia myadas	Green Sea Turtle	marine (shore dweller during breeding season)
Iguanidae		
Iguana sp.	Iguana	terrestrial
Bony Fish (Randall 1983)		
Serranidae		
Epinephelus sp.	Grouper	reef carnivore
Carangidae		
Caranx hippos	Jackfish	inshore, offshore

Table A1 Continued.

Scientific Name	Common Name	Habitat
Lutjanidae		
Lutjanus sp.	Snapper	reef, estuarine, mangrove
Haemulidae		
Haemulon sp.	Grunt	reef carnivore
Labridae		
Halichoeres sp.	Wrasse	reef carnivore
Scaridae		
Scarus sp.	Parrotfish	reef herbivore
Sparisoma sp.	Parrotfish	reef herbivore
Sphyraenidae		
Sphyraena sp.	Barracuda	pelagic, reef, inshore
Acanthuridae		
Acanthurus sp.	Surgeonfish	reef herbivore
Tetraodontiformes		
Balistidae sp.	Triggerfish?	reef carnivore
Polyplacophora (Rote 1991)		
Chitonidae	Chiton	sublittoral, intertidal zone
Gastropod (Rote 1991)		
Trochidae		
Cittarium pica	West Indian Top Shell	sublittoral; reef, rocky bottom, intertidal zone
Muricidae		
Murex brevifrons	Short Frond Murex	sublittoral, mangrove roots
Phasianellidae		
Nerita sp.	Nerite	littoral, intertidal zone

Table A1 Continued.

Scientific Name	Common Name	Habitat
Nerita peloronta	Bleeding Tooth	sublittoral, shallow water attached to rocks
Olividae		
Oliva reticularis	Netted Olive Shell	sublittoral, sandy - muddy bottom
Strombidae		
Strombus gigas	Queen Conch	sublittoral, sandy - muddy bottom
Littorinidae		
Tectarius murictaus	Knobby Periwinkle	supralittoral, intertidal
Mytilidae		
Modiolus americanus	Tulip Mussel	sandy-muddy bottom
Cassis tuberosa	King Helmet	sublittoral, shallow water
Cymphoma gibbosum	Flamingo Tongue	sublittoral, shallow water
Cypraea sp.	Cowry Shell	sublittoral, sandy-muddy bottom
Turbinidae		
Astrea Coelata	Carved Star Shell	sublittoral
Arcidae		
Arca zebra	Turkey Wing	sublittoral, reef - rocky bottom
Donacidae		
Donax sp.	Coquina Shell	sublittoral, sand - beach, intertidal zone
Phacoides pectinata	Lucine Shell	sublittoral, deep waters

Table A1 Continued.

Scientific Name	Common Name	Habitat
Bivalve (Rote 1991)		
Pteriidae		
Pinctada radiata	Atlantic Pearl Oyster	sublittoral, reef - rocky bottom
Spondylus americanus	Atlantic Spiny Oyster	sublittoral, reef - rocky bottom
Crustacean (Voss 1980)		
Gecarcinidae		
Cardisoma guanhumi	Great Land Crab	littoral, mangrove zone, burrows
Xanthidae		
Menippe cf. *mercenaria*	Florida Stone Crab	sublittoral, littoral, burrows

Table A2. Species List of Identified Vertebrate and Invertebrate Fauna from Unit 4, Muddy Bay (PH-14), Antigua.

Scientific Name	**Common Name**	**Habitat**
Mammal (Woods 1989)		
Muridae		
Oryzomyine sp.	Rice Rat	extinct, terrestrial
Dasyproctidae		
Dasyprocta cf. *aguti*	Agouti	introduced, terrestrial
Bird (Bond 1985)		
Laridae sp.	Gull	coastal/inshore
Columbidae		
Columba squamosa	Red Necked pigeon	woodland and dry lowland
Columba sp.	Pigeons	woodland
Zenaidura sp.	Zenaida Dove	open lowlands
Strigidae sp.	Burrowing Owl??	semi-open scrub-covered land
Procellariidae		
Puffinus cf. *lherminieri*	Audubon's Shearwater	oceanic, nests in crevices
Reptile (Schwartz and Henderson 1991)		
Cheloniidae		
Chelonia myadas	Green Sea Turtle	marine (shore dweller during breeding season)
Iguanidae		
Iguana sp.	Iguana	terrestrial
Colubridae	Non-poisonous snake	terrestrial
Cartilaginous Fish		
Orectolobidae	Nurse shark?	reef

Table A2. Continued.

