PROCEEDINGS
OF THE
FIFTH SYMPOSIUM
ON THE
NATURAL HISTORY OF THE BAHAMAS

Edited by
Lee B. Kass

Conference Organizer
Daniel R. Suchy

Bahamian Field Station, Ltd.
San Salvador, Bahamas
1994

Cover photo by
Sandra Buckner

Printed in USA by Don Heuer

ISBN 0-935909-52-4

PRELIMINARY REPORT ON A VERTEBRATE ASSEMBLAGE EXCAVATED FROM THE THREE D0G SITE, SAN SALVADOR, BAHAMAS

Mary Jane Berman, PhD
Department of Anthropology
P.O. Box 7807
Wake Forest University
Winston-Salem, North Carolina 27109

ABSTRACT

The role of animals in Lucayan diet and economy is a major focus of investigation at the Three Dog Site (SS21), an early Lucayan occupation on San Salvador Island, dating to the A.D. 800's. A vertebrate assemblage, consisting of 11 taxa of fish, 2 taxa of marine turtle, and 1 taxa of freshwater turtle were identified from a midden sample. Analysis of these remains informs us primarily on diet and procurement patterns and secondarily on butchering and discard practices. Comparisons with vertebrate assemblages from other Lucayan sites are made when possible.

INTRODUCTION

Animal remains from archaeological sites are meaningful to the delineation of prehistoric lifeways, the interpretation of adaptive patterns, and the reconstruction of past environments. The role of animals in the prehistoric diet and economy of the occupants of the Bahamas is an important concern and the faunal assemblages from a number of sites have been systematically studied (Wing, 1969, 1993; Wing and Reitz, 1982; Wing and Scudder, 1983). The expression of animals in a variety of media, suggesting their ideological, and possibly symbolic significance, has also been noted. At the Pigeon Creek Site, for example, Rose (1987) recovered an image of a parrotfish carved from limestone. At the Three Dog Site we have recovered a carved limestone pendant figurine in the shape of a porpoise or seal and a shell pendant figurine depicting a porpoise in adjacent units. Images of bats, scorpions, and other zoomorphic creatures figure prominently into the designs of locally-made and imported ceramics, while shell pendants resembling various kinds of animals have been recovered. At the Three Dog Site we have found shell pendants resembling an owl and a sting ray. Finally, the exploitation of fauna is an essential element of Keegan's (1992a) model of prehistoric colonization and settlement of the Bahamas archipelago.

The role of animals in the prehistoric diet and the economy of the Three Dog Site (SS21) is a major focus of investigation (Berman and Gnivecki, 1990, 1993a). Another primary goal of the research is to understand the nature of the faunal environment during the occupation of the site. The Three Dog Site is the earliest dated site thus far systematically excavated in the Bahamas and represents an early (if not the first) peopling of San Salvador (Berman and Gnivecki, 1993b). The identification of the faunal assemblage contributes toward the formulation of a baseline view of what fauna were present or introduced when the island was colonized.

This paper is confined to the vertebrate assemblage and treats the following concerns: 1) what vertebrate fauna did the site's inhabitants eat; 2) what habitats did they exploit; and 3) how was the vertebrate assemblage butchered and cooked? To this end issues of preservation were also investigated. The vertebrate fauna from later sites on San Salvador (Minnis Ward, Palmetto Grove, and Long Bay sites) have been identified (Wing, 1993). A long-term picture of Lucayan animal use, patterns of selection, food procurement strategies, and the character of the faunal environment during different time periods on San Salvador can begun to be drawn. It must be emphasized, however, that a more accurate picture includes the invertebrate assemblage.

THE THREE DOG SITE

The Three Dog Site is a coastal site located on Sugar Loaf Bay on the western side of San Salvador. It is approximately 50 meters long and 10 meters wide. Erosion has destroyed the seaward facing portion of the site and thus, we do not know how large it was at the time of settlement and abandonment. The site was excavated in 1 x 1 square meter units. Non-cultural sediments were sifted through 1/4" (6.4 mm) mesh screen and sediments from the cultural strata were passed through 1/16" (1.6 mm) mesh screen. Paleoenvironmental and subsistence data were collected from each strata. Additional samples destined for geological, macro- and micro-botanical, and zooarchaeological analyses were taken, as well.