Scientific Name	Common Name	Habitat
Bony Fish (Randall 1983)		
Perciformes		
Holocentridae		
Holcentrus sp.	Squirrelfish	reef carnivore
Serranidae		
Epinephelus sp.	Grouper	reef carnivore, banks
Carangidae		
Caranx hippos	Jack fish	inshore/offshore
Lutjanidae		
Lutjanus sp.	Snapper	reef, estuarine, mangrove
Haemulidae		
Haemulon sp.	Grunt	reef carnivore
Labridae		
Halichoeres sp.	Wrasse	reef carnivore
Scaridae		
Scarus sp.	Parrotfish	reef herbivore
Sparisoma sp.	Parrotfish	reef herbivore
Sphyraenidae		
Sphyraena sp.	Barracuda	pelagic, reef, inshore
Acanthuridae		
Acanthurus sp.	Surgeonfish	reef herbivore
Tetraondontiformes		
Balistidae sp.	Triggerfish?	reef carnivore
Polyplacophora (Rote 1991)		
Chitonidae sp.	Chiton	sublittoral, intertidal zone

Table A2. Continued.

Scientific Name	Common Name	Habitat
Gastropod (Rote 1991)		
Acmaeidae		
Acmaea leucopleura	Cuban Limpet	supralittoral, intertidal zone attached to snail shells
Fissurellidae		
Fissurella nodosa	Knobby Keyhole Limpet	supralittoral, intertidal zone
Littorinidae		
Tectarius murictaus	Knobby Periwinkle	supralittoral, intertidal zone
Muricidae		
Murex brevifrons	Short Frond Murex	sublittoral, mangrove zone
Olividae		
Oliva sp.	Olive Shell	shallow water sublittoral, sandy, muddy bottom zone
Phasianellidae		
Nerita sp.	Nerite	littoral, intertidal zone attached to rocks
Strombidae		
Strombus gigas	Queen Conch	sublittoral, sandy, muddy bottom zone
Strombus pugilis	Fighting Conch	sublittoral,sandy, muddy bottom zone
Turbinidae		
Astrea brevspina	Long Spined Star Shell	sublittoral, shallow water
Trochidae		
Cittarium pica	West Indian Top Shell	sublittoral, reef - rocky bottom, intertidal zone

Table A2. Continued.

Scientific Name	Common Name	Habitat
Bivalve (Rote 1991)		
Arcidae		
Anadara braziliansis	Incongruous Ark	moderately shallow water
Anadara notabilis	Eared Ark	shallow water, grass and muddy bottom zone
Arca zebra	Turkey Wing	sublittoral, reef/rocky bottom zone
Calyptraeidae		
Crepidula sp.	Slipper Shell	shallow water
Chamidae		
Chama macerophylla	Jewel Box	sublittoral, moderately deep water
Donacidae		
Donax sp.	Coquina Shell	sublittoral, sand beach intertidal zone
Isognomonidae		
Isognomon alatus	Flat Tree Oyster	littoral, mangrove zone
Isognomon radiata	Oyster	littoral, mangrove zone
Lucinidae		
Codakia obicularis	Great White Lucine	moderately shallow water
Lucina pennsylvanica	Pennsylvania Lucine	shallow water
Mytilidae		
Brachidontes sp.	Mussel	moderately shallow water
Modiolus americanus	Tulip Mussel	moderately shallow water, sandy - muddy bottom zone

Table A2. Continued.

Scientific Name	Common Name	Habitat
Ostreidae		
Crassotrea rhizophorea	Caribbean Oyster	moderately shallow water
Ostrea frons	Coon Oyster	mangrove zone, submerged brush
Pteriidae		
Pinctada radiata	Atlantic Pearl Oyster	sublittoral, reef/rocky bottom zone
Crustacean (Voss 1980)		
Coenobitidae		
Coenobita clypeatus	Land Hermit Crab	terrestrial
Gecarcinidae		
Cardisoma guanhumi.	Great land Crab	littoral, mangrove zone, burrows
Majidae		
Mithrax spinossimus	Spiny Spider Crab	shallow water, rocks, rubble
Xanthidae		
Menippe cf. *mercenaria*	Florida Stone Crab	sublittoral, littoral, burrows