Two occupations are present at the site. The later component dates to the Spanish Contact Period and is restricted to the upper strata in the northern sector of the site. The early component, which is the concern of this study, is represented by one thermoluminescence date of A.D. 860 (Alpha-2871), and five wood charcoal radiocarbon dates (uncablibrated): 1290 ± 90 B.P. (BETA-26896), 1200 ± 100 B.P. (BETA-26894), 1170 ± 70 B.P. (BETA-55102), 1050 ± 70(BETA-55103, CAMS 3549), 1085 ± 65 B.P. (BETA-26138, ETH-4266). Excavations conducted during 1984-1989 and 1990-1993 have revealed a midden and two activity areas believed to be food preparation areas. The tool kit of a pendant or netsinker maker was found. Beadmaking, pottery manufacture, and the production of microliths also took place (Berman, in press). Five taxa of wood charcoal interpreted to be fuelwood have been identified (Pearsall, 1989; Berman, 1992).

MATERIALS AND METHODS

The faunal remains from five contiguous midden squares were studied. These were recovered in 1/16" (1.6 mm) mesh screen and from *in situ* contexts. Although fauna are present throughout the site, only a sample from the midden was selected for identification. First, the density of bones was greater here than at any other portion of the site. Second, Wing (pers. comm.) has commented that the bones were in poor condition rendering analysis difficult. The bones were best preserved in the midden and offered the analysts better opportunity for identification.

The identification of tooth, bone, and carapace fragments were made by comparison with prepared skeletons of recent animals at the Florida Museum of Natural History of the University of Florida by Dr. Elizabeth Wing. The Minimum Number of Individuals (MNI), a common means of representing archaeological fauna was determined by pairing like elements (White, 1953). Specimens were counted and weighed using a metric scale. The materials from the five squares were considered one sample and the strata within each square lumped. Unfortunately, measures of size, taken from skeletal remains, were not taken. Thus any variation in size which might be attributed to environmental change or predation patterns could not be identified.

RESULTS AND DISCUSSION

The Assemblage

Four hundred and twenty five (425) bones were present in the sample; of these 328 could be identified by family or genus. Fifty seven vertebrate MNI have been counted. Of these 55 were fish, while two were turtle (Table 1). Unfortunately, the specimens are highly fragmentary, rendering identification difficult. Mechanical damage caused by the constant inundation and drying of the sediments, as well as the high saline content have contributed to the attrition. Wing (1993) has noticed that faunal preservation is also bad at the Palmetto Grove, Minnis Ward, and Long Bay Sites which date to later time periods.

The vertebrate assemblage is distinguished by the predominance of fish; 371 bones or 87 per cent of the assemblage were fish, while 54 bones, or 13 per cent of the assemblage could be attributed to marine or freshwater turtle (Table 1). Eleven taxa of fish and a body of unidentified bony fish (Osteichthyes) have been recognized from teeth, scales, otoliths, and various body parts. The taxa include:

TABLE 1: VERTEBRATE ASSEMBLAGE, THREE DOG SITE, SAN SALVADOR, BAHAMAS

SHALLOW REEF:				
Acanthurus sp.	surgeonfish/tang	2	0	2
Halichoeres sp.	wrasse	9	2	5
Scaridae	parrotfish	7	2	0
Scarus sp.	stoplight parrotfish	9	2	2
Sparisoma sp.	parrotfish	214	50	38
DEEP REEF:				
Balistidae	leatherjackets/triggerfish	7	2	1
Caranx sp.	jack	1	0	1
Epinephelus sp.	grouper	6	1	3
Lutjanidae	snappers	2	0	1
Serranidae	sea basses	16	4	1
PELAGIC:				
Sphyraena sp.	barracuda	1	0	1
BEACH:				
Cheloniidae	sea turtle	8	2	1
FRESH WATER:				
Trachemys sp.	pond turtle (possibly introduced)	4	1	1
INDETERMINATE:				
Osteicthyes	indeterminate fish	97	23	0
REEFS OR BEACH:				
Testudines	turtle	42	10	0
TOTAL		425		57

55 MNI = fish
2 MNI = turtle

[1]Wing and Reitz (1982, pp. 13-32), Randall (1983)

surgeonfish/tang (*Acanthurus* sp.), leatherjackets/trigger fish (Balistidae), jack (*Caranx* sp.), grouper (*Epinephelus* sp.), wrasse, (*Halichoeres* sp.), snapper, (Lutjanidae), three taxa of 5-parrotfish (Scaridae, *Scarus* sp., *Sparisoma* sp.), sea bass (Serranidae), and barracuda (*Sphyraena* sp.). Seventy one (71) per cent of the fish are parrotfish. There is a close resemblance between the Three Dog Site vertebrate assemblage and that of other sites excavated on San Salvador. At the Palmetto Grove Site, 96 per cent of the vertebrate assemblage is fish fauna (Wing, 1969; Wing and Reitz, 1982); all vertebrates except for sea turtle are fish at the Minnis Ward Site, and 84 per cent are reef fish (Wing, 1993). Parrotfish predominate at the Long Bay Site (Wing, pers. comm.) and at the Minnis Ward Site (Wing, 1993). At the Palmetto Grove Site, 63 per cent of the fish

remains were parrotfish (Wing, 1969). Wing and Reitz (1982) have interpreted this pattern as an example of extreme barrier reef dependence.

Two different taxa of marine turtle (Cheloniidae and Testudines) have been distinguished. The carapace fragments of a freshwater pond turtle (*Trachemys* sp.) have also been recovered.

Hutia and iguana, other components of the Lucayan diet (Keegan, 1985, 1992a), are not present in the sample.

METHODOLOGICAL CONSIDERATIONS

The presence of animal remains in the archaeological record is influenced by a range of factors related to prehistoric selection, post-depositional processes, and recovery techniques. Fish bones, which constitute the greatest number of specimens and MNI at the Three Dog Site, are particularly vulnerable to the effects of differential preservation.

Preservation

According to Wheeler and Jones (1989), fish bones have less chance of being deposited or surviving if deposited in the archaeological record than bones of other classes of vertebrates, noting that fish bone is more fragile than mammals or birds. Fish bone is also less resistant to mechanical damage than mammal bone. Therefore, if hutia were present in this sample, it most likely would have survived the archaeological record.

Fish bone, otolith, and scale survival is determined by: the nature of the hard tissue material, the treatment of the animal from the time it was procured to the moment it is studied, the physical and chemical composition of the soils in which the bones were deposited, the effects of heating and cooking, chewing and ingestion, scavengers, weathering, and trampling (Colley, 1990; Wheeler and Jones, 1989). Within the bony fishes, there is variability in the number of bones in the skeleton and some species have tougher, more resistant bones. Moreover, the robustness of elements within a single species varies; in many species, dentary elements are more robust than other body parts and thus are more likely to survive the archaeological record. Vertical location within the archaeological context is important, too. Fish bones found deeper in a site have a greater chance of survival than those resting at shallower depths (Wheeler and Jones, 1989), although at the Three Dog Site this seems to be the reverse. Fish remains in the shallower deposits characterizing the midden were larger and less fragmentary than those found elsewhere.This is probably related to the rubbish disposal and site maintenance patterns of the site's occupants. One area identified as an activity area was essentially devoid of organic remains (bones and charcoal), while those present at another activity locus were smaller and fragmentary (Berman, 1992). The effects of trampling and other forms of turbations are also responsible for breakage and differential survival. Highly fragmented bones are typically represented in greater frequencies than unfragmented bones, while bones exhibiting greater robusticity will survive at the expense of fragile bones (Colley, 1990).

Retrieval

Recovery methods play an important role in determining what is present for study and interpretation. Small fish, which can easily pass through standard size mesh, can be retrieved if mesh size is 2 mm or smaller (Colley, 1990). The Long Bay, Minnis Ward and Three Dog Site faunal remains were recovered with 1/16" (1.6mm) screen, while 1/4" (6.4 mm) screen was used at the Palmetto Grove Site (Wing, 1969), MC-6, MC-12, and Pine Cay sites (Keegan, 1992b). Therefore, retrieval of small fish at the Three Dog Site can be assumed. Unstudied fragments from flotation, which uses even finer sized screen mesh, might reveal previously unrecognized species. Wing (1993) has argued for the use of 1/16" and smaller mesh screen to recover more complete faunal assemblages from Bahamian sites.

The location of the sample also influences what is recovered for study. Different animals (as well as varying body parts) may have been deposited at distinct areas of the site. Thus, analysis of other squares in the midden or

fauna from other portions of the site might reveal missing species or body parts.

Quantification

Finally, controversy exists about how to quantify recovered body parts so they best reflect dietary contribution (Grayson, 1984). Various measures such as counts of fragments (NISP), counts of elements (MCE), weights, or MNI have been suggested, and a large literature devoted to the computation of MNI exists. The effects of fish bone decay on the determination of MNI has been discussed (Wheeler and Jones, 1989; Nichol and Wild, 1984), but requires more study. Butchering patterns also affect the determination of MNI. Wing (1993) aims for 200 MNI, but this standard been met only at the Palmetto Grove Site for prehistoric Bahamian sites. No unbiased method of quantifying animals' relative dietary contribution exists (Colley, 1990), however.

HABITAT

Faunal remains inform us on the habitats exploited by prehistoric peoples. This faunal assemblage indicates that bank, reef, pelagic, and beach habitats were used by the occupants of the Three Dog Site to procure their food. Five of the fish species in the assemblage can be found today in shallow reefs, four of the species derive from deep reef habitats, and one from pelagic sources (Table 1). However, there is a certain amount of fluidity in fish movement (Ehrlich, 1975) and fish might have been procured outside of their common habitats. The pelagic-dwelling barracuda, for example, has been observed preying on fish in shallow reef areas. Parrotfish may leave the reefs at night to feed (Wing and Reitz, 1982). Keegan (1985) notes that parrotfish, surgeonfish, grunts, and snappers travel from deep water to shallow feeding grounds at dusk. Jacks frequent both reefs and inshore waters (Wing, 1993). Furthermore, as Wing (1993) has pointed out, the composition of reef fish captured in traps is expected to vary from one catch to the next, as the size of the trap and its placement in the reef changes.

The marine turtle could have been procured in turtle grass feeding grounds or along beach where it comes to lay its eggs (Wing and Reitz, 1982). Age or sex data can be used to determine which habitat was exploited (Wing and Reitz, 1982), but unfortunately, I do not have that data on the Three Dog Site specimens.

Wing (pers. comm.) suggests that *Trachemys* sp. was probably introduced to the island by humans. However, Olson, Pregill, and Hilgartner (1990) found evidence of emydid turtles in fossil deposits on San Salvador. This indicates that they are indigenous to the island. It also suggests that turtle might have been procured from one of San Salvador's inland lakes and raises the possibility that the lakes contained fresh water or possessed a sizeable freshwater lens to support such fauna during the period of aboriginal occupation. This is a highly debated topic among geologists working on San Salvador. Recently, Keegan (1991) reported remains of freshwater turtle from Grand Turk which he attributes to standing fresh water on that island. Alternately, freshwater turtle may also have been brought with colonists from their homeland or obtained via exchange as a means of supplementing their diet. Dye and Steadman (1990) suggest that the Lapita overcame resource uncertainty and fluctuating productivity by importing plants and animals from their homeland.

PROCUREMENT TECHNOLOGY

Fishing technology is determined by fish behavior, morphology (Wing and Reitz, 1982), and environmental features. The types of fish caught and the size of the individuals captured are determined by the types of fishing equipment (Wing and Scudder, 1983). According to Wing and Reitz (1982), hooks would have been used to catch groupers and snappers, both deep reef carnivores. (Omnivores and herbivores would not take to a hook). Harpoons or bow and arrows would have been used to procure large fishes that often swim in shallow water, such as rainbow parrotfish (*Scarus guacamaia*) or congregate in narrow passes such as drums and snooks (Wing and Reitz, 1982). Nets or traps are effective in

capturing omnivorous and herbivorous species, but nets would get caught on coral heads, so they would not have been used where such features were pronounced. Traps would have been used to catch parrotfish and surgeonfish which cannot be speared except when they are present in very shallow reefs (Wing and Reitz, 1982), and nets would have been used to procure mullets, jacks, and snooks (Wing and Reitz, 1982). Once fish are taken in traps, they attract predators or fish of the same species (Keegan, 1985). The barracuda, might therefore, have been taken in the trap or through other means, while traps were being emptied. Wing and Reitz (1982) have suggested that conformity in body size suggests the use of standard size nets.

Evidence for these forms of fishing technology has not been recovered from the site, although it is possible that the drilled pieces referred to earlier as pendants could have been netsinkers. A fishhook has been recovered from the Gordon Hill Site on Crooked Island (Granberry, 1978).

Spears or nets would have been used to capture turtles (Wing and Reitz, 1982). On the beaches, turtles, particularly nesting females, would have been easy prey.

BUTCHERING AND FOOD PREPARATION

One of the major questions facing the archaeologist is whether the recovered animal parts represent butchering and food preparation practices, differential preservation due to varying bone density, sample size, or discard practices. Zooarchaeologists are well aware of the relationship of bone survivability and bone density within and between taxa (Grayson, 1984). Thus, it is hard to differentiate whether the presence of bones related to the mouth and dentition and the absence of vertebrate for a particular taxon in the midden is due to how the animal was butchered (i.e. heads cut off) or the fact that the head bones from this particular taxon survive the archaeological record better than the post-cranial elements. The presence of the head bones also might indicate cooking practices and dietary choices. Alternately, the whole fish might have been discarded, after it was cooked, but only the head bones and dentition survived. Finally, enlarging the sample size and increasing it to include additional squares might reveal missing body parts or parts represented in small frequencies. An examination of the elements from the Three Dog Site fish assemblage indicates there is a proclivity for cranial, particularly mouth bones and bones associated with dentition to be present in greater numbers than post-cranial body parts. Of the 371 fish bones, over 80 per cent can be attributed to the head bones, mouth, or dentition. In the next section I will discuss the possible reasons for such a pattern.

Post-cranial elements were found in four taxa of fish and among the Cheloniidae (sea turtle). Carapace remains have been identified from the *Trachemys* sp. This suggests these two taxa of turtles were dismembered and cooked on-site. The surgeonfish/tangs (*Acanthurus* sp.) are lacking heads. Only the spine fragments are present. Wheeler and Jones (1989) note that this genus exhibits characteristic jaw teeth and sharp spines in the sides of the caudal peduncle. Perhaps the heads and tails of this fish was cut off elsewhere due to these distinctive traits.

Of the seven bones attributed to Scaridae, two were post-cranial and included the atlas (first cervical vertebrate) and the hypural large plate. Because of the distinctive dentition of members of this family, identification of two genera of this family could be made. Of the numerous bones recovered from *Sparisoma* sp., a urostyle and the left scapula were found. The remainder were mouth bones and those related to dentition.

Of the five bones recovered from Balistadae, (leatherjackets/triggerfish) only one was the dentary; the remainder were dorsal spine bones and the pterygial carine. The family is characterized by strong first dorsal fin spines, strong 'rat-like' teeth, and large flattened pelvic fins support (Wheeler and Jones, 1989). The specialized spines are often the criteria upon which taxon identification can be made (Wheeler and Jones, 1989). The first dorsal spine and the strongly modified fused basipterygia of triggerfishes survive the archaeological record (Wheeler and Jones, 1989).

Dentition and mouth parts have been recorded for the other species such as *Caranx* sp. (jack), *Epinephelus* sp. (grouper), *Halichoeres* sp. (wrasse), Lutjanidae (snapper), Serranidae (sea bass), and the parrotfish, *Scarus* sp. Several of these species have distinctive dentition which make them easy to identify and recover and able to survive the archaeological record, or both. For example, Wheeler and Jones (1989) note that Lutjanidae (snappers) have strong teeth. Colley (1990) notes that the pharyngeal plates of wrasses survive extremely well.

Of the bones identified by element, only 24 per cent are from the spinal area. This is somewhat confounding since vertebrae are present in large numbers in each fish skeleton (although the number varies). According to Colley (1990) vertebrae are relatively robust and usually survive well in the soil. Wing (1993) has noted, however, that they are "notoriously difficult" to identify by species.

The attribution of varying butchering practices to this pattern of fauna is complicated by the factors mentioned above: differential element survival, small sample size, location of the sample, and discard practices. It is possible that the examination of additional squares in the midden might reveal greater numbers of vertebrae and what is observed in this sample represents one stage in a discard process. A possible butchering and discard model is proposed for future analysis. First, fish heads and tails were cut off and discarded. The trunk of the fish (with vertebrae) was then cooked and eaten. The fish vertebrae were then discarded and deposited during another depositional episode. Such remains may be present in another part of the midden which has not been examined for faunal contents. Alternately, the squares containing a high density of vertebrae were not excavated.

We do not know what implements were used to remove scales, gut, or fillet the fish. However, a bipolar produced assemblage of chert microliths believed to have been used for a variety of purposes, including fish processing, has been recovered from the site (Berman, in press). Flenniken (1981) studied a similarly produced assemblage on the Northwest Coast; his work suggests that fish butchering was one of the tasks to which such artifacts were put (Flenniken, 1981).

CONCLUSION

Wing and Reitz (1982) noted a pan-Caribbean pattern in which people exploited marine habitats closest to their habitation sites. The vertebrate assemblage from the Three Dog Site conforms to this trend. A relative specialization upon a narrow range of vertebrate fauna found in nearby reefs can also be found at the Palmetto Grove, Minnis Ward (Wing, 1993) and Long Bay Sites (Wing, pers. comm.). Although separated by several hundred years, the prehistoric inhabitants of San Salvador exhibited a pattern of vertebrate exploitation consistent throughout the occupational sequence, leading one to speculate that environmental factors, technology, and organization of production remained constant over this period. Environmental change or overpredation, which can be recognized through the examination of size and other measures, will be treated in a future study. Finally, examination of the body parts present in the assemblage were inconclusive indicators of butchering practices. A model of butchering and discarding fish may be found to exist with expanded examination of the faunal remains.

ACKNOWLEDGMENTS

I thank Donald and Mrs. Kathy Gerace for their support of the excavation of the Three Dog Site. Dr. Gerace was the Executive Director of the Bahamian Field Station, San Salvador, Bahamas, under whose auspices the research was conducted. As director of the Three Dog Site excavation, Perry L. Gnivecki, Ph.D. has contributed to the research represented here in ways too numerous to mention. Donna Bargoil, Michelle Elmore, and Heather Forbis are thanked for their help in preparing tables and conducting library research. Mrs. Chris Maletta, Department of Anthropology and Mrs. Myrna Mackin, Museum of Anthropology helped in the production of the manuscript. Dr. Gail Saunders, Director of Archives, and Mr. Tony

Aarons have consistently supported the excavation of the Three Dog Site since its inception in 1984.

The faunal assemblage was analyzed by Dr. Elizabeth S. Wing, Curator of Zooarchaeology, Florida Museum of Natural History, University of Florida, Gainesville, Florida, with support of N.S.F. Grant BNS-8903377.

Funds for the analysis of the plant remains were supported by a Hartwick College Board of Trustees Research Grant in 1986. Funds for radiocarbon and thermoluminescence dating were supported by a Hartwick College Board of Trustees Research Grant in 1985 and a Wake Forest University Research and Creative Activities Council Grant in 1990. Funds for other aspects of the study were supported by a Hartwick College Board of Trustees Research Grant in 1984, a National Endowment for the Humanities (NEH) Institute for College and University Professors award in 1989, a 1991 NEH Travel Grant in 1991, and a NEH/Newberry Library Workshop award in 1991.

REFERENCES CITED

Berman, Mary Jane. 1992. Fuel wood selection and the Lucayan-Taino landscape. Pp. 1-10 in W. Hardy Eshbaugh, ed. Proceedings of the Fourth Symposium on the Natural History of the Bahamas Conference. Bahamian Field Station, San Salvador.

____. In press. A chert microlithic assemblage from an early Lucayan site on San Salvador, Bahamas. In Miguel Rodriguez, ed. Proceedings of the XVth Congress for Caribbean Archaeology. San Juan, Puerto Rico.

Berman, Mary Jane and Perry L. Gnivecki. 1990. Research design: Three Dog Site (SS21), San Salvador Island, Commonwealth of the Bahamas. Lucayan Ecological Archaeology Project, Research Report Number 1. Department of Anthropology, Wake Forest University, Winston-Salem, North Carolina.

____. 1993a. Research design for the 1993 field season: Three Dog Site (SS21), San Salvador Island, Commonwealth of the Bahamas. Lucayan Ecological Archaeology Project, Research Report Number 4. Department of Anthropology,Wake Forest University, Winston-Salem, North Carolina.

____. 1993b. The colonization of the Bahamas Archipelago: a view from the Three Dog Site, San Salvador, Bahamas. Pp. 170-186 in Allisandra Cummins, ed. Proceedings of the XIVth International Congress for Caribbean Archaeology. Barbados.

Colley, Sarah M. 1990. The analysis and interpretation of archaeological fish remains. Pp. 207-253 in Michael B. Schiffer, ed. Archaeological Method and Theory, Volume 2. University of Arizona Press, Tucson.

Dye, Tom, and David W. Steadman. 1990. Polynesian ancestors and their animal world. American Scientist 78: 207-215.

Ehrlich, Paul R. 1975. The population biology of coral reef fishes. Annual Review of Ecology and Systematics 6: 211-247.

Flenniken, Jeffrey J. 1981. Replicative systems analysis: a model applied to the vein quartz artifacts from the Hoko River Site. Washington State University Laboratory of Anthropology Reports on Investigations, Number 59. Hoko River Archaeological Project Contribution, Number 2. Washington State University, Pullman.

Granberry, Julian. 1978. The Gordon Hill Site, Crooked Island, Bahamas. Journal of the Virgin Islands Archaeological Society 6: 32-44.

Grayson, Donald. 1984. Quantitative Zooarchaeology. Academic Press, Orlando, Florida.

Keegan, William F. 1985. Dynamic

Horticulturalists: Population Expansion in the Prehistoric Bahamas. Ph.D. Dissertation, Department of Anthropology, University of California, Los Angeles. University Microfilms International, Ann Arbor.

_____. 1991. Personal communication to the author. Telephone converstion.

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

_____. 1992b. Personal communication to the author. Telephone conversation.

Nichol, R.K. and C.J. Wild. 1984. "Numbers of individuals" in faunal analysis: the decay of fish bone in archaeological sites. Journal of Archaeological Science 11: 35-51.

Olson, Storrs L., Gregory K. Pregill, and William B. Hilgartner. 1990. Studies on Fossil and Extant Vertebrates from San Salvador (Watling's) Island, Bahamas. Smithsonian Contributions to Zoology, Number 508. Smithsonian Institution Press, Washington, D.C.

Pearsall, Deborah. 1989. Final report on analysis of macroremains and phytoliths from the Three Dog Site, San Salvador, Bahamas. Department of Anthropology, University of Missouri-Columbia.

Randall, John E. 1983. Caribbean Reef Fishes. T.F.H. Publications Inc., Neptune City, New Jersey.

Rose, Richard. 1987. Lucayan lifeways at the time of Columbus. Pp. 321-340 in Donald T. Gerace, compiler. Columbus and His World: Proceedings of the First San Salvador Conference. CCFL Bahamian Field Station, Ft. Lauderale, Florida.

Wheeler, Alwyne, and Andrew K.G. Jones. 1989. Fishes. Cambridge University Press, Cambridge.

White, Theodore. 1953. A method of calculating the dietary percentage of various food animals utilized by aboriginal peoples. American Antiquity 18(4): 396-398.

Wing, Elizabeth S. 1969. Vertebrate remains excavated from San Salvador Caribbean Journal of Science 9(102): 25-29.

_____. Personal communication. Letter dated January 30, 1991, to the author.

_____. 1993. Faunal remains from the Minnis Ward Site, San Salvador, Bahamas. Manuscripts in possession of author.

Wing, Elizabeth S., and Elizabeth J. Reitz. 1982. Prehistoric fishing economies of the Caribbean. Journal of New World Archaeology 5(2): 13-32.

Wing, Elizabeth S. and Sylvia Scudder . 1983. Animal exploitation by prehistoric people living on a tropical marine edge. Pp. 197-210 in Caroline Grigson and Juliet Clutton-Brock, eds. Animals and Archaeology: Shell Middens, Fishes, and Birds. BAR International Series, Number 183